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COMMUNITY NOISE ASSESSMENT MANUAL

COMPUTER PROGRAMS FOR THE STRATEGY GUIDELINES FOR DEVELOPING A COMMUNITY NOISE CONTROL PROGRAM

July 1981

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Noise Abatement and Control
Washington, D.C. 20460

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16. ABSTRACT

This report was prepared by EPA, Office of Noise Abatement and Control, in support of its function to provide technical assistance to communities. It is one of nine which comprises the Community Noise Assessment Manual. The Manual provides a comprehensive and computerized system for assessing the noise problems of a community and then planning a noise control strategy for its abatement. This report provides a copy of the computer programs required for running the "Strategy Guidelines for Developing a Community Noise Control Program." The programs have been written for a UNIVAC 1108. The source language used is FORTRAN IV. A listing of the source programs are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

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FOREWORD

This report was prepared for the Motor Vehicle Manufacturers Association of the United States under Agreement Number WYL 7704-C2.1 entitled 'Community Noise Countermeasures Cost Effectiveness Computer Program (NOIZOP) and Documentation', effective September 20, 1976.

The original version of NOIZOP was written by Charles Coughlin in 1974, and implemented on an IBM 370 operated by Tymshare, Inc. The version of NOIZOP described in this manual represents a significant improvement over the original version and was developed by the author of this manual in 1976 on a Univac 1108 operated by University Computing Company. For reference purposes, the version of NOIZOP described herein will be referred to as version 2.1. The source language (FORTRAN IV) used conforms to ANSI standards to facilitate possible transfer of NOIZOP to other computers.

This document consists of three volumes. Volume I is the User's Guide. Volume II contains Appendix A, the listing of the source programs. Volume III contains Appendices B and C. Appendix B discusses the theory behind program generation as well as the general command and data flow. Appendix C gives an explanation of the program variables contained in COMMON blocks (storage areas jointly used by several subroutines).

The concepts according to which NOIZOP operates were developed in a study for the Motor Vehicle Manufacturers Association of the United States documented in Wyle Research Report WCR 75-2, by Rackl, R., Sutherland, L., Swing, J., entitled COMMUNITY NOISE COUNTERMEASURES COST-EFFECTIVENESS ANALYSIS, and dated July 1975. That study was performed on the city of Spokane, Washington, as a typical community, using the original NOIZOP version. Since then, many significant improvements to concepts as well as to NOIZOP have been made. At the time of this writing, it was contemplated to reexamine the Spokane study in the light of these improvements.

Chapter 1 of this volume provides a general overview and introduction, briefly examining the program's purpose, capabilities, and limitations. This should provide a potential user enough information to decide whether NOIZOP can suit his application.

All subsequent chapters are intended for the actual user, supplying all information necessary to utilize NOIZOP to the fullest of its capabilities. Chapter 3 is a reference for debugging input data errors. The examples of Chapter 5 present actual applications to clarify the text of the previous chapters. The user may find it helpful to refer to these examples as he is reading through the text.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Approximate Page Number

LIST OF FIGURES

CHAPTER 1

INTRODUCTION AND BASIC CONCEPTS

1.1 Background

Historically, the need for this computer program (NOISEP) arose when a study was begun that had as its ultimate goal the development of a tool for rational and objective decision making in policy and regulatory activity concerning environmental acoustic noise from all sources. Simply stated, the problem was to distribute a given hypothetical sum of money in such a way as to obtain the greatest possible benefit in terms of reduction of the number of people adversely affected by environmental noise. This is a problem of operations research, and it was quickly recognized that an involved computer program would be required to properly handle the task. The inherent non-linearity of the mathematics describing the problem prevented the use of well developed methods of linear algebra. A step-by-step gradient method was developed and implemented for finding the most cost-effective way of distributing the given sum of money.

For purposes of a mathematical formulation of the problem, a quantity was defined that rates the quality of the environmental noise climate of a community. This quantity is called the Noise Impact Index, abbreviated to NII:

$$\text{NII} = \frac{\text{NUMBER OF PEOPLE ADVERSELY AFFECTED BY NOISE}}{\text{TOTAL NUMBER OF PEOPLE}}$$

Clearly, the NII may vary between zero and one. The noise climate quality improves with declining NII. In operations research language, the NII is the objective function (i.e., it is the single function to be minimized by the judicious distribution of the given sum of money).

In order to evaluate changes in the NII, the concept of the 'countermeasure' was created. Countermeasures relate expenditures of money to specific effects of removing people from the list of those adversely affected by noise. Examples of countermeasures are:

- Reducing the noise level emitted by trucks,
- Changing the flight path of commercial jet aircraft,
- Moving people to quieter areas.

The community is specified to NOIZOP as a collection of cells grouped into zones. A cell usually comprises several city blocks and has a population which is exposed to the noise from all sources.

The basic task performed by NOIZOP is, for a specified distribution of expenditures, to apply the countermeasures at each cell, noting the number of people no longer adversely affected by noise, and computing a new (reduced) NII. This task is performed a large number of times during any one execution of NOIZOP as it searches for the distribution of expenditures which gives the greatest NII reduction for a given budget.

1.2 Basic Concepts and Program Limitations

The concept of the 'countermeasure' was intoduced above. The concept of the 'cell' was created in order to organize the community under analysis into manageable portions. Cells are grouped into zones. A cell is assumed to be acoustically homogeneous, i.e., it is reasonable to lump all of its population into a central point of the cell; it is at that point that the noise levels from all sources (traffic, aircraft, etc.) are evaluated (for more details and justification of the concepts refer to the Spokane study mentioned in the preface). As far as the computer program is concerned, a cell exists simply by having been given an identification number. It is important to note that the program does not know a cell's geographical location, nor its location relative to other cells. This means that the program does not perform calculations which depend on geographical location, or on the separation of the receiver from a noise source. Such calculations (e.g., propagation losses) must be carried out beforehand during the stage of input data preparation for NOIZOP which then provides a sophisticated bookkeeping system for noise countermeasures, and cost-effectiveness optimization algorithms. Nor is the program concerned with the physical nature of the noise sources. The existence of a noise source is made known to the program by giving it a name and a sequence number, and by

INTRODUCTION

specifying as input data the noise level the source generates at each cell. The program is therefore not concerned with such things as traffic density and speed, aircraft altitude, thickness of a building wall, etc.. Of course, the person preparing the input data will deeply concern himself with these items, and possibly use other computer models (such as traffic noise models) for calculating noise levels, transmission losses, and cost data, etc.

Up to two cells may be specified at one cell 'location': day cells are different from night cells in that they contain different populations, are exposed to different noise levels, and exhibit different sensitivity of people to noise. If two cells are specified at one cell location, two cells must be counted when adding up the total number of cells.

NOIZOP Version 2.1 is designed to accept up to a total of 200 cells. This may not be sufficient if a good size community is to be fully analyzed. However, a method of judiciously (not randomly) selecting a representative cell sample has been developed and is documented elsewhere (*). Use of this deterministic sampling method will rarely necessitate the use of more than 100 cells for one community. The program can be modified to accept more cells. Depending on the computer configuration, this may necessitate the use of 'large core' options, or of peripheral devices for intermediate data storage, such as is available with 'virtual core' systems.

See Wyle. Obtain copy of sampling method for selecting representative cell sample(s).

NOIZOP can also be used for evaluating the relative merits of strategies in noise regulation for future time periods. A data factoring facility is available which allows making selective and overall adjustments to the input data in order to model a time period different from that for which the input data was generated.

NOIZOP uses the energy summation principle throughout for adding and subtracting noise levels; two levels, L1 and L2, are added according to:

L = 10*LOG(10**(L1/10) + 10**(L2/10))

where the '*' signifies multiplication and the '**' signifies exponentiation. In the cell-by-cell input data, all noise levels

----

(*) As yet unpublished work by Wyle Research. — Must obtain information should be specified in terms of energy equivalent levels (Leq), separately for day and night.

When the number of people adversely affected by noise at a cell is calculated, the above noise level summation is carried out for all noise sources. The resulting noise level is used to enter a 'transfer function' which relates the noise level to the fraction of people expected to suffer an adverse affect due to noise.

NOIZOP will issue an error message and not execute when one of the following conditions exist (this is not an exhaustive list):

** More than 200 cells,

** More than 20 stationary sources,

** More than 20 types of noise sources (other than stationary),

** More than 20 countermeasures,

** More than 100 sound barriers.

Most of the above restrictions are due to memory limitations imposed by storage assignment values. Moderate expansion of the above restrictions may involve some minor modifications to basic program functions.

The next section in this chapter defines several terms and concepts more rigorously. The last section of this chapter presents a simplified flow diagram of NOIZOP.

1.3 Definitions

Throughout this manual, there are references to terms and concepts which may be better understood with the establishment of the following definitions.

** A countermeasure is an action or a series of coordinated actions leading to a reduction of the degree of noise exposure of people.

** An expenditure is the commitment of funds required to implement a countermeasure.

** Cost functions define the effectiveness of each countermeasure in utilizing expenditures for reducing the degree of noise exposure of people.

** Baseline refers to the condition when no countermeasures have been applied.

** Present year refers to a point in time for which the raw input data applies. Target year refers to a later point in time and a condition of the input data as modified by the data factoring facility in NOIZOP (see Section 2.8). The final analysis (expenditure allocation optimization) is carried out for the target year.

** An indicator is an auxiliary data item used in conjunction with countermeasures. It may have various functions depending on the countermeasure type. Many indicators must be calculated by the user and specified in the input data.

1.4 N0IZ0P Flow Diagram

Figure 1-1 shows a simplified flow diagram of N0IZ0P. The control module accepts commands from the input stream and reacts in basically three ways:

** Read more input data.

** Perform calculations on the side.

** Evaluate the NII and modify expenditures until the budget is exhausted; at which time (due to the process described in Section 2.11) the minimum NII for the given budget and the associated most cost-effective expenditure distribution over the defined countermeasures has been found.

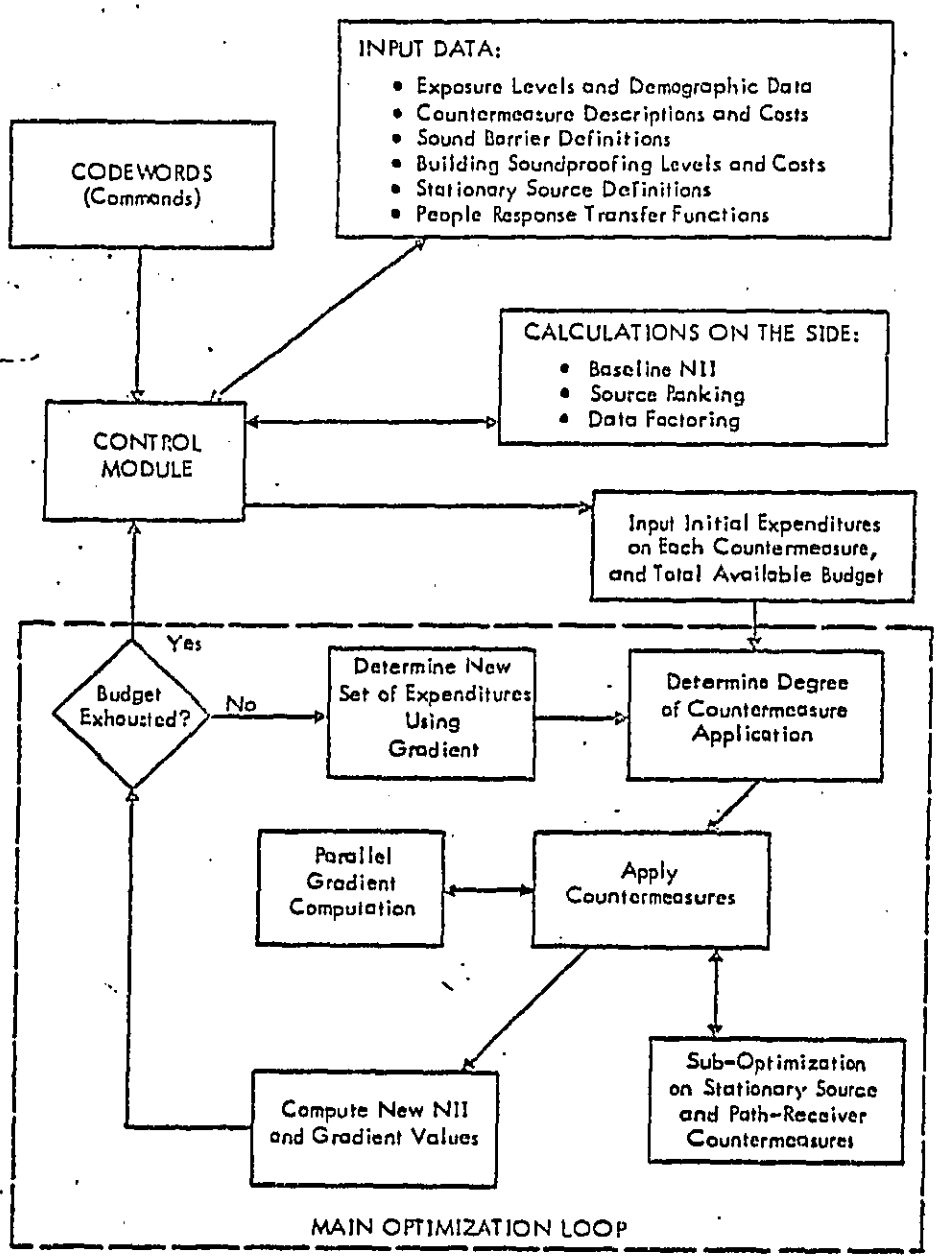

Figure 1-1. NOIZOP General Flow Diagram

CHAPTER 2

INPUT DECK STRUCTURE

Program operation is controlled by codewords which initiate program functions. The input deck consists of a number of sections which are identified by the codeword on the first card of each section. Each section causes execution of a certain program function module.

Each codeword consists of a pre-defined string of two, three, or four alphabetic characters descriptive of the function. Table 2-1 is a listing of these pre-defined codewords (in alphabetical order) recognized by the program.

These codewords occupy the first four columns of the codeword card and must be left justified in the field. A codeword initiated program function may have up to two associated option parameters. These two option parameters are input as integers and must be right-justified in each of two fields on the codeword card, columns 5 and 6, and columns 7 and 8. A blank field initiates the default handling of that option. A specific description of these option parameters will be included in each section describing the associated codeword.

Following the option parameters, starting in column 9 of the codeword card, the user may insert any title pertinent to the user's application for that codeword. This title may be up to 40 characters long and will appear on the printed ouput.

The user may note the prolific use of title cards in this program. It is suggested that the user make full use of titles; reasons for certain actions and references for data identification tend to be items of information that become very valuable when later referring to your work.

The following sections in this manual will describe in detail the sub-structure of each of the program modules in the approximate order in which they would appear in the input deck.

Table 2-1
Codewords Recognized by NOIZOP

CODEWORD	BASIC FUNCTION
BAR	Input of Barrier Definitions.
BASE	Compute Noise Impact Index for Baseline Case.
CM	Definition of Countermeasures.
COST	Definition of Cost Functions.
CRIT	Transfer Function Modifications.
DTA	Input of Cell Data Set.
END	Termination of Job.
FAC	Data Factoring.
OPT	Initiate Optimization Process.
PARE	Input of Soundproofing Data.
RANK	Compute a Ranking of the Noise Sources by Adverse Effect.
STAS	Input of Stationary Source Data.

Immediately preceding the collection of codeword sections (see Figure 2-1) in the input deck there must appear three cards.

Card 1 contains the necessary information regarding an optional auxiliary or secondary print file to be sent to a teletypewriter type terminal. This file will contain a short-form of the program output which will give the user, who does not have immediate access to a line printer, the essential results of the program as well as any error

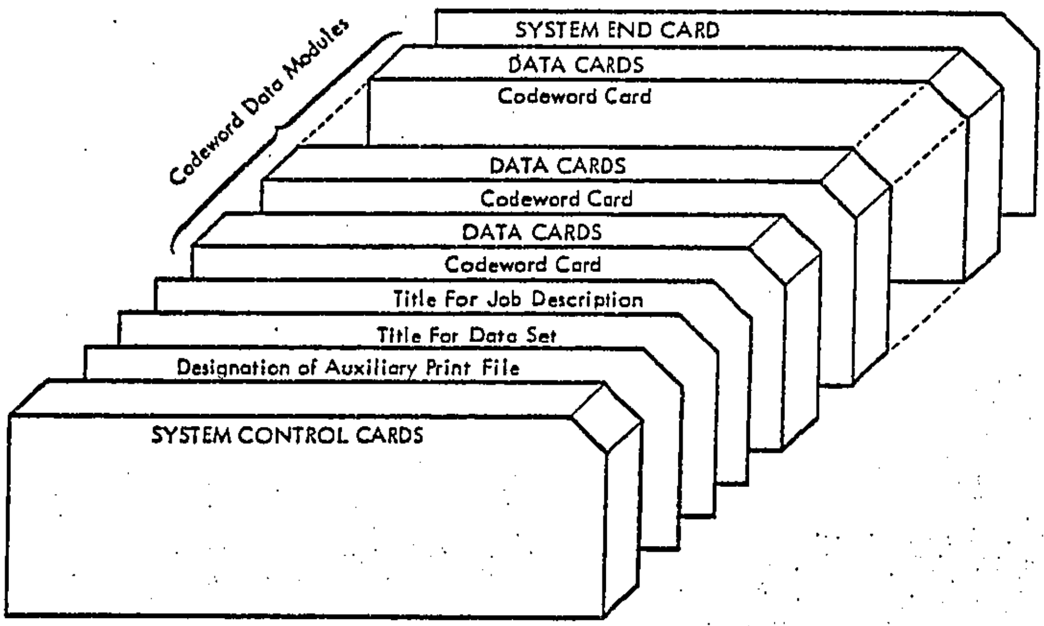

Figure 2-1. Input Deck Structure (see Section 4.1 for a detailed description of the control cards needed to execute the program on the University Computing Company UNIVAC 1108).

messages that may have resulted from improper input data. An example of this short-form output is presented in section 2.11.3.

This auxiliary file will be created if the user places a 'T' in column 1 of the first card. An 'F' or a blank in column 1 will suppress the creation of the auxiliary print file. If the auxiliary file is desired, the user must also input the Fortran logical unit number of the device to which this secondary print file will be output in column 4 of this card. Note that this unit number must also appear in an 'FCL' command before NOIZOP is executed (see SYSTEM CONTROL CARDS, section 4.1).

<u>Card</u> 2 is a title card describing the cell data set for the current job. All 80 columns may be used.

<u>Card</u> 3 is another title card which is used as a description for the job. This description can be useful when referring to a particular run. All 80 columns may be used. This title will also appear in the optional short-form output. however, in the shortened form the first 40 columns will be printed on one line and the second 40 columns on a second line. Hence, a word may appear broken in the short form output.

DATA INPUT

At each cell location, the user may specify levels from up to two stationary sources. The user might specify source titles such as 'STATIONARY SOURCE NO. 1' and 'STATIONARY SOURCE NO. 2'. These are source titles which are used to describe data fields in the master data set and are not related to the numbers (up to 20) assigned to the individual stationary sources in the community. The program is informed as to which actual stationary sources affect a particular cell by the use of countermeasure manipulation indicators (see Section 2.2, countermeasure definition, CM).

Following the source title cards, the user must place the array of elements (ones or zeroes) for source contribution for baseline case index evaluation. This array consists of 20 integers, one for each source, Format 20I2. A zero in the i-th field indicates that the i-th source is not to be considered in the computation of the baseline index. The user will normally define a source that should not be considered when a type 1 countermeasure is defined for that source (see section 2.2, countermeasure definition, CM). A source not to be considered will usually refer to alternate levels from another defined source. An example of such a source may be rerouted aircraft. In the baseline condition no aircraft are rerouted and, therefore, there should be no contribution from the rerouted source.

The remainder of the data cards following contain the necessary data specific to each defined cell. Up to five cards per cell may be needed to enter all the data.

```
Field:   1   2   b  3    4        5        6        7        8
        |---|---|---|-|--------|--------|--------|--------|--------|
Column:  1   4      1 1        1        2        3        3
                    0 1        8        5        2        9
```

Card 1 (see above diagram; 'b' indicates a blank field) contains various parameters necessary for cell definition.

Field 1 - the zone number for the cell, I format.

Field 2 - the number of the cell within the zone, I format. A cell number greater than 100 implies the cell is defined during the nighttime period. As such, there is a maximum of 99 cell locations per zone. A day is generally acknowledged to be defined from 7 a.m. to 10 p.m., and a night from 12 p.m. to 7 a.m. and 10 p.m. to 12 p.m. Therefore, the program assumes that the day is 15 hours long, and the night is 9 hours long. To define a cell over 24 hours, two cells must be defined, one for the day, and one for the night. The night cell number will be the day cell number plus 100.

Field 3 - must contain a '1' signifying card type 1.

Field 4 - the population of the cell during the specified time period, F format. If a person is present in the cell during both day and nighttime, then he should be counted twice, once in the population of the day cell, and once in the population of the night cell. The program will weight the input population figures for the time over which the cell is defined.

Field 5 - contains the cost to relocate all people in the cell in thousands of dollars, F format. (Relocation costs usually consist of property values plus moving expenses). Specifying a cost greater than 999 million dollars is equivalent to inhibiting consideration of people relocation in this cell (see sections 2.2 and 2.5, Path-Receiver Countermeasures).

Field 6 - the total floor area within the cell in thousands of square feet, F format. This value is used in the computation of soundproofing costs for this cell (see sections 2.2 and 2.5, Path-Receiver Countermeasures).

Field 7 - specifies the lower criterion level for this cell, either I or F format is acceptable. The value specified must be an integer, that is, it must not have a fractional part. The lower criterion level is the decibel level at which zero percent of the people will be adversely affected by noise. These levels are usually a function of the land use type. Table 2-2 contains suggested values for lower criterion levels. That section also provides a facility for entering the lower criterion levels on the basis of land use. If that facility is used, field 7 can be left blank.

Field 8 - contains the land use code for the cell, either I or F format is acceptable. The land use code is an integer value ranging from 1 to a maximum of 15. Table 2-2 contains suggested uses of land use codes.

Table 2-2
Suggested Usage of Land Use Codes

Land Use Code	Suggested Usage	Suggested Lower Criterion Levels (0 per-cent adverse response, dB)	
		DAY	NIGHT
1	Single and Two-family Residential	54	46
2	Open for Additional Residential Use	54	46
3	Single, Two, and Multifamily Residential	54	46
4	Multifamily Residential	59	46
5	Business and Commercial	59	59
6	Wholesale and Warehousing	59	59
7	Central Business District	59	59
8	Industrial	70	70
9	Public and Semi-public Areas		
10	Parks	55	—
11	Schools	55	—
12	Hospitals and Nursing Homes	50	50
13	Open		
14	Open		
15	Open		

BEST COPY AVAILABLE

```
Field:    1   2     3  4       5       6       7       8
         |---|---|---|-|-------|-------|-------|-------|
Column:   1   4     1 1     1       2       3       3
                    0 1     8       5       2       9

                          9       10      11      12      13
     (cont.)           |-------|-------|-------|-------|-------|
                        4       5       6       6       7
                        6       3       0       7       4
```

Card 2 (see diagram above which is also applicable to cards 3, 4, and 5) contains the decibel levels for noise sources 1-10.

Fields 1-2 - are the same as for card type 1

Field 3 - contains a '2' for card type 2.

Fields 4-13 - are the source levels for noise sources, 1-10 respectively, F format.

Card 3 contains the decibel levels for noise sources 11-20.

Fields 1-2 - are the same as for card type 1.

Field 3 - contains a '3' for card type 3.

Fields 4-13 - are the source levels for noise sources 11-20, respectively, F format.

Card 4 contains countermeasure manipulation indicators 1-10.

Fields 1-2 - are the same as for card type 1.

Field 3 - contains a '4' for card type 4.

Fields 4-13 - are countermeasure indicators 1-10, respectively, F format. Although the input is in F format, indicators are always integer values. The user can ignore the format by right-adjusting the number in the field. The user should also note that any indicators which are equivalent for both the day and the night cell must be entered in the appropriate field for both cells. Note that if indicator values are the same over all cells, they may be input using the 'IND' feature described below. In this case, the appropriate field may be left blank.

Card 5 contains countermeasure manipulation indicators 11-20.

Fields 1-2 - are the same as for card type 1.

Field 3 - contains a '5' for card type 5.

Fields 4-13 - are countermeasure indicators 11-20, respectively, F format.

A blank card must follow the last cell data card. The program has room for up to 200 cells, counting day cells and night cells as separate cells.

There is an important restriction placed on the order in which the cell data cards must be placed. The cells must be input in order of ascending zone numbers. In addition, within a zone the cells must be placed in order of ascending cell number. One zone can contain from 1 to 99 cell locations. There is no restriction to the total number of zones as long as the maximum number of cells does not exceed 200. The usefulness of grouping cells into zones becomes apparent when studying the section on data factoring of this manual. When a large community is analyzed, cells will be naturally grouped into zones by their geographical proximity. Those cells designated as nighttime cells, numbers greater than 100, should not be treated as having large cell numbers for the purpose of numerically arranging cells within a zone. In fact, the '1' in the 1xx is stripped away and used separately. As such, for cell ordering within a zone, the night version of a cell must be placed immediately following the associated day version.

Card type 1 must precede cards type 2-5 within a cell, however, there is no restriction on the order of cards type 2-5 following card 1. There is no necessity to include cards type 2,3,4, and 5 if they are not all needed. For example, if there are only 8 defined sources and 3 indicators, then cards type 3 and 5 would be omitted. The program will not allow the user, however, to omit card type 1.

Following the blank card which terminates the cell data cards, the user may place a card with the letters 'IND' in columns 1-3. Following this card the user may input countermeasure indicators which are constant (have the same numerical value) for all cells. This feature relieves the user of the tedious chore of entering the same number in the appropriate field for every cell. Since 'IND' is an option apart from the main program, the user must indicate beforehand that the option will be employed. This is done by placing a non-zero integer in the option parameter field indicated by 'J' on the DTA codeword card. Following the 'IND' card, if that option has been implemented, the user places cards containing the constant indicator values. As many cards as necessary can be input, one card per indicator. A blank card signals an end to the constant indicator cards and returns control back to the main program. The constant indicator cards have the following format:

```
Field:     1        2
         |----|-|----------|
Column:  1      6
```

Field 1 - indicator number, I format.

Field 2 - actual indicator value, I format.

Figure 2-2 illustrates a sample output resulting from cell data input. This output was the result of card input lines 4 through 218 in Figure 5-3. Figure 2-3 indicates the format of the 'echo input' feature (initiated with a non-zero integer in the 'I' option parameter field). This output reflects the constant indicators which are input in lines 219 through 226 of Figure 5-3. The first line of each data set at the right hand side of the page is the levels from noise sources 1 through 10, line number 2 is for noise sources 11 through 20. Line number 3 is for indicators 1 through 10, line number 4 is for indicators 11 through 20. This feature is also an option of the data factoring facility (see section 2.8, data factoring, FAC). Also note that indicator numbers 19 and 20 may be reserved for special use (see section on barrier definition, BAR).

```
*********
DTA   1 1        MASTER DATA FOR SA II, LOW RELOC. COSTS
*********

          SOURCES                                    INDICATORS
          -----                                      --------

 1 AUTOMOBILES LOW   SPEED LINE SRC    1 NEW AUTOS LO SP+LOC.TRAFF.SRC.RED.,CM =1
 2 AUTOMOBILES HIGH SPEED LINE SRC     2 EXIST.AUTOS LO SP+LOC.TRAFF.SC.RED,CM =3
 3 AUTOMOBILES LOCAL TRAFFIC SOURCE    3 TRUCKS LO SP NEW VEH SOURCE RED., CM =4.
 4 TRUCKS      LOW   SPEED LINE SRC.   4 TRUCKS LO SP ENFORC.+RETROF.SC.RED,CM =5
 5 TRUCKS      HIGH SPEED LINE SRC.    5 TRUCK TIRES SOURCE RED., CM = 6
 6 MOTORCYCLES LOW   SPEED LINE SRC.   6 AIRCRAFT SAM TREATMENT, CM = 9
 7 MOTORCYCLES LOCAL TRAFFIC SOURCE    7 RAILROAD LOCO SOURCE RED, CM = 12
 8 BUSES       LOW   SPEED LINE SRC.
 9 RAILROAD    LOCOMOTIVES, LINE S.
10 RAILROAD    CARS, LINE SOURCE
11 AIRCRAFT    COMMERCIAL, FLIGHT

SOURCE CONTRIBUTION ELEMENTS FOR BASELINE INDEX:

 1 1 1 1 1 1 1 1 1 1 1-0-0-0-0-0-0-0-0-0

DATA ENTERED FOR  78 CELLS
```

Figure 2-2.   Output Resulting From Cell Data Input.

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
15	3	116.9	5056.	201.	57	1	48.5	.0	49.2	48.0	.0	52.7	61.4	38.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	103	134.6	5056.	201.	49	1	42.5	.0	42.8	42.0	.0	46.7	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
16	1	75.1	2661.	94.	62	4	.0	.0	49.2	.0	.0	.0	61.4	.0	71.8	62.4
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	10100	10100
16	101	71.6	2661.	94.	49	4	.0	.0	42.8	.0	.0	.0	55.4	.0	67.8	56.3
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	10100	10100
17	1	32.5	423.	30.	57	1	.0	.0	49.2	.0	.0	.0	61.4	.0	65.9	61.9
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	7100	7100
17	101	32.2	423.	30.	49	1	.0	.0	42.8	.0	.0	.0	55.4	.0	61.1	57.1
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	7100	7100
17	2	36.2	437.	30.	57	1	61.1	57.9	49.2	58.7	62.0	66.8	61.4	.0	52.7	48.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	7080	7080
17	102	35.6	437.	30.	49	1	56.1	52.9	42.8	53.7	56.0	60.8	55.4	.0	47.9	43.2
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	7080	7080
18	1	21.2	524.	27.	57	1	67.6	.0	49.2	69.0	.0	70.6	61.4	50.4	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
18	101	20.6	524.	27.	49	1	61.6	.0	42.8	63.0	.0	64.6	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

Figure 2-3. Example of Cell Data Echo Print

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2.2 Countermeasure Definition

```
 CM        ANY APPROPRIATE TITLE
|---|--|--|---------------------------------------|
 1   5  7  9
```

To examine possible noise abatement strategies, the user may define up to 20 countermeasures. This section will describe in detail the various types of countermeasures the user may define and how to implement them. The CM codeword has no associated option parameters. In the following, 'indicators' are referred to which are used in countermeasure manipulation and have different meanings for different countermeasure types. Indicator values are contained in the master data set and are specified individually for each cell. They are utilized by the countermeasures as described below. A 'countermeasure variable' indicates the quantity varied by a countermeasure when money is spent on that countermeasure.

The exact input format is given after the description of all countermeasure types. The format will illustrate the mechanics of countermeasure definition and specification.

Type 1. A type 1 countermeasure is used for effecting cumulative noise reduction either through reducing the frequency of noise source generation or by rerouting the path of a moving noise source. There is no associated indicator. If the countermeasure is used to describe a reduction in the frequency of operations of a noise source, the countermeasure variable becomes the fraction of operations that are curtailed. This variable can have extreme limits of 0. (no operations curtailed) to 1.0 (all operations curtailed). The reduction is the same for both day and nighttime periods; i.e., the same for all cells. In general, countermeasures may be defined to apply to two sources. However, a frequency reduction countermeasure can apply to one source only, hence, a second source must not be defined. The user may, of course, define more than one frequency reduction countermeasure, each applying to a different source.

If a second source is defined for a type 1 countermeasure, then this countermeasure is treated as implying source relocation or rerouting. The first source number refers to field elements in the input cell data set that contain exposure from the source in its original position. The second source number refers to exposure that would be measured if the entire source were relocated or rerouted. The countermeasure variable becomes the fraction of the source population moved. This variable must fall in the range 0. to 1.0.

Type 3. This type of countermeasure refers to frequency reductions in night operations only. It may apply to one or two sources. There is no associated indicator. The countermeasure variable is the fraction of night operations eliminated.

Type 5. Curfews are type 5 countermeasures. To the program a curfew is defined as an operation that transfers nighttime activity into the daytime period. A reduction in night operations will be accompanied by a corresponding increase in daytime operations. The curfew may apply to one or two sources. An indicator is required for each source defined to be affected by this countermeasure. This indicator contains the portion (expressed in hundredths of a percent) of total acoustic energy that is received from that source during the nighttime period at each cell location. A cell location refers to the actual space occupied by both the day and the night versions of a cell. Each cell location may have a different exposure value. The countermeasure variable is the fraction of the night operations shifted to day. If the variable is negative, it refers to the fraction of day operations shifted to the nighttime period. Thus the variable may range from -1.0 to +1.0. However, under normal application (night operations to day) the feasible range will be specified as 0.0 to 1.0.

The user should note that the program does not verify the existence of the day or night cell into which the noise energy will be transferred. If the user neglects to define the night version of a cell location the application of this countermeasure will be erroneous because the energy increase during the day version will not be compensated for by a decrease in the night version. Note also that the nocturnal energy indicator must be input with both the day and night version of the cell location in the data set.

Type 10. A type 10 countermeasure is used to describe the application of a device which produces a fixed noise reduction. This device is applied to a fraction of the source population. This fraction is the countermeasure variable and may range from 0. to 1.0. The device may be applied to two sources. An example of how two sources may be utilized follows:

If the countermeasure consisted of applying new mufflers to locomotives, but freight and passenger trains were separate noise sources in the input data, both sources would be used in the countermeasure definition. If, however, the mufflers were to be applied preferentially to the locomotives pulling freight trains, two separate type 10 countermeasures would be required; one for each source.

A type 10 countermeasure utilizes one indicator to be calculated by the user: Given dB1 and dB2 as the source level reductions at the cell location from sources 1 and 2 respectively, and both reductions are expressed to the nearest 0.5 dB, then the indicator is defined at that cell as:

$$I = (dB1 \times 2 + 200) \times 1000 + (dB2 \times 2 + 200)$$

Note that either dB1 or dB2, or both, may be zero; in the latter case the resulting indicator would be equal to 200200. The program will recognize an indicator value of zero (or a blank data field) as being equivalent to 200200. Since indicators of this type will tend to be constant for every cell, the user may find the 'IND' feature of cell data input to be convenient (see DTA codeword description). The alternative would be to place the same number in the appropriate indicator field for every cell in the data set.

Type 12. This type of countermeasure defines straight Leq reductions in source levels. The countermeasure variable is the decibel reduction in the source level. One or two sources may be considered and there are no associated indicators. If the countermeasure applies to two sources the reduction is the same for each of them. The source Leq reduction is the same for all cells in the community.

Type 15. This type of countermeasure is very similar to a type 10 countermeasure. The difference lies in the fact that if two different devices are applied to the same source population, the second device is applied exclusively to that portion of the source population left untreated by the first device. Whereas with type 10 countermeasures, the second device would be applied proportionately to treated and untreated segments of the source population alike. Hence, type 15 countermeasures are useful only when more than one is defined to affect the same source. The countermeasure variable for each type 15 countermeasure is the fraction of the _source noise energy_ produced by the fraction of the source population to be treated with the device. The user should take care that the total fractional application of all type 15 countermeasures applying to any single source does not exceed unity. This can be assured by careful selection of the feasible range of each of these countermeasures which is input with the cost functions. An error message will be printed if, during the optimization process, it is found that the fractional application on any one source exceeds unity. An example of the use of type 15 countermeasures follows:

> Two-dimensional cost functions can be synthesized by the use of two type 15 countermeasures. Two-dimensional cost functions determine a single noise reduction parameter by the application of two countermeasures. Assume that two sources are also affected by the countermeasures: 1.) Vehicle noise produced by automobiles on arterials, and 2.) Vehicle noise produced by traffic on collector type streets.
>
> During the preliminary stage of input data preparation these two sources required different mathematical models to predict the levels. One axis of the two-dimensional countermeasure cost function describes retrofit of a muffler device on vehicles in non-compliance with municipal statutes. The other axis of the function specifies alternatives for new vehicle noise regulations. The user wishes to obtain the optimum combination of retrofit regulations and new vehicle regulations. Two type 15 countermeasures are defined, each with arterial traffic as the first noise source and collector traffic as the second source. The user has determined that 10 percent of the noise energy from vehicles is due to new vehicles and 90 percent from older vehicles. Note that these fractions are portions of energy rather than the composition of the vehicle fleet. The user has also calculated that the maximum decibel reduction possible from retrofit of older vehicles is 8 dB and a maximum benefit from new vehicles of 6 dB. These decibel values apply to both noise sources defined. The user defines the feasible range of the countermeasure variable for new vehicles as 0. to 0.1 and the range for older vehicles of 0. to 0.9. This would physically be entered with the cost functions. Finally, the decibel values (placed in the correct format, see type 10) would be entered with the cell data as the actual indicator values, which would be constant over all cells and identical for both sources. In fact,

the indicator could be entered once, and the field number in which the indicator was placed could be referred to for both sources. Refer to Section 4.2 for further details on the use of type 15 countermeasures.

Type 18. All stationary source countermeasures are grouped into a single countermeasure definition. The actual countermeasure options within the stationary source countermeasure are listed in Table 2-3.

Table 2-3
Stationary Source Countermeasure Options

1.	Minimum Reduction
2.	Maximum Reduction
3.	Elimination of Night Operations
4.	Elimination of the Source
5.	Elimination of Night Operations and Minimum Reduction
6.	Elimination of Night Operations and Maximum Reduction

Up to 20 stationary sources may be defined in the community (see STAS codeword description, Section 2.6). The program will decide which options are to be taken with each source. A listing of the results will be contained in the output following the optimization results (see OPT codeword description).

The master data set contains noise exposure levels for up to two stationary sources at each cell. The numbers of these stationary sources are given by two indicators also contained in the master data set for each cell (see DTA codeword description).

Type 20. Type 20 refers to path-receiver countermeasures. As with stationary sources, all path-receiver measures are combined into one countermeasure definition. A listing of all possible path-receiver measures is shown in Table 2-4. There are no associated sources or indicators to consider in the definition.

Table 2-4
Path-Receiver Countermeasure Options

1.	Minimum Soundproofing
2.	Medium Soundproofing
3.	Maximum Soundproofing
4.	Low Barriers
5.	High Barriers
6.	Relocation
7.	Minimum Soundproofing and Low Barriers
8.	Medium Soundproofing and Low Barriers
9.	Maximum Soundproofing and Low Barriers
10.	Minimum Soundproofing and High Barriers
11.	Medium Soundproofing and High Barriers
12.	Maximum Soundproofing and High Barriers

The following paragraphs describe the actual countermeasure definitions. Two cards are required for each countermeasure. A blank card follows the last set of definitions cards to signal return of control to the main program for input of another codeword. However, if the maximum number, 20, of countermeasures is defined, the blank card would not be necessary. Numbering of the countermeasures is done automatically as they are input. The user should note that the cost functions must appear in the same order as the countermeasures to which they correspond (see COST codeword description). The program will allow input of the countermeasure definitions before or after the cost functions have been input.

The countermeasures may be defined in any sequence the user wishes with one restriction: countermeasure types 18 and/or 20 (stationary source and path-receiver) must be the last to appear in the definition cards. The reason for this restriction is explained in the section on cost function input (COST). Tables 2-5 and 2-6 contain a summary of the countermeasures, their indicators and variables. Figure 2-4 is a sample printout resulting from countermeasure definition. This output is the result of cards number 227 through 254 in Figure 5-3. The countermeasure definition card format follows:

<u>Card</u> 1 contains titling information for this countermeasure. The first 72 characters of the card may be used.

<u>Card</u> 2 consists of five data fields, Format 5I5.

```
Field:     1     2     3     4     5
        |-----|-----|-----|-----|-----|
Column:  1     6     1     1     2
                     1     6     1
```

Field 1 - specifies the countermeasure type code (see Table 2-5).

Field 2 - the noise source number affected by this countermeasure.

Field 3 - the noise source number of a second source, if any, affected by this countermeasure.

Field 4 - contains the number of the indicator, if any, utilized in the computation for this countermeasure. The 'number of the indicator' actually refers to the position that the indicator value occupies on card types 4 and 5 (see master data input); beginning with indicator number one in field 4 of card 4, card type 4 contains indicators 1 through 10, and type 5 contains 11 through 20.

Table 2-5
Countermeasure Type Codes

Code Number	Countermeasure Definition
1	A reduction in the frequency of operation of the noise source. The fractional reduction is the same during the day and at night.
3	A reduction in the frequency of nighttime operation of the noise source.
5	A shifting of nighttime activity into the daytime period, or vice versa.
10	Application of a device that produces a fixed Leq reduction to a portion of the source population.
12	An overall Leq reduction.
15	Like 10, except that no further modifications are allowed to the treated portion of the source population.
18	Stationary source countermeasures.
20	Path or receiver modifications.

Field 5 - contains the number of a second countermeasure indicator, if required. Note that only countermeasure types 5 and 18 can have more than one indicator.

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Table 2-6
Countermeasure Definition Data

Countermeasure Code Number	Indicator	Countermeasure Variable	
		Units	Extreme Range
1	NA	Fraction	0, to 1,
3	NA	Fraction	0, to 1,
5	Fraction of energy emitted during nighttime period (hundredths of a per-cent),	Fraction	-1, to 1,
10	Decibel reduction (special format, see text),	Fraction	0, to 1,
12	NA	Decibel	0, to (no program imposed limit)
15	Decibel reduction (special format, see text),	Fraction	0, to 1,
18	Stationary source number	NA	NA
20	NA	NA	NA

```
*********
CM   -0-0       5A II COUNTERMEASURE DEFINITIONS
*********

--------- AUTOMOBILES LOW  SPEED NEW VEHICLES SOURCE REDUCTION
COUNTERMEASURE  1 TYPE 15 'EXCL TRT' APPLIES TO: AUTOMOBILES LOW  SPEED LINE SRC    INDICATOR NO.  1
                                                 AUTOMOBILES LOCAL TRAFFIC SOURCE                 -0

--------- AUTOMOBILES LOW  SPEED OOS ENFORCEMENT
COUNTERMEASURE  2 TYPE 12 'DB  RED ' APPLIES TO: AUTOMOBILES LOW  SPEED LINE SRC    INDICATOR NO. -0
                                                 AUTOMOBILES LOCAL TRAFFIC SOURCE                 -0

--------- AUTOMOBILES LOW  SPEED EXISTING VEHICLES RETROFIT SOURCE REDUCTION
COUNTERMEASURE  3 TYPE 15 'EXCL TRT' APPLIES TO: AUTOMOBILES LOW  SPEED LINE SRC    INDICATOR NO.  2
                                                 AUTOMOBILES LOCAL TRAFFIC SOURCE                 -0

--------- TRUCKS      LOW  SPEED NEW VEHICLES SOURCE REDUCTION
COUNTERMEASURE  4 TYPE 15 'EXCL TRT' APPLIES TO: TRUCKS      LOW  SPEED LINE SRC.   INDICATOR NO.  3

--------- TRUCKS      LOW  SPEED OOS ENFORCEMENT AND RETROFIT SOURCE REDUCTION
COUNTERMEASURE  5 TYPE 15 'EXCL TRT' APPLIES TO: TRUCKS      LOW  SPEED LINE SRC.   INDICATOR NO.  4

--------- TRUCKS      HIGH SPEED TIRE NOISE REDUCTION
COUNTERMEASURE  6 TYPE 10 'PART TRT' APPLIES TO: TRUCKS      HIGH SPEED LINE SRC.   INDICATOR NO.  5

--------- BUSES       LOW  SPEED SOURCE REDUCTION, NEW AND EXISTING VEHICLES
COUNTERMEASURE  7 TYPE 12 'DB  RED ' APPLIES TO: BUSES       LOW  SPEED LINE SRC.   INDICATOR NO. -0

--------- MOTORCYCLES LOW  SPEED OOS ENFORCEMENT
COUNTERMEASURE  8 TYPE 12 'DB  RED ' APPLIES TO: MOTORCYCLES LOW  SPEED LINE SRC.   INDICATOR NO. -0
                                                 MOTORCYCLES LOCAL TRAFFIC SOURCE                 -0

--------- AIRCRAFT    SOUND ABSORPTION MATERIAL NACELLE TREATMENT SOURCE REDUCTION
COUNTERMEASURE  9 TYPE 10 'PART TRT' APPLIES TO: AIRCRAFT    COMMERCIAL, FLIGHT     INDICATOR NO.  6

--------- AIRCRAFT    FLIGHT PATH REROUTING (EFFECTIVELY A FLIGHT FREQUENCY RED.)
COUNTERMEASURE 10 TYPE  1 'RED FREQ' APPLIES TO: AIRCRAFT    COMMERCIAL, FLIGHT     INDICATOR NO. -0


--------- AIRCRAFT    REDUCTION OF NIGHT OPERATIONS
COUNTERMEASURE 11 TYPE  3 'NITE RED' APPLIES TO: AIRCRAFT    COMMERCIAL, FLIGHT     INDICATOR NO. -0

--------- RAILROAD    LOCOMOTIVE MUFFLERS, SOURCE REDUCTION
COUNTERMEASURE 12 TYPE 10 'PART TRT' APPLIES TO: RAILROAD    LOCOMOTIVES, LINE S.   INDICATOR NO.  7

--------- PATH-RECEIVER CONTROL: INSULATION, BARRIERS, LAND ACQ. AND PEOPLE RELOC.
COUNTERMEASURE 13 TYPE 20 'P-R MOD ' APPLIES TO: ALL SOURCES                        INDICATOR NO. -0
```

Figure 2-4. Sample Printout Due to CM Codeword

2.3 Cost Function Input

```
    COST      ANY APPROPRIATE TITLE
   |----|--|--|----------------------------------------|
    1    5  7  9
```

For each defined countermeasure, except types 18 and 20, there must be an associated cost function. These cost functions must be input in the same order as the countermeasure definitions. There are no option parameters recognized for this codeword.

The program will allow either the cost functions or the countermeasure definitions to be input first. This facility can allow the user to conduct several optimizations, each based on a different set of cost functions. The user simply initiates another COST codeword after the OPT codeword. The program will then have the new set of cost functions stored in memory and will compute an optimized expenditure scenario based on the new cost functions following the implementation of another OPT codeword.

It is important to note that costs for the stationary source and path-receiver countermeasures (types 18 and 20) are not input in this section. Since the cost functions must be input in the same order as the defined countermeasures, the user should verify that the stationary source and path-receiver countermeasures (if desired) are the last two that are defined. That is, the countermeasure definition cards (see section 2.2, countermeasure definition, CM) for these two countermeasures must follow the definition cards for all other countermeasure types. The user must input cost functions for all the other countermeasure types in the sequence in which they are defined in the countermeasure definition section.

Four data cards are required to define a cost function. A blank card must be placed following the last defined cost function to signal a return to the main program for input of another codeword. However, if the maximum number of cost functions, 20, was input, the blank card would not be necessary. Note that in this case there would be neither a stationary source nor a path receiver countermeasure defined.

Card 1 contains titling information for the cost function defined on the subsequent three cards. The first 72 columns of the card may be used.

Card 2 contains the feasible range of the countermeasure variable. The countermeasure variable is either a decibel reduction or a fractional application of a device which produces a fixed decibel reduction (see section 2.2 on countermeasure definition, CM, for a complete description of countermeasure variables). The feasible range defines the limits of allowed countermeasure variable application. The Format is 2F10.0 with the first field defining the minimum allowed value and the second the maximum allowed value.

Card 3 contains the values of the countermeasure variable for which corresponding costs will be input on card 4. Up to eight values are allowed, Format 8F10.0. Extreme values at the feasible range defined on card 2 need not be defined. The program will perform a linear interpolation between the data points to create a piece-wise linear curve of up to seven segments. The feasible range values on card two define the bounds of the cost function regardless of the range of data points specified on this card. If necessary, linear extrapolation is performed to extend the function. If only one data point is specified, that countermeasure will remain fixed at that value of countermeasure application. The countermeasure variables should otherwise be listed in order of increasing countermeasure effectiveness.

Card 4 contains corresponding costs for each of the countermeasure variable data points specified on card 3. Costs must be input in thousands of dollars. Format 8F10.0.

It is conceptually important that the cost functions be strictly increasing and contain no discontinuities. The cost functions should not contain any discontinuous jumps in the countermeasure variable or have regions of constant countermeasure variable application for variable cost. In addition, negative numbers are not allowed and will result in an error message. The reason for these limitations on the form of the cost functions lies in the technique used by the program for optimization. The program calculates a countermeasure cost-effectiveness gradient based on a user-supplied expenditure increment. The components of the gradient vector determine which countermeasures are the most cost-effective at the current expenditure level. Discontinuous jumps are nonsensical because the function would not be single valued at that point. Discontinuous jumps at the origin to simulate an automatic noise reduction with no cost may not achieve the intended purpose because the program will not recognize that there is no cost associated with the benefit and, hence, may never implement that countermeasure. Regions of constant benefit for variable cost will cause the program to stall on that countermeasure because the gradient of the function at that point is zero. Refer to the section on data factoring, FAC for simulation of certain desirable discontinuities.

Figure 2-5 illustrates a sample output which is the result of card images as seen in lines 255 through 304 of Figure 5-3.

```
*********
COST -0-0       SA II (MENLO PARK) LOW COST FUNCTIONS
*********

--------- COST FUNCTION FOR AUTOMOBILES LOW SPEED NEW VEHICLES SOURCE RED., CASE 3
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        .432
NOISE RED PARAMETER:         .00          .16           .29          .39          .43         -.00        -.00        -.00
CORRESPONDING COSTS:         .00        14.31         47.72       162.23       248.12         -.00        -.00        -.00

--------- COST FUNCTION FOR AUTOMOBILES LOW SPEED OOS ENFORCEMENT
FEASIBLE RANGE OF CM VARIABLE:          .000 TO       6.200
NOISE RED PARAMETER:         .00         4.50          5.50         5.80         6.20         -.00        -.00        -.00
CORRESPONDING COSTS:         .00          .25           .76         3.12        12.44         -.00        -.00        -.00

--------- COST FUNCTION FOR AUTOMOBILES LOW SP. EXIST. VEH. RETROFIT, CASE 2
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        .568
NOISE RED PARAMETER:         .00          .21           .38          .51          .57         -.00        -.00        -.00
CORRESPONDING COSTS:         .00          .06           .21          .73         1.11         -.00        -.00        -.00

--------- COST FUNCTION FOR TRUCKS LOW SPEED NEW VEH. SOURCE REDUCTION
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        .436
NOISE RED PARAMETER:         .00          .20           .35          .41          .44         -.00        -.00        -.00
CORRESPONDING COSTS:         .00        31.01         63.62       143.15       222.67         -.00        -.00        -.00

--------- COST FUNCTION FOR TRUCKS LOW SPEED OOS ENFORCEMENT AND RETROFIT SOURCE R
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        .564
NOISE RED PARAMETER:         .00          .33           .41          .51          .56         -.00        -.00        -.00
CORRESPONDING COSTS:         .00          .09          4.00        32.00       143.00         -.00        -.00        -.00

--------- COST FUNCTION FOR TRUCKS HI SPEED TIRE NOISE REDUCTION
FEASIBLE RANGE OF CM VARIABLE:          .000 TO       1.000
NOISE RED PARAMETER:         .00         1.00          -.00         -.00         -.00         -.00        -.00        -.00
CORRESPONDING COSTS:         .00        92.09          -.00         -.00         -.00         -.00        -.00        -.00

--------- COST FUNCTION FOR BUSES LOW SP. SOURCE RED.; NEW AND EXIST. VEHICLES
FEASIBLE RANGE OF CM VARIABLE:          .000 TO       6.780
NOISE RED PARAMETER:         .00          .23          2.35         6.78         -.00         -.00        -.00        -.00
CORRESPONDING COSTS:         .00          .03          1.78        16.22         -.00         -.00        -.00        -.00
```

Figure 2-5. Sample Printout Due to COST Codeword

```
********* COST FUNCTION FOR MOTORCYCLES LOW SPEED DOS ENFORCEMENT
FEASIBLE RANGE OF CM VARIABLE:        .000 TO      17.000
NOISE RED PARAMETER:          .00       5.04        9.46       12.75       17.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00        .02         .06         .16         .50        -.00        -.00        -.00

********* COST FUNCTION FOR AIRCRAFT SAM SOURCE REDUCTION
FEASIBLE RANGE OF CM VARIABLE:        .000 TO       1.000
NOISE RED PARAMETER:          .00       1.00        -.00        -.00        -.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00      19.28        -.00        -.00        -.00        -.00        -.00        -.00

********* COST FUNCTION FOR AIRCRAFT FLIGHT PATH REROUTING (*FREQ. REDUCTION)
FEASIBLE RANGE OF CM VARIABLE:        .000 TO       1.000
NOISE RED PARAMETER:          .00       1.00        -.00        -.00        -.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00       9.07        -.00        -.00        -.00        -.00        -.00        -.00

********* COST FUNCTION FOR AIRCRAFT NIGHT OPERATIONS REDUCTION
FEASIBLE RANGE OF CM VARIABLE:        .000 TO       1.000
NOISE RED PARAMETER:          .00       1.00        -.00        -.00        -.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00      32.76        -.00        -.00        -.00        -.00        -.00        -.00

********* COST FUNCTION FOR LOCOMOTIVE MUFFLERS, SOURCE REDUCTION
FEASIBLE RANGE OF CM VARIABLE:        .000 TO       1.000
NOISE RED PARAMETER:          .00       1.00        -.00        -.00        -.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00      16.22        -.00        -.00        -.00        -.00        -.00        -.00


SUMMARY OF ALLOWED COST RANGES ($000'S):

 COUNTERMEASURE
     NUMBER                   RANGE
 --------------      ------------------------

       1             $    .00 TO $    248.12
       2             $    .00 TO $     12.44
       3             $    .00 TO $      1.11
       4             $    .00 TO $    222.07
       5             $    .00 TO $    143.00
       6             $    .00 TO $     92.09
       7             $    .00 TO $     16.22
       8             $    .00 TO $       .50
       9             $    .00 TO $     19.28
      10             $    .00 TO $      9.07
      11             $    .00 TO $     32.76
      12             $    .00 TO $     16.22
```

Figure 2-5 (Continued)

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2.4 Barrier Definitions

```
BAR   I    ANY APPROPRIATE TITLE
|----|--|--|----------------------------------------|
1    5  7  9
```

This section is used to input data defining barriers for the path-receiver countermeasure. This codeword is optional and is used only if the user has defined a path-receiver countermeasure. There is only one option parameter, identified by 'I' above and described later.

The first data card contains titling information. The first 72 columns of the card can be used.

The second and third cards contain the barrier effectiveness ratios. Card 2 contains effectiveness ratios for the 20 possible sources and a low barrier height. Card 3 contains the same information for a high barrier height.

The effectiveness ratio for a particular source is the dB reduction achieved by the barrier on that source divided by the dB reduction achieved by the barrier on a standard source of the user's choosing. Effectiveness ratios are used to allow for the fact that barrier effectiveness generally varies with the type of source.

For example, a barrier 15 feet high is found to attenuate automobile traffic levels by 10 dB. This same barrier has an effectiveness of only 8 dB on locomotive generated noise. It is decided that the height of the traffic noise source will be the standard height. The effectiveness ratio for the traffic noise source is 1.0 and the effectiveness ratio for the locomotive noise source is 0.8. Note that the effectiveness ratios for aircraft noise sources should be zero since barriers have no effect on airborne noise sources. Since the program allows the definition of two barrier heights at each location, effectiveness ratios must be supplied for a low barrier height and a high barrier height.

The array of effectiveness ratios for the high barrier height is independent of the array for the low barrier height. A standard source is selected to have an effectiveness ratio of 1.0 for the high barrier height and then the ratio is calculated for each of the other sources at the high barrier height. This process is repeated for the low barrier height. A different standard source may be selected to have a ratio of 1.0 and the ratios are recalculated for the low barrier height. Note also that these ratios will be applicable to all defined barriers. The effectiveness ratio for any unused source number must be zero. Each of the two ratio cards has Format 20F4.0.

The remainder of the data cards contain the actual barrier definitions, one card per barrier. A blank card must appear after the last barrier definition card to return control to the main program for input of another codeword. The card contents are described below.

```
Field:      1       2         3       4   5    6      7
         |----|--------|--------|---|--|-----|-----|
Column:  1   5         1        2   2  2     3
                       3        1   4  6     1

          8   9   10     11    12 13   14    15   16 17   18    19
(cont.)  |---|--|-----|-----|---|--|-----|-----|---|--|-----|-----|
          3   3  4     4     5   5  5     6     6   6  7     7
          6   9  1     6     1   4  6     1     6   9  1     6
```

Field 1 - Format I4, contains the barrier number. Up to 100 barriers are allowed. The barrier numbers do not need to be consecutive or sequential, no individual barrier number greater than 100 is allowed. Barrier numbers are actually barrier location numbers since both the low barrier and high barrier are referred to with the same number. Even though there is a limit of 100 barrier locations, there can actually be 200 defined barriers, 100 low, and 100 high. The computer program will decide which barrier height (if any) is the most cost-effective to build at the defined location.

Field 2 - Format F8.0, is the cost of building a low barrier at this location in thousands of dollars. Presumably, the user calculated this cost from the knowledge of the barrier length and the cost per linear foot of building low barriers.

Field 3 - Format F8.0, is the cost of building a high barrier at this location, in thousands of dollars. Note that the actual height of the barrier is not an input data item.

Only barrier effectiveness is specified in fields 6-7, 10-11, 14-15, 18-19 (they may not all be used). The user decides on the actual barrier heights, low and high, which, in turn, determine the effectiveness of each barrier.

Field 4 - Format I3, contains the zone number of the primary (adjacent) cell affected by this barrier (see section 2.1 for zone and cell specification).

Field 5 - Format I2, contains the cell number of the primary cell affected by this barrier. Only the day cell number is necessary, the program will automatically assign the barrier to the night cell (if any) as well.

Field 6 - Format F5.0, is the base attenuation at the population centroid of the primary cell for the low barrier. The base attenuation is the effectiveness of the barrier in decibels on the selected standard source. The standard source is one which has an effectiveness ratio of 1.0 for the low barrier height. The attenuation value may only be entered to a maximum accuracy of a tenth of a dB.

Field 7 - Format F5.0, is the base attenuation at the population centroid of the primary cell for the high barrier. This value is input in similar fashion to the low barrier attenuation. Maximum attenuation of a barrier is limited by the program at 24 dB. This value is considered to be a practical engineering limitation.

The previous four field definitions (4-7) are then repeated for up to three additional cells also affected by this barrier. These additional cells are not immediately adjacent to the barrier and are referred to as secondary cells for this barrier. A cell may be a secondary cell to more than one barrier.

Barrier data is stored in the program as indicators 19 and 20 (see section on countermeasure input, CM, for a definition of indicators). This assignment occurs automatically and requires no physical action on the part of the user. The user should also be aware that any countermeasure indicators numbered 19 or 20 will be lost if barriers are defined. That is, barrier input overwrites any information stored as indicators 19 and 20. Use of indicators

19 and 20 is allowable, however, if the BAR codeword is not implemented.

If a zone-cell combination is specified in the barrier definition cards which was not defined in the main cell data set, a message to that effect will be printed (see Chapter 3, Error Messages) and program execution will terminate. However, the option parameter can be used to suppress these messages and override program termination. This is accomplished by placing a non-zero value in the position occupied by the 'I' in the option parameter field on the codeword card illustrated at the beginning of this section.

This option would normally be employed by the user in the event that a large set of barrier definition cards had been developed for a large community. The user would be able to select separate sections of the community for analysis and leave the large set of barrier definition cards intact.

A sample printout resulting from barrier input is shown in Figure 2-6. See Figure 5-3, lines 305 through 318 for the card images which caused this output.

```
*********
BAR  -0-0        BARRIER DATA  SA II  LOW COST
*********

---------- BARRIERS FOR STUDY AREA II (MENLO PARK), LOW COST

BARRIER EFFECTIVENESS RATIOS:
                                                  LOW  HIGH

     1 AUTOMOBILES LOW   SPEED LINE SRC          1.25  1.50
     2 AUTOMOBILES HIGH  SPEED LINE SRC          1.25  1.50
     4 TRUCKS      LOW   SPEED LINE SRC.         1.00  1.40
     5 TRUCKS      HIGH  SPEED LINE SRC.         1.10  1.50
     6 MOTORCYCLES LOW   SPEED LINE SRC.         1.25  1.50
     8 BUSES       LOW   SPEED LINE SRC.         1.00  1.40
     9 RAILROAD    LOCOMOTIVES, LINE S.           .50  1.00
    10 RAILROAD    CARS, LINE SOURCE             1.50  1.50
```

NBR	COSTS(-$1000'S) HI 1	HI 2 *	PRIMARY CELL ID		DB1	DB2 *	SECONDARY CELLS ---> ID		DB1	DB2 *	ID		DB1	DB2 *	ID		DB1	DB2 *
* 1 *	37.6	55.8 *	23	1	0.0	0.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *
* 2 *	167.2	248.4 *	22	1	10.0	10.0 *	22	2	8.0	8.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *
* 3 *	167.2	248.4 *	21	1	10.0	10.0 *	21	2	8.0	8.0 *	21	3	6.0	6.0 *	-0	-0	-.0	-.0 *
* 4 *	51.9	77.1 *	20	1	10.0	10.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *
* 6 *	192.9	289.7 *	6	1	10.0	10.0 *	6	2	8.0	8.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *
* 7 *	505.3	759.0 *	17	1	10.0	10.0 *	17	2	8.0	8.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *
* 8 *	257.0	386.0 *	10	1	10.0	10.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *
* 9 *	432.7	649.9 *	9	1	10.0	10.0 *	9	2	8.0	8.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *
* 10 *	171.3	257.3 *	16	1	10.0	10.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *	-0	-0	-.0	-.0 *

Figure 2-6. Sample Printout Due to BAR Codeword

2.5 Soundproofing Data and Path Receiver Options Selection

```
PARE        ANY APPROPRIATE TITLE
|----|--|--|-----------------------------------------|
1    5  7  9
```

This section is used to input soundproofing data associated with the path-receiver countermeasure. If the user has not defined a path-receiver countermeasure, this codeword would not be implemented. If there is a path-receiver countermeasure this codeword must be implemented. There are no associated option parameters recognized by the program.

The codeword card must be followed by the following six data cards.

Card 1 is an additional title card which may be used for any purpose. The first 72 columns of the card may be used. The title will appear on the output.

Card 2 contains the path-receiver countermeasure option override array. One of the many NOIZOP program functions is to perform a cost/benefit analysis and to apply in an optimal manner the various path-receiver countermeasure alternatives. There are twelve such alternatives which are listed in Table 2-4. The user may, at his discretion, decide to eliminate any of these options from consideration. For example, the user may disallow barriers and soundproofing to be implemented in combination. This is accomplished through the use of the path-receiver countermeasure override array. The array consists of twelve integers, Format 12I5, input on one card. A zero in the i-th field instructs the program to eliminate that option from consideration. A positive integer instructs the program to include that option. In our example just mentioned, the user would place a zero in fields 7 through 12, corresponding to options 7 - 12.

The relocation path-receiver option has additional features. As mentioned in the section on cell data input (DTA), an individual cell may be eliminated from consideration for relocation by specifying a relocation cost greater than 999 million dollars. In addition, possible relocation of any cells can be overridden by placing a zero in the sixth field of the override array. The method the program uses to evaluate the potential benefits of relocation can also be controlled through the use of the override array. A positive integer in the sixth field will correct the benefit of relocation by considering the noise level of the area into which people are being moved. The program does not actually decide where to move people but assumes a noise level which will produce an adverse effect equal to one-half of a standard deviation below the mean residential adverse effect in the community. The residential cells are scanned and the mean and standard deviation are calculated. The current noise levels (i.e., after all non path-receiver countermeasures have been applied) are used in the calculation of these statistics. If there are no residential cells in the data set then the effect would be equivalent to removing the entire population as next described. A negative integer in the sixth field will instruct the program to treat relocation as a simple removal of people from the area, no attempt is made to maintain a closed system with a fixed number of people as is done with the alternate (statistical) option. The choice the user makes may affect the manner in which the user calculates the relocation costs.

__Card 3__ contains three decibel levels, Format 3I5, corresponding to the basic noise reduction for minimum, medium and maximum soundproofing, respectively, in residential dwellings. Residential cells are identified by a land use code of 1, 2, 3, or 4. Zeroes in any of the fields are normally not allowed and will result in an error message. If the user has cost data for only one or two levels of soundproofing, he may input a zero in an unwanted field and by-pass the error-checking facility just mentioned by placing a zero in the proper option field of the path-receiver option override array (card 2).

For example, only two levels of soundproofing are known. The user leaves the maximum soundproofing field blank and places a zero in the third field of the override array. Note, in this example, that any maximum soundproofing levels defined for non-residential cells (card 5) will also be by-passed.

__Card 4__ contains costs per square foot in dollars for each of the three levels of residential soundproofing defined on Card 3. The same rules for zeroes as on Card 3 also apply. The format is 3F10.0.

__Card 5__ contains three soundproofing levels for non-residential cells in the same format as on Card 3.

Card 6 contains corresponding costs for the three non-residential soundproofing levels in the same format as on Card 4.

Figure 2-7 illustrates a sample printout resulting from the PARE codeword. See lines 319 through 325 of Figure 5-3 for the cards which caused this output.

```
*********
PARE -0-0
*********

--------- SOUNDPROOFING DATA SA II (MENLO PARK), LOW COST ESTIMATES; ALL PR OPTION

P/R MOD OVERRIDE ARRAY:
     1    1    1    1    1    1    1    1    1    1    1    1

RESIDENTIAL SOUNDPROOFING AND COST FACTORS ($/SQ FT):

    5 DB      10 DB      15 DB
    2.25       6.44      11.68

COMMERCIAL  SOUNDPROOFING AND COST FACTORS ($/SQ FT):

    5 DB      10 DB      15 DB
    2.25       6.44      11.68
```

Figure 2-7. Sample Printout Due to PARE Codeword

2.6 Stationary Source Data

```
 STAS       ANY APPROPRIATE TITLE
|----|--|--|-----------------------------------------|
 1    5  7  9
```

This section is used to input data describing stationary sources. No option parameters are recognized. If there are no stationary sources or no stationary source countermeasure, this section is not used.

The first data card is a title card containing any appropriate information. The first 72 columns are read and the title appears on the output.

The second data card contains the stationary source countermeasure option override array, Format 6I5.

One of the many NOIZOP program functions is to decide, based on a cost/benefit analysis, which stationary source countermeasure options should be applied to which stationary source, constrained by the allowable expenditure on the stationary source countermeasure. These six options are listed in Table 2-3. The user may instruct the program to overlook the i-th option by placing a zero in the i-th field on the card. There are six possible stationary source countermeasure alternatives. Any or all of these may be eliminated from consideration. The following diagram illustrates a sample stationary source override array card.

```
          1  1  1  0  1  1
         |--|--|--|--|--|--|
Column:  1  3  5  7  9  1
                        1
```

Following the override array are the actual stationary source data cards, one for each of up to twenty stationary sources. A blank card following the last stationary source data card returns control to the main program for input of another codeword.

The stationary source data card must contain seven items of information.

```
Field:    1   blank       2          3          4          5
        |---|-------|----------|----------|----------|----------|
Column:  1           1          2          3          4
                     1          1          1          1

                                         6          7
                    (cont.)        |----------|----------|
                                    5          6
                                    1          1
```

Field 1 - Stationary source number, I format. These must be sequential beginning with number 1.

Field 2 - A minimum source level reduction for this stationary source, in decibels, F format.

Field 3 - A maximum source level reduction in decibels, F format.

Field 4 - Cost for the minimum level reduction, F format.

Field 5 - Cost for the maximum level reduction, F format.

Field 6 - Cost for elimination of nighttime operations.

Field 7 - Cost for elimination of the source altogether, F format.

All costs are input in thousands of dollars.

Note that zeroes in any of the fields are normally not allowed. However, the stationary source override array may be used to allow input of zeroes in the fields if certain countermeasure alternatives have not been costed by the user or are simply not feasible options. For example, a zero in the fourth field of the override array card (see example diagram above) would allow an input cost of zero for the cost of source elimination. Note that any positive cost value in the cost field will be ignored if the appropriate override array field is zero. The reason for not allowing zeroes in the cost fields is to eliminate the 'something for nothing' cases which the program cannot handle directly. Also note that a zero entry in the override array applies to all stationary sources.

Figure 2-8 illustrates a sample output resulting from stationary source data input. This output is the result of input from cards as seen in lines 75 through 80 in Figure 5-1.

```
*********.
STAS -0-0        STATIONARY SOURCE INPUT
*********


--------- STATIONARY SOURCE SAMPLE INPUT

STATIONARY SOURCE OVERRIDE ARRAY:
     1     1     1     1     1     1

STATIONARY SOURCES-
                                                    COSTS IN THOUSANDS
                 MIN.      MAX.         MIN.        MAX.       ELIM.        ELIM.
SOURCE           RED.      RED.         RED.        RED.       NIGHT        SOURCE
------------------------------       -----------------------------------------------

   1              3.        5.         20.00       30.00       40.00       100.00
   2              6.        8.         20.00       30.00       40.00       100.00
```

Figure 2-8. Sample Printout Due to STAS Codeword

2.7 Transfer Function Options

```
CRIT II  J ANY APPROPRIATE TITLE
|----|--|--|---------------------------------------|
1    5  7  9
```

The transfer function, Φ, is used to relate the fraction of people adversely affected to the overall noise level.

The independent variables needed for function evaluation are the equivalent A-weighted level (Leq) plus upper and lower bound criterion levels, Lcu and Lcl, respectively. For levels greater than Lcu, Φ equals 1 (see exception below) and for levels less than Lcl, Φ equals 0. However, the shape of the function in between these limits is not usually known with any great precision. Consequently, the user is given a choice of transfer function shapes for the intermediate region. The shape options are plotted in Figures 2-9 to 2-12.

The CRIT option is used to specify the shape and/or criterion limits of the transfer function to be used.

'II' and 'J' are the option parameters that control the transfer function changes to be made. Table 2-7 describes the default conditions in effect before the implementation of the CRIT option. These would be in effect if the CRIT codeword were not used.

As can be determined from Table 2-7 the transfer function takes on different limits depending on the land use type of the cell in question or whether the cell is defined over a day or a nighttime period.

Remember that the lower criterion level (zero percent adversely affected) is input with the cell data set separately for each cell and as such can be different for each cell; it is not confined to uniformity within the land use type. However, use of the CRIT option to change the lower criterion levels will change those levels to the same specified value at all cells within the land use type indicated. That is, no cell-selective changes are possible.

Table 2-7
Default Transfer Function Conditions

Land Use Code	Upper Criterion Level (100 Percent Adverse Response), dB	
	Day	Night
1	85	77
2	85	77
3	85	77
4	90	77
5	90	85
6	90	85
7	90	85
8	90	85
9	85	85
10	85	85
11	85	85
12	85	85
13	85	85
14	85	85
15	85	85

Note: Default transfer function shape is linear (Type 1), default bulge factor is 0., and default maximum value is 1, i.e., not more than 100 percent people adversely affected. See Table 2-2 for suggested usage of these land use codes. The above levels were the product of a preliminary criterion analysis. It is recommended that the user specify upper criterion levels that are 20 dB greater than the lower criterion levels in Table 2-2. The 20 dB window is consistent with EPA recommended levels.

Table 2-8 summarizes the use of the 'II' and 'J' option parameters.

Note that if the transfer function for more than one but not all land use types are to receive modification, the CRIT option must be invoked as many times as is necessary.

There are a variable number of data cards depending on the

Table 2-8
Use of Option Parameters with CRIT Option

'II'	'J'
Land Use Types 1-15 0 = All Types	0 = Upper and lower criterion levels 1 = Lower criterion levels only 2 = Upper criterion levels only 3 = Transfer Function shape (0,1,2 - any one or all land use types 3 - always all land use types)

option indicated by the option parameters. If a single land use type is specified, then one card is required to change the upper criterion level and one card is required to change the lower criterion level. If 'J' equals 1 or 2, only one card is necessary; if 'J' equals 0, two cards are necessary; the first card containing the new day/night lower levels and the second card containing the new upper levels for the land use type indicated by 'II'. The levels card has Format 2I5.

Field 1 - contains the new criterion level (upper or lower) for each day cell of the specified land use type.

Field 2 - contains the new criterion level (upper or lower) for each night cell of the specified land use type.

If 'II' equals 0, 30 following data cards are required. The first 15 contain the new lower criterion levels for each of the 15 possible land use types, respectively, and the second 15 contain upper criterion levels for each of the 15 possible land use types. Blank cards or dummy values must be included for any unused land use types.

If 'J' equals 3 then the 'II' parameter has no effect. There is only one data card. This card contains the new transfer function type number (1-5) and the new bulge factor, r. The format is I5, F5.0.

A Type 1 (linear) transfer function can be made to extend beyond the 100 per-cent adverse effect level ($\Phi = 1$). Normally the actual bulge factor value has no effect on a Type 1 transfer function, however, the function can be made to extend beyond the $\Phi = 1$ point by specifying any positive value for the bulge factor. Figures 2-9 to 2-12 also show the shape option number and the equation used for each option where:

$$X = (L - Lcl)/(Lcu - Lcl)$$

and,

$$Lcu > L > Lcl$$

L = Equivalent A-weighted Level (Leq)

Figures 2-13 and 2-14 show sample printouts from each of the two general types of usage of the CRIT option. Figure 2-13 was the result of cards from lines 326 through 327 of Figure 5-3. Figure 2-14 resulted from cards in lines 328 through 358 also from Figure 5-3.

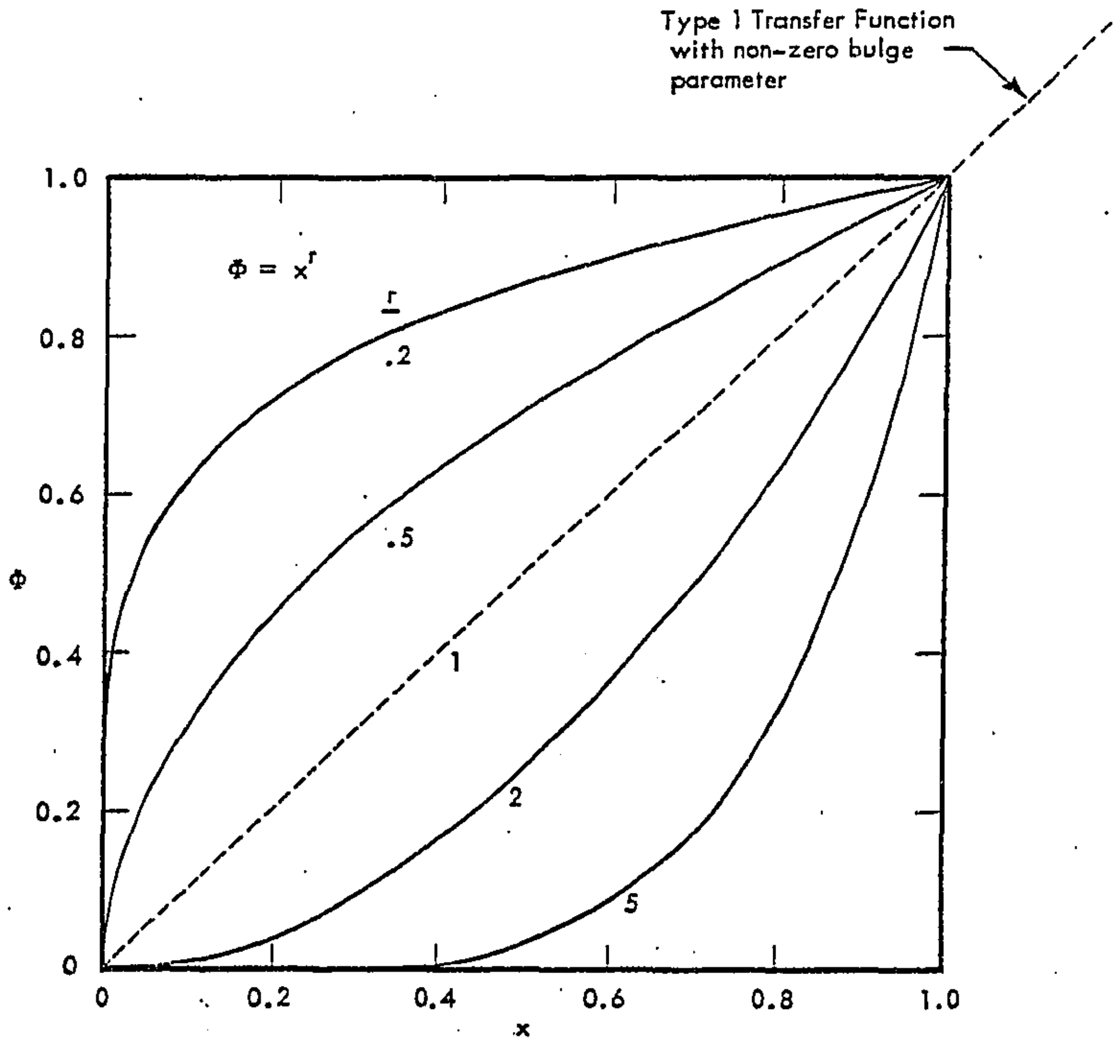

Figure 2-9. Linear Transfer Function, Type 1 (dashed line), and Power Law Transfer Function, Type 4 (solid lines).

(Linear Transfer Function, Type 1, occurs for r = 1 on a Type 4 transfer function. However, the bulge parameter has no effect on a Type 1 Transfer Function other than to indicate the maximum function value: 1.0 or greater than 1.0.)

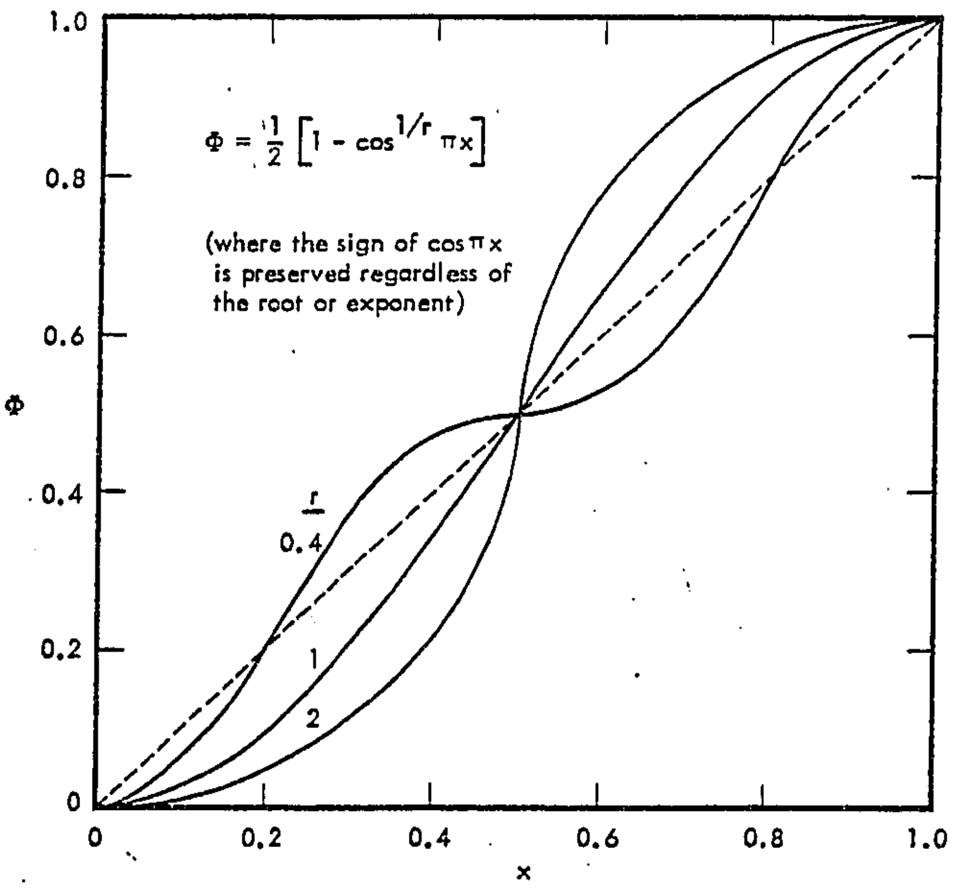

Figure 2-10. Cosine Transfer Function, Type 2

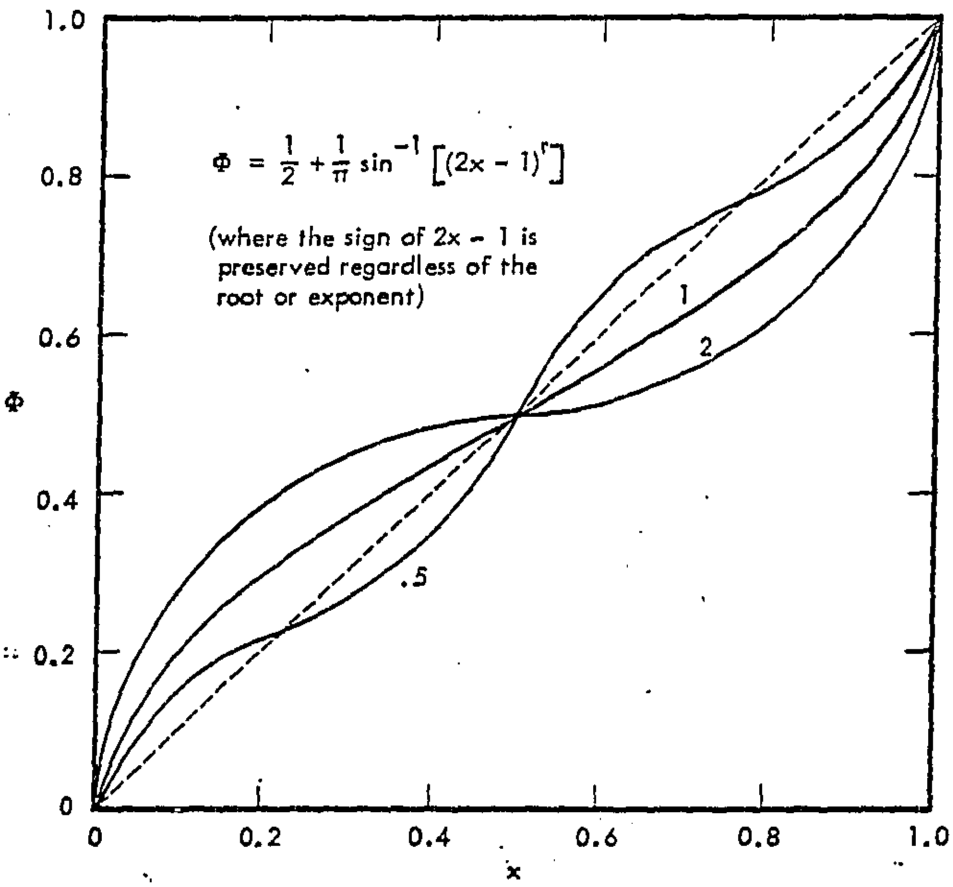

Figure 2-11. Inverse Sine Transfer Function, Type 3

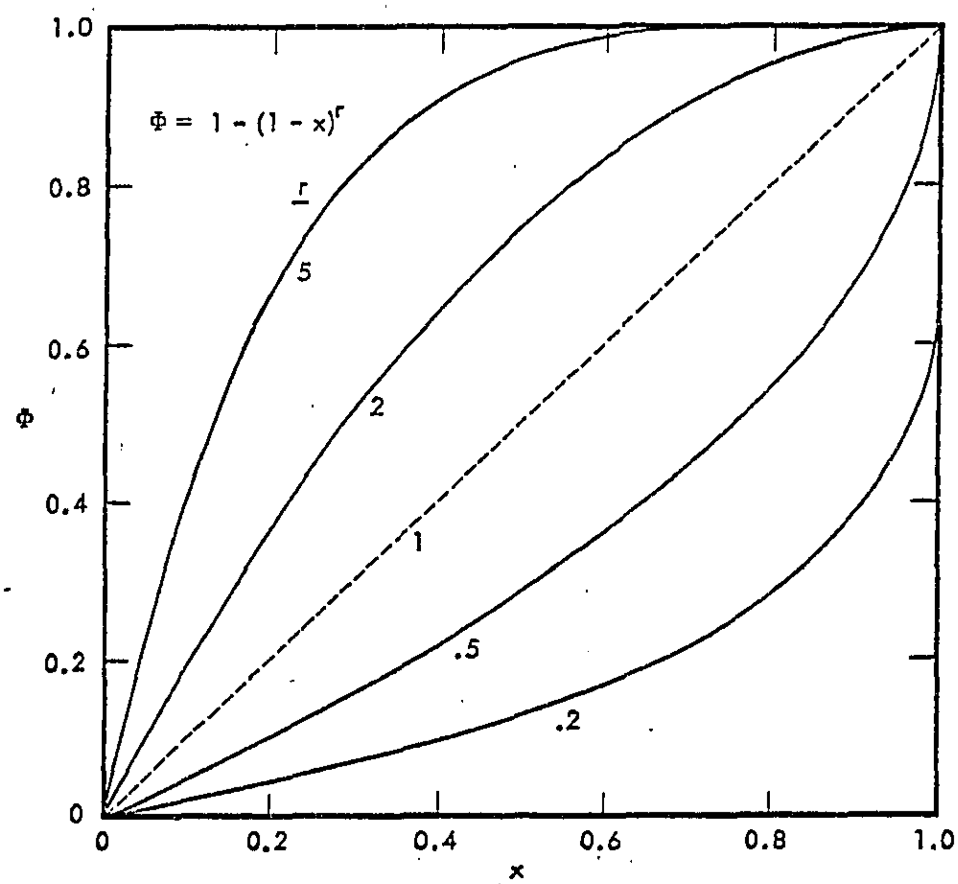

Figure 2-12. Inverse Power Law Transfer Function, Type 5

```
*********
CRIT -0 3       ALLOW MORE THAN 100 PERC. ADV. EFFECT
*********

TRANSFER FUNCTION TYPE 1 IN EFFECT WITH BULGE FACTOR OF  1.00

LINEAR FUNCTION ALLOWING MORE THAN 100 PERCENT ADVERSE EFFECT
```

Figure 2-13. Sample Printout Due to CRIT Codeword, Changing Transfer Function Shape

```
*********
CRIT  0 0   .   TRANSF.FCT. FOR SFU STUDY, 20 DB RANGE
*********

LOWER CRITERION LEVELS OF  60 CELLS TYPE  1 CHANGED TO  57 DBA(D) AND  49 DBA(N)
LOWER CRITERION LEVELS OF   6 CELLS TYPE  4 CHANGED TO  62 DBA(D) AND  49 DBA(N)
LOWER CRITERION LEVELS OF   2 CELLS TYPE  5 CHANGED TO  62 DBA(D) AND  62 DBA(N)
LOWER CRITERION LEVELS OF   0 CELLS TYPE  8 CHANGED TO  70 DBA(D) AND  70 DBA(N)
LOWER CRITERION LEVELS OF   8 CELLS TYPE 11 CHANGED TO  57 DBA(D) AND  -0 DBA(N)
LOWER CRITERION LEVELS OF   2 CELLS TYPE 12 CHANGED TO  60 DBA(D) AND  57 DBA(N)


UPPER CRITERION LEVELS OF ALL CELLS TYPE  1 CHANGED TO  77 DBA(D) AND  69 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  2 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  3 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  4 CHANGED TO  82 DBA(D) AND  69 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  5 CHANGED TO  82 DBA(D) AND  82 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  6 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  7 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  8 CHANGED TO  90 DBA(D) AND  90 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  9 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 10 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 11 CHANGED TO  77 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 12 CHANGED TO  80 DBA(D) AND  77 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 13 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 14 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 15 CHANGED TO   0 DBA(D) AND   0 DBA(N)
```

Figure 2-14. Sample Printout Due to CRIT Codeword, Changing Criterion Levels

WYLE LABORATORIES

BEST COPY AVAILABLE

2.8 Data Factoring

```
FAC   I    ANY APPROPRIATE TITLE
|----|--|--|--------------------------------------|
1    5  7  9
```

The FAC codeword is used to factor noise exposure values, population, and relocation cost. The purpose of the factoring is to update the data set from the year for which the data was calculated to a target year in which the countermeasures are to be implemented.

For example, operational data may be available for the noise sources in the current year 1976, but the countermeasures are to be implemented over a five year period and as such the cost functions reflect the costs to the year 1981. The countermeasure optimization is, therefore, to be based on the noise environment in the target year, 1981. The data factoring capability is used to simulate the noise environment in this target year using constant factors based on predicted trends.

Another example illustrates an application to simulate a 'something for nothing' countermeasure cost function.

> Current vehicle noise regulations will result in a decrease in the overall vehicle fleet noise level in the target year even without the application of extra noise countermeasures. However, the cost-function for the vehicle noise countermeasure should not have any regions where noise reduction is achieved with zero additional cost (see section 2.3, cost function input, COST). Therefore, to force the program to accept the automatic noise reduction in the target year, the user employs the data factoring option to reduce overall vehicle noise to the predicted level. The cost function can thus be redefined to eliminate the troublesome region.

Factors for population growth (or decline) and property value can also be specified. These data factors can be made to apply to specific zones and/or specific land use types.

A nonzero integer in the option parameter field indicated by 'I' above will initiate a formatted output of the master cell data set as it appears following the data factoring. Note that if barriers are defined (BAR codeword), indicator fields 19 and 20 have been filled with data on barriers. The data consists of a number of up to six digits. The first three digits are the barrier number. The second three digits are the barrier attenuation in tenths of a dB.

FAC may be invoked as often as required. Five data cards are required each time:

<u>Card 1</u> is a title card which will appear on the output, the first 72 characters may be used.

<u>Card 2</u> contains zones and land use codes for which ratios apply. Format 6I5.

Field 1 - The number of the first zone for which ratios apply. A zero implies a start from the beginning of the data, i.e. the first zone.

Field 2 - The number of the last zone for which ratios apply. A zero implies that zones will be considered to the end of the data, i.e. the last zone.

Fields 3-6 - Land use codes for which ratios apply. Up to four may be specified. If none are input, i.e. four zeroes or blanks, all land uses will be considered.

<u>Card 3</u> contains factors for population and property values respectively. Format 2F8.0.

<u>Cards 4-5</u> contain noise energy factors for the 20 possible sources. Format 10F8.0. Example: If noise reduces by 4.3 dB, then the factor to input is 10**(-4.3/10) = 0.3715 (the two asterisks ** signify exponentiation).

Note that a factor of 1.0 will result in no change to the corresponding data item. Figure 2-15 illustrates a sample printout resulting from implementation of the data factoring option. This output was the result of card images as seen in lines 359 through 364 of Figure 5-3.

```
*********
FAC   1-0        SFO DA II (MENLO PARK)
*********

---------- SIMULATE BASELINE MOTOR VEHICLE LEVELS (I.E., FOR NO ENFORCEMENT)

THE FOLLOWING FACTORS APPLY TO ZONES:   1- 23 AND CELLS:    1-  78
                              LAND USES: ALL

POPULATION AND PROPERTY VALUE FACTORS:

  1.000000  1.000000

EXPOSURE FACTORS:

  1.548100  1.000000  1.548100  2.238700  1.000000  1.724400  1.724400  1.000000  1.000000  1.000000
  1.000000  -.000000  -.000000  -.000000  -.000000  -.000000  -.000000  -.000000  -.000000  -.000000
```

Figure 2-15. Sample Printout Due to FAC Codeword

2.9 Base Index Calculation

```
BASE       ANY APPROPRIATE TITLE
|----|--|--|--------------------------------------|
1    5  7  9
```

The BASE codeword is used to calculate the baseline Noise Impact Index (NII) for the community. The NII is the fraction of the people in the community which are adversely affected by their noise environment. There are no options or data cards for this codeword. The baseline index is calculated using the current data either in the raw form as input by the DTA codeword, or in an amended form due to the FAC codeword. Hence, the BASE codeword should appear after the DTA codeword in the input deck.

Normally the baseline index is meaningful in the target year before actual source level reductions are achieved through countermeasures. Therefore, the FAC codeword would normally be invoked before the BASE codeword. However, if all the input noise data is consistent to the present year, the user might be interested in the present day NII as well. As such, the BASE codeword may be invoked more than once, before and after data factoring (FAC codeword).

Calculation of the baseline index is optional, that is, this codeword does not have to be invoked. If it is, however, it will allow a comparison to be made between baseline and final NII. The final NII being the noise impact index which has been optimized using the input countermeasure and cost functions together with budgeted expenditures. The comparison will be presented in the form of an NII reduction from the baseline and a final cost/benefit ratio. The cost/benefit ratio is defined to be dollar amount spent per person in the community to achieve the reduction in NII.

Figure 2-16 is a sample output from the BASE function. This output was caused by the codeword card seen in line 365 of Figure 5-3. The NII value seen is for the cell data also defined in Figure 5-3.

```
*********
BASE -0-0
*********

FOR AN AVE POPULATION OF   3345. PERSONS, THE BASELINE NOISE IMPACT INDEX IS:      .579245
```

Figure 2-16. Sample Printout Due to BASE Codeword

2.10 Source Ranking

```
RANK        ANY APPROPRIATE TITLE
|----|--|--|-----------------------------------------|
1    5  7  9
```

The RANK command initiates the computation of a ranking of the noise sources by adverse effect. There are no option-parameters or following data cards for this codeword.

The basis for the source ranking is the contribution to the Noise Impact Index (NII) which is due to each of the defined sources. The most offending noise source will be responsible for having the most adverse effect on the population.

The output of this calculation is the contribution to the NII from each of the 20 possible sources, the fractional contributions (sum to unity) to the NII from each of the 20 possible sources, and a listing of the noise sources in order of decreasing adverse impact. Figure 2-17 illustrates a sample output. The input card causing this output can be seen in line 366 of Figure 5-3. The sources and cell data used in this ranking are also defined in Figure 5-3.

This option functions much like the BASE codeword in that it employs the cell data set as it exists at the time the codeword is implemented; which may be before or after the optional data factoring (FAC) has been carried out. Hence, the user may be interested in obtaining a source ranking before and after the data factoring has taken place.

```
*********
RANK -0-0
*********

POPULATION WEIGHTED AVE INDICES FOR SOURCE RANKING:            SOURCES (1-10) / (11-20)

  .067116  .015178  .005290  .053056  .039825  .183512  .122751  .000376  .081579  .008599
  .001963  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000


FRACTIONAL CONTRIBUTION TO NOISE IMPACT INDEX:                 SOURCES (1-10) / (11-20)

  .115868  .026203  .009132  .091595  .068753  .316813  .211916  .000650  .140836  .014845
  .003389  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000

MOST OFFENDING SOURCES:                              SOURCE NO.

          1  MOTORCYCLES LOW  SPEED LINE SRC.        ( 6)
          2  MOTORCYCLES LOCAL TRAFFIC SOURCE        ( 7)
          3  RAILROAD    LOCOMOTIVES, LINE S.        ( 9)
          4  AUTOMOBILES LOW  SPEED LINE SRC         ( 1)
          5  TRUCKS      LOW  SPEED LINE SRC.        ( 4)
          6  TRUCKS      HIGH SPEED LINE SRC.        ( 5)
          7  AUTOMOBILES HIGH SPEED LINE SRC         ( 2)
          8  RAILROAD    CARS, LINE SOURCE           (10)
          9  AUTOMOBILES LOCAL TRAFFIC SOURCE        ( 3)
         10  AIRCRAFT    COMMERCIAL, FLIGHT          (11)
         11  BUSES       LOW  SPEED LINE SRC.        ( 8)
```

Figure 2-17. Sample Printout Due to RANK Codeword

2.11 Countermeasure Cost Effectiveness Optimization

```
 OPT   I  J ANY APPROPRIATE TITLE
|----|--|--|----------------------------------------|
 1    5  7  9
```

2.11.1 Control Parameters

The OPT codeword is used to initiate the cost-effectiveness optimization process. The program uses a gradient method in the process of finding the optimal point representing that allocation of expenditures among the defined countermeasures which results in the smallest Noise Impact Index. The constraining factors in the NII minimization process consist of the maximum feasible application of any of the countermeasures and the user defined total budget for all countermeasure expenditures combined. In essence, then, the program will find the minimum Noise Impact Index that can be achieved with the amount of money that has been budgeted.

The option parameter indicated by 'I' above controls the detailed breakdown of the path-receiver countermeasure results. A zero in the field (default) will initiate a cell by cell listing of the particular path-receiver countermeasure options (see Table 2-4 for a listing of these options) employed at each of the cell locations. A nonzero integer in this field will suppress this listing. A detailed explanation of the printout is included later below.

The gradient value for a countermeasure is the change in the Noise Impact Index that would occur if an additional dollar were spent on that countermeasure alone.

The option parameter indicated by 'J' above controls the handling of the stationary source gradient evaluation. For various reasons, the calculation of the stationary source countermeasure gradient is quite complex, however, an approximation is very easily obtained. This approximation will always have a higher numerical value than the true gradient. The program will increase the expenditure level of only one countermeasure at a time. The criteria for selecting the countermeasure is based on gradient magnitude. The countermeasure with the largest gradient will receive the next expenditure increment (the determination of the actual increment value will be discussed later below). If the approximation to the stationary source gradient is not the largest of all the gradients then the actual magnitude of the stationary source countermeasure gradient is not important. A zero in the 'J' option parameter field (default) will allow the program to take advantage of this fact and suppress the procedure which calculates the actual gradient value. If the approximate gradient is the largest the actual value will then be calculated. Remember that the approximate value is always larger than the actual value. A non-zero integer in the 'J' option parameter field will cause the program to compute the actual gradient value at every point; resulting in increased execution time. This feature is included in the event that the user is interested in the true gradient values of the stationary source countermeasure at every point in the optimization process.

Up to three data cards are necessary to control the optimization process.

Cards 1-2 define the point at which the optimization process is to begin. These cards contain the initial expenditures on the countermeasures at which the user wishes the optimization process to commence. The initial values would normally be zero but this is not a restriction. The program will adjust these input expenditures to account for any minimum or maximum expenditure constraints on any of the countermeasures which were declared during countermeasure and cost definitions. The user must input an initial expenditure for each defined countermeasure. Ten expenditures can be placed on each card. Format 10F8.0. The values must be input in thousands of dollars. If there are ten or fewer defined countermeasures then only one card will be necessary; more than ten defined countermeasures requires the use of both cards.

Card 3 contains three control parameters, the total budget, the gradient stepsize, and the maximum initial expenditure ratio. The format is 3F10.0.

The total budget is the maximum allowed expenditure for all countermeasures together. The desired value is entered in millions of dollars.

The gradient step size is the dollar increment which the program will add to the current expenditure for each countermeasure to calculate the components of the gradient vector. Remember that the gradient is calculated using the specified stepsize (not a step size of one dollar), but is presented as a per-dollar benefit. The stepsize must be entered in thousands of dollars. The default value (initiated by a blank field) is 10,000 dollars.

The initial maximum expenditure ratio governs the rate at which progress will be made toward reaching the optimum point. Beginning with the input initial expenditures, the program will spend additional funds on one countermeasure at a time until the total budget has been expended. The particular countermeasure that is selected for expenditure increase is the one that is the most cost-effective at that point (i.e., has the largest gradient). The actual additional dollar amount allocated to that countermeasure is determined by:

$$\text{Increment} = \text{MIN}(Gl/Gn\ ,\ \text{MAX}(Ir * Ca/Tb\ ,\ 1)) * SS$$

where,

- Gl = Largest component of the gradient vector
- Gn = Second largest vector component
- Ir = Initial maximum expenditure ratio
- Ca = Current total expenditure on all countermeasures
- Tb = Total allowed budget
- SS = Gradient stepsize

'MIN' means take the smallest of the arguments within parentheses separated by commas, 'MAX' means take the largest of the arguments within the following parentheses.

As can be seen from the expression above, the initial ratio limits the coarseness of the steps which can be taken. The allowed coarseness is a decreasing linear function of expenditures which is why the input maximum expenditure ratio is referred to as 'initial'. Note that the increment is never allowed to fall below the gradient stepsize. A large ratio will potentially reduce the number of steps required to reach the optimum point, but it is likely that the result will be less accurate than a result achieved with a smaller ratio. The smallest allowed ratio is 1.0, meaning that the gradient stepsize will be the incremental value at every step. The default initial expenditure ratio (initiated by a blank field) is 10. Note that this incremental procedure is applicable for the countermeasures with continuous cost functions. Because the program can deal only with one whole stationary source or one whole cell at a time, the stationary source and path-receiver countermeasures have discrete expenditure steps and are independent of the controlled increment expression.

2.11.2 Interpretation of Output

This discussion is included to assist the user in interpreting the output of the optimization process appearing in the primary output. The results should be self-explanatory but there are some subtle points of which the user should be aware. A sample output is shown in Figure 2-18. See lines 367 through 370 of Figure 5-3 for the cards which caused this output, blank cards (lines 368 - 369) are equivalent to zero initial expenditures.

Two identical pages, each containing the program leader, are printed so that the user will be able to tear off his printout and always have a leader page facing upwards.

The adjusted input expenditures are the initial values specified by the user which have been corrected for minimum or maximum expenditure constraints placed on any of the countermeasures.

The total budget, gradient stepsize, and initial maximum expenditure ratio are all user defined variables described in section 2.11.1.

The program will output the current expenditures on each of the countermeasures as well as the associated components of the gradient vector. The resultant noise impact index and expenditure total are also output with each of the steps.

Note that if all the initial expenditures are zero then the resultant Noise Impact Index will be equal to the baseline case Noise Impact Index calculated as a result of the BASE codeword.

If any of the gradient values are negative, the user should suspect erroneous data preparation. A negative value implies that expenditures on this countermeasure will result in increased noise. This type of error may frequently occur for curfew countermeasures where noise energy is transferred into the community from non-existent cells. Since countermeasure-cost functions are assumed to give a monotonically increasing benefit with increasing expenditure, the program will suppress any further gradient calculation on this countermeasure. Note that any negative gradients will usually be spotted following the

```
*********
OPT -0-0
*********

ADJUSTED INPUT EXPENDITURES:

        0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
        0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
                                                                                                   TOTAL= $          0.

TOTAL BUDGET =                        $      763440.00
GRADIENT STEPSIZE =                   $        5000.00
INITIAL MAX. EXPENDITURE RATIO =                  2.00

 STEP                              EXPENDITURES (1-10) / (11-20)  /  GRADIENTS (1-10) / (11-20)
------ ----------------------------------------------------------------------------------------------------------

     1 .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000
       .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000
       .163656-06  .414896-05  .348593-05  .133713-06  .156506-05  .836956-07  .251732-07  .377252-04  .432597-07  .152271-06
       .634941-08  .121289-05  .444519-06  .000000     .000000     .000000     .000000     .000000     .000000     .000000
INDEX=     .579245          SUM= $           .00

     2 .000000     .000000     .000000     .000000     .000000     .000000     .000000     .496240+03  .000000     .000000
       .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000
       .267499-06  .726059-05  .606184-05  .237046-06  .289101-05  .140131-06  .410563-07  .000000     .136364-06  .495808-06
       .160939-07  .153068-05  .504032-06  .000000     .000000     .000000     .000000     .000000     .000000     .000000
INDEX=     .393895          SUM= $         496.24

     3 .000000     .598877+04  .000000     .000000     .000000     .000000     .000000     .496240+03  .000000     .000000
       .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000
       .881563-07  .136583-06  .186599-05  .310690-06  .395293-05  .183883-06  .488382-07  .000000     .633271-07  .217673-06
       .204661-07  .159009-05  .498023-06  .000000     .000000     .000000     .000000     .000000     .000000     .000000
INDEX=     .357453          SUM= $        6485.01

     4 .000000     .598877+04  .000000     .000000     .999350+04  .000000     .000000     .496240+03  .000000     .000000
       .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000
       .111322-06  .172798-06  .237247-05  .403361-06  .107350-06  .204236-06  .530671-07  .000000     .746765-07  .257694-06
       .246595-07  .164261-05  .502405-06  .000000     .000000     .000000     .000000     .000000     .000000     .000000
INDEX=     .336765          SUM= $       16478.51

     5 .000000     .598877+04  .111300+04  .000000     .999350+04  .000000     .000000     .496240+03  .000000     .000000
       .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000
       .804000-07  .124568-06  .000000     .427174-06  .197374-06  .212202-06  .528874-07  .000000     .780031-07  .269409-06
       .259551-07  .165110-05  .502122-06  .000000     .000000     .000000     .000000     .000000     .000000     .000000
INDEX=     .331039          SUM= $       17591.51
```

Figure 2-18. Sample Printout Due to OPT Codeword

****
PATH-RECEIVER BREAKDOWN BY CELL:
****

ZONE	CELL	LND USE	CELL POP.	TOTAL ADV. AFF. NO P-R MODS	REMAINING ADV. AFF. W/ P-R MODS	PER-CENT ADV. AFF. NO P-R MODS	PER-CENT ADV. AFF. W/ P-R MODS	P-R MOD TYPE	P-R MOD EXPENDITURE
1	1	11	142.5	.0	.0	.000	.000	0	.00
2	1	4	7.5	.7	.7	9.287	9.287	0	.00
3	1	5	174.4	.0	.0	.000	.000	0	.00
4	1	1	40.9	.0	.0	.000	.000	0	.00
4	2	1	53.1	.3	.3	.554	.554	0	.00
5	1	1	102.9	35.8	35.8	34.752	34.752	0	.00
5	2	1	81.4	.0	.0	.000	.000	0	.00
6	1	1	55.9	24.2	24.2	43.359	43.359	0	.00
6	2	1	18.4	.0	.0	.000	.000	0	.00
7	1	1	29.6	11.5	11.5	38.779	38.779	0	.00
7	2	1	50.8	.0	.0	.000	.000	0	.00
8	1	1	163.9	69.4	69.4	42.335	42.335	0	.00
8	2	1	22.1	.2	.2	.778	.778	0	.00
9	1	1	102.9	62.6	62.6	60.840	60.840	0	.00
9	2	1	33.7	7.5	7.5	22.215	22.215	0	.00
10	1	1	22.1	12.9	7.4	58.483	33.520	1	23625.00
10	2	1	3.8	.0	.0	.000	.000	0	.00
11	1	1	12.2	2.4	2.4	19.452	19.452	0	.00
11	2	1	9.9	.0	.0	.000	.000	0	.00
12	1	11	142.5	.0	.0	.000	.000	0	.00
13	1	1	87.9	7.9	7.9	9.045	9.045	0	.00
13	2	1	29.6	.0	.0	.000	.000	0	.00
14	1	12	314.0	.0	.0	.000	.000	0	.00
15	1	1	32.4	.7	.7	2.109	2.109	0	.00
15	2	1	33.4	.0	.0	.000	.000	0	.00
15	3	1	271.5	.0	.0	.000	.000	0	.00
16	1	4	144.7	69.8	69.8	48.195	48.195	0	.00
17	1	1	64.7	28.1	28.1	43.382	43.382	0	.00
17	2	1	71.9	23.7	23.7	32.950	32.950	0	.00
18	1	1	41.9	17.1	17.1	40.894	40.894	0	.00
18	2	1	48.7	.0	.0	.000	.000	0	.00
19	1	11	142.5	.0	.0	.000	.000	0	.00
20	1	4	21.5	15.9	15.9	74.000	74.000	0	.00
21	1	1	98.1	85.0	28.1	86.619	28.596	4	167200.00
21	2	1	144.7	43.1	-.0	29.770	-.000	4	.00
21	3	1	72.9	9.6	-.0	13.211	-.000	4	.00
22	1	1	156.4	134.9	20.2	86.261	12.916	5	248400.00
22	2	1	155.0	50.6	-.0	32.625	-.000	5	.00
23	1	11	142.5	69.9	-.0	49.083	-.000	5	55000.00

Figure 2-18 (Continued)

```
*********************************
PATH-RECEIVER MODS COST BREAKDOWN:
*********************************

  SP-1      SP-2      SP-3      B-1       B-2     RELOCATE  SP-1/B-1  SP-2/B-1  SP-3/B-1  SP-1/B-2  SP-2/B-2  SP-3/B-2
 --------  --------  --------  --------  --------  --------  --------  --------  --------  --------  --------  --------
      0.        0.        0.        0.    20000.        0.        0.        0.        0.        0.        0.   340000.

PATH-RECEIVER EXPENDITURE = $   360000.01

COST OF NEXT P-R MEASURE  = $   400000.01

*************************
STATIONARY SOURCE SUMMARY:
*************************

SOURCE   CM TYPE    EXPENSE
------   -------    -------

  1        2      $  30000.00
  2        1      $  20000.00

STATIONARY SOURCE EXPENDITURE = $     50000.

COST OF NEXT STATIONARY SOURCE MEASURE = $    10000.00


FINAL EXPENDITURES:

    15000.     12438.      1113.     66996.     29993.     92090.      5000.       496.  /     0.      9066.
        0.     16223.    495025.         0.         0.         0.         0.         0.  /     0.         0.
                                                                                  TOTAL= $  .  763440.

FINAL COUNTERMEASURE VARIABLES:

 .163605-00  .620000+01  .568000-00  .370205-00  .500192-00  .100000+01  .333732+01  .170000+02 -.000000    .100000+01
-.000000     .100000+01  .495025+06  .000000     .000000     .000000     .000000     .000000    .000000    .000000


IMPACT GRADIENT VECTOR (REDUCTION IN NII/$):

 .334991-07  .000000     .000000     .551709-07  .513676+07  .000000     .179009-07  .000000    -.456201-12  .000000
-.456201-12  .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000     .000000
                                                                  GRADIENT MAGNITUDE =   .844102-07

COUNTERMEASURE RANKING:  4  5  1  7 13 12  3 10  2  8  6 11  9
SPENDING LIMIT REACHED:  0  0  0  0  0  1  1  1  1  1  1  0  0


                                                                  ********************************

                                                                  NOISE IMPACT INDEX =   .129561-00
                                                                  RED. FROM BASELINE =   .449604-00
                                                                  COST/BENEFIT RATIO =   .507579+03   $/PERSON

                                                                  ********************************
```

Figure 2-18 (Continued)

calculations at the initial expenditure level.

Due to inherent inaccuracies in some of the computer system mathematical functions, there may be occasions when a gradient value which should be identically equal to zero, will be output as a number with a very small magnitude. This situation occurred in the example of the San Francisco Study Area presented in Section 5. When the spending limit was reached on the aircraft rerouting countermeasure (all aircraft rerouted), the gradient values for the SAM (Sound Absorbing Material) retrofit and night frequency reduction countermeasures were reduced to zero; but, in some instances, appeared as very small numbers. This causes no problem with the operation pf the program, but should be noted and ignored by the user.

When any of the countermeasures reach their spending limits, gradient calculation for them will subsequently be suppressed and will appear to be zero. The gradients for the stationary source and path-receiver countermeasures will be set to zero if it is determined that the next discrete expenditure on that countermeasure would cause the total budget to be exceeded.

Figure 2-19 shows the optimization concept in three dimensions: The NII surface as a function of two countermeasure expenditures with associated constraints. In real application, up to 20 dimensions (20 countermeasures) may be involved. Since the optimization process proceeds along the path of steepest descent, the intermediate results that are obtained are themselves optimum points for their respective expenditure levels. This assumes, of course, that the user has chosen gradient stepsize and initial maximum expenditure ratio values which allow the program to follow closely the actual optimum path. Remember that the selection of these parameters is normally based on achieving the most accurate result at the total target budget level.

Following the completion of the optimization process, the program will output a cell by cell breakdown detailing the sub-optimization of the path-receiver countermeasure options. This output may be deleted at user option by implementing one of the option parameters described earlier (see summary Table 2-9). The breakdown is by cell location; that is, day and night cells occupying the same physical space appear combined. The user determines the option that has been employed by comparing the 'P-R MOD TYPE' number with the option descriptions in Table 2-4. The cost to implement this option is disclosed in the expenditures column.

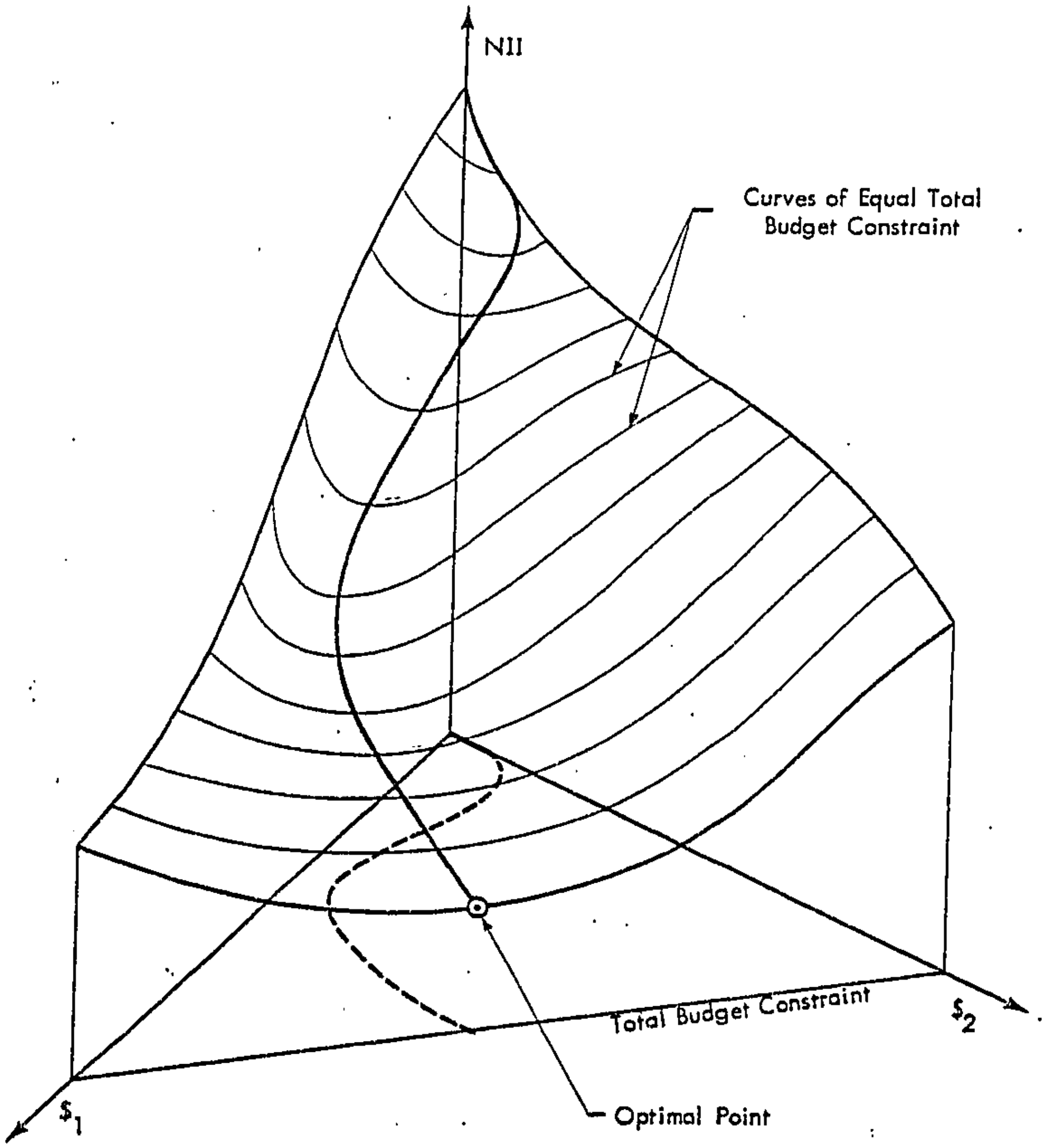

Figure 2-19. Three-Dimensional Illustration of Steepest Descent Path Optimization Method

Table 2-9
Summary of Option Parameters

Codeword	Parameter No. 1	Parameter No. 2
BAR	0 = Printout nonexistent cells 1 = No printout	NA
BASE	NA	NA
CM	NA	NA
COST	NA	NA
CRIT	Land use type 1-15 0 = All	0 = Upper and lower bound 1 = Lower bound only 2 = Upper bound only 3 = Transfer function shape (0,1,2 - any one or all land use types 3 - always all land use types)
OTA	0 = No echo of input 1 = Echo input	0 = No constant indicators 1 = Input of constant indicators
END	NA	NA
FAC	0 = No printout of factored data 1 = Printout of data	NA
OPT	0 = Breakdown of Path Receiver measures by cell location 1 = No breakdown	0 = Evaluation of true Stationary source gradient only when necessary 1 = always calculate true Stationary Source Gradient
PARE	NA	NA
RANK	NA	NA
STAS	NA	NA

In addition to the breakdown by cell, the program outputs a breakdown by option. The 'COST OF NEXT P-R MEASURE' is the next discrete expenditure that would be allocated to the path-receiver countermeasure.

The stationary source summary is a breakdown by source of the measures implemented on each of them. The user relates the type number specified with the listing of the options in Table 2-3.

SUMMARY OF OUTPUT The final page of the output is a summary of the essential results. The final countermeasure variables indicate the relation of the final expenditures to the corresponding noise reduction parameters. You will remember that these noise reduction parameters are either fractions or decibels, depending on the countermeasure type. The final variables for stationary source and path-receiver countermeasures are simply the dollar amounts expended on them.

The countermeasure ranking is an ordered list of the countermeasures by final gradient magnitude. It gives an indication as to the manner in which funds would be allocated beyond the specified total budget. 'Spending limit reached' indicates (with a '1') whether the spending limit was reached on the countermeasure numbered immediately above it (in the ranking row).

The final noise impact index is repeated; if the BASE codeword was invoked, two additional parameters are output. The 'reduction from baseline' is the difference between the initial and final Noise Impact Indices. The cost/benefit ratio is the dollar amount per person in the community that was spent to achieve the reduction in the Noise Impact Index.

2.11.3 Short Form Output

The short form output appearing in the secondary print if so desired and indicated by appropriate controls at the beginning of the input deck (see the beginning of Chapter 2 and Section 4.1 on system control cards) contains abbreviated messages resulting from each of the implemented codewords.

The output for the optimization process indicates the step number, the countermeasure which received the expenditure increase, the current sum of all expenditures, and the resultant Noise Impact Index. Figure 2-20 illustrates a sample short form output.

```
JOB DESCRIPTION:
TEST DATA FOR SHORT SAMPLE CASE INCLUDIN
G STATIONARY SOURCE
---- DTA   1-0
DATA ENTERED FOR    3 CELLS
---- CM   -0-0
  8 COUNTERMEASURES DEFINED
---- COST -0-0
  6 COST FUNCTIONS READ
---- PARE -0-0
INPUT OF SOUNDPROOFING DATA COMPLETE
---- STAS -0-0
DATA READ FOR  2 STATIONARY SOURCES
---- BAR   1-0
DATA READ FOR   2 BARRIERS
---- BASE -0-0
BASELINE NII =  .588147
---- RANK -0-0
MOST OFFENDING SOURCES:
     1  STATIONARY SOURCE                        ( 6)
     2  BUSSES                                   ( 3)
     3  AUTOMOBILES                              ( 1)
     4  TRUCK TIRES                              ( 2)
     5  RAILROAD                                 ( 4)
     6  AIRCRAFT                                 ( 5)
---- OPT  -0-0
 STEP  CM  TOTAL (ALL CM)   NII
   1    0            .00   .588147
   2    8       10000.00   .498579
   3    8       20000.00   .411951
   4    8       40000.00   .371385
   5    8       60000.00   .338580
   6    8      160000.00   .292322
   7    8      260000.01   .246192
   8    7      280000.00   .236992
   9    7      290000.01   .232913
  10    8      340000.01   .208841
  11    7      410000.00   .204301
  12    1      420000.00   .202624
  13    1      430000.01   .200910
  14    1      440000.01   .199159
  15    1      450000.00   .197369
  16    1      460000.01   .195538
  17    1      470000.01   .193665
  18    1      480000.00   .191746
  19    1      490000.00   .189780
  20    1      500000.00   .187765
FINAL EXPENDITURES:
$      90000. $          0. $          0. $          0. $          0.
$          0. $      50000. $     360000. $          0. $          0.
$          0. $          0. $          0. $          0. $          0.
$          0. $          0. $          0. $          0. $          0.
FINAL NII =   .187765-00
---- END  -0-0
```

Figure 2-20. Sample Short Form Output

2.12 Program Termination

```
 END        ANY APPROPRIATE TITLE
|----|--|--|--------------------------------------|
 1    5  7  9
```

The END card is the last codeword to be input, signalling that there are no more codewords coming, and terminates program execution. No option parameters are recognized.

CHAPTER 3

DIAGNOSTIC AND ERROR MESSAGES

Incorporated into the program are many error checking routines which monitor the data that is input. This error checking facility is designed to catch errors resulting from data that is improperly formatted as well as those errors in the input data that would cause erroneous results to be computed. The detection of any error causing any of the following messages to be printed results in almost all cases in termination of execution. The messages will appear identically in the main print as well as in the auxiliary short-form file except where noted.

TOO MANY CELLS

The program is designed to handle a maximum of 200 cells. The user must reduce the number of cells he has defined. A reasonable approach is to select a representative sample.

INDEX OUT OF RANGE

The user has specified an illegal option parameter. See Table 2-9 for a listing of meaningful values.

ILLEGAL CODEWORD

Check for codewords spelled incorrectly or placed in the wrong columns. A likely occurrence is that the user did not inform the program that he is using the 'IND' feature of indicator input. See Table 2-9 for a description of the option parameters required for the 'IND' feature.

BLANK CODEWORD CARD ENCOUNTERED

This is a non-fatal error, the user has probably terminated some input with too many blank cards.

CELLS NOT INPUT IN NUMERICAL ORDER

Short form:
ERROR IN INPUT DATA, CARDS MISSING OR OUT OF ORDER

The cells must be input in a certain numerical sequence; in ascending order by zone number and in ascending order by cell number within each zone (refer to Section 2.1).

ERROR IN INPUT DATA
ZONE AND CELL WERE www AND xxx ON CARD NUMBER i;
DATA FOR ZONE AND CELL yyy AND zzz WAS EXPECTED

Short form:
ERROR IN INPUT DATA, CARDS MISSING OR OUT OF ORDER

Note that the short form message is the same as for the error above. This error will occur when a cell data card type 1 has been omitted from the cell data set. This error can also occur if a card type 2-5 is misplaced and does not immediately follow the associated card type 1 which has the same zone and cell number. In other words, whenever a type 1 card is encountered in the input stream the program expects any subsequent card type 2-5 to contain the same zone and cell numbers that appeared on the card type 1. This expectation process is repeated when a new card type 1 is encountered.

NIGHT CELL FOR CELL NO. xxx IN ZONE NO. yyy OUT OF SEQUENCE

Short form:
NIGHT CELL OUT OF SEQUENCE. ZONE = xxx CELL = yyy

Cell data cards for a night cell must be placed immediately following the associated day version in the input deck (refer to Section 2.1).

'IND' CARD NOT FOUND

This will normally occur if the user has indicated, by placing a non-zero integer in the second option parameter field of the DTA codeword card, that the constant indicator input feature is being employed. Following the blank card that terminates cell data input, the user must place an 'IND' card.

PROGRAM MESSAGES

INVALID LAND USE CODE xx ZONE yyy CELL zzz

Valid land use codes range from 1-15.

INDICATOR NUMBER xxx IS NOT ALLOWED. 20 IS THE MAXIMUM.

The program can handle as many as 20 countermeasure manipulation indicators. Specifying a number greater than 20 while using the 'IND' feature will produce this message.

ERROR IN BARRIER DATA

This error can arise if any of the following data items have been specified:

1. Negative or zero barrier attenuation.
2. Barrier attenuation greater than 24 dB.
3. Barrier number greater than 100.
4. Cell not defined in master data set (see next message).

CELL xxx NOT FOUND - BARRIER yyy

The user has specified a cell in the barrier data which is not defined in the master data set. The xxx is the internal cell number in order of input in the master data set.

COUNTERMEASURE xx MISDEFINED

An unknown countermeasure type code number has been input. See Table 2-5 for a list of allowable type codes.

COUNTERMEASURES DO NOT MATCH COSTS

The user has defined more or less countermeasures than cost functions (refer to Sections 2.2 and 2.3).

CM TYPE 18 OR 20 OUT OF ORDER

PROGRAM MESSAGES

Stationary source and path-receiver countermeasures must be the final countermeasures to be defined.

NEGATIVE CM PARAMETERS NOT ALLOWED

Countermeasure parameters (variables) must always be positive in the cost functions.

NEGATIVE COSTS DISALLOWED

No negative values in the cost functions are permitted.

COSTS DO NOT MATCH COUNTERMEASURES

More or less cost functions have been input than countermeasures defined. Refer to Sections 2.2 and 2.3.

ERROR IN SOUNDPROOFING DATA

Zeroes for decibel or cost specifications are not allowed unless the path-receiver override array has been prepared to allow them (see Section 2.5).

ERROR IN RATIO DATA

The user must take care to specify the first and last zones for which the ratios apply in the correct numerical order. In addition, the user must not specify zones which do not exist.

ERROR IN STATIONARY SOURCE DATA

Three separate types of errors can cause the above message to be printed.

1. More than 20 stationary sources are defined.
2. The sources are not input in numerical sequence.
3. There are unexpected zeroes in the cost or decibel fields (See Section 2.6).

INITIAL EXPENDITURES EXCEED BUDGET

The user has defined a set of initial expenditures which exceed the total budget he has allowed.

NEGATIVE INITIAL EXPENDITURE, CM xx

All initial expenditures must be non-negative.

ERROR IN TYPE 15 CM NO. xx AFFECTING SOURCE NO. yy

Short form:
ERROR TYPE 15 CM xx SOURCE NO. yy

The program has encountered a situation in which the sum of the countermeasure variables for type 15 countermeasures affecting a source exceeds unity. Refer to Section 2.2.

In addition to the above messages, there are a few messages remaining in the program which were inserted during the debugging phase of development. While these messages should no longer occur, they may have some value to anyone wishing to modify the program to suit his particular needs.

TOO MANY P/R COUNTERMEASURES

The bounds of the DOLPER array (see Appendix C, Common block descriptions) have been exceeded. This may happen if the user has attempted to increase the number of cells the program can contain but has neglected to increase the size of the DOLPER array sufficiently.

TOO MANY CELL LOCATIONS

This error is similar to the message above. The arrays in the /RECPAT/ Common block must be expanded.

TOO MANY SECONDARY CELLS

The bounds of the NSEC array have been exceeded or the array was not zeroed before use. The array must be zeroed before every new expenditure scenario is evaluated.

PROGRAM ERROR x. CONTACT PROGRAMMING PERSONNEL.

This error can occur for a large number of reasons, most of which are in the area of arrays being overwritten or misused. If x is 2, 3, or 5, then the error has occurred in subroutines DISBRS, REPCAL, and REBEN, respectively.

CHAPTER 4

SPECIAL C0NSIDERATI0NS F0R N0IZ0P APPLICATI0NS

4.1 System Control Cards for Execution of N0IZ0P on University Computing Company Univac 1108.

It is assumed that the user has a basic familiarity with the University Computing Company-1108 Executive System Manual (*) and the FASBAC User's Guide (**) (FASBAC is an interactive teletype accessible timesharing system connected to the 1108 computer). The word 'card' is used here to denote one physical input record. In actual practice, this may indeed be a card, or it may be a line of information if input is from a file, for instance through the use of FASBAC, or through the use of the ADD UCC EXEC control card. In the following instructional control card setups the hypothetical University Computing Company-1108 user account number XXXYYY is used, and it is assumed that the primary printed output is to be routed to a line printer with the site code 2215 (every remote batch station is identified to the UCC system by a unique site code). Furthermore, it is assumed that the user wishes to direct the secondary output to his FASBAC account BZZZVVV0 where this output will be stored as a 'common' file with the name N0ISEC. Also, an immediately executable copy of the N0IZ0P program is assumed to be stored in the file N0IZ0P/UCCABS (this is also called a 'pseudo-processor'). A typical card deck setup would look like this (the @-sign is a 7-8 multipunch on cards):

(*) University Computing Company, 'Univac 1108 Executive System Programmer's Reference Manual,' UCC Publication 3025, June 1974.

(**) University Computing Company, 'FASBAC User's Guide,' UCC Publication 3010, 07-01-75, updated June 2, 1975.

```
@ RUN,D INTID,XXXYYY,3,100                                 BZZZVVV0
@ MSG PLEASE NOTIFY JOHN DOE, EXTENSION 345
@ DIR 7=1/37(N0ISEC)
@ FCL AUXPR,AUXPR
PRINTER 8,ALTERNATE FILE 1
@ N0IZ0P XQT
      .
      .
      .
Input data (described in previous sections of this report)
      .
      .
      .
@@
```

The RUN card says that the run is at normal priority ('D'), is identified by 'INTID' (this field is often used for the user's internal accounting; it will appear on University Computing Company's monthly billing sheet), the user's account number is XXXYYY, he is allowing for up to 3 minutes of central processing time, and up to 100 pages of printed output. He also identifies with BZZZVVV0 his FASBAC account number, with the B in column 45.

Any number of MSG cards can be used to transmit messages to appear on the primary printed output.

The DIR card says direct the secondary printed output ('7') to FASBAC which has the site code 1/37, and store it there in the common file N0ISEC. The FCL card and the card that follows it sets up FORTRAN logical unit 8 as the secondary printed output.

N0IZ0P XQT actually loads the computer program into core and starts executing it. This card is followed by the input data cards. The card deck is ended by an end-of-file card which consists of two @-characters. This last card is not required if input is from a FASBAC file.

If the user now wishes to look at his secondary printed output in FASBAC after his run has been made, he would log in and could then obtain a printed copy by giving the command

TYPC N0ISEC

It is recommended however, that the file N8ISEC be stripped of undesirable and confusing lines and characters before typing out the hard copy by the use of a command file here called AUX, looking like this:

```
T8P
LABEL 1
N
E8F 3
:IF/C2,2 /$/: JUMP 2
DELETE %L,%L
JUMP 1
LABEL 2
C/NP/W*/C1,2 /**//
JUMP 1
LABEL 3
TYPE
```

With this command file AUX in existence, the commands after logging in would be like this:

```
8LD N8ISEC C8
USE AUX
```

After a short time delay, the secondary print will be typed out. To avoid unnecessary storage charges, N8ISEC should be deleted after a hard copy has been obtained by commanding:

```
UNSAVE N8ISEC C8
```

For the next example, let us assume that the file N8IZ8P/PR8GS contains both the symbolic and object modules of all the routines that collectively make up the N8IZ8P program. Let us further assume that the main program is also called N8IZ8P. Also, this time, we do not wish to generate a secondary print. A typical card deck setup would then look like this:

```
@ RUN,D INTID,XXXYYY,3,100
@ MSG N8 SEC8NDARY PRINT
@ XQT CUR
FSTIN N8IZ8P/PR8GS
@N XQT N8IZ8P
   .
   .
   .
data cards
   .
   .
   .
@@
```

SPECIAL CØNSIDERATIØNS

The XQT CUR commands the execution of the 'Complex Utility Routines', in this case loading the Fastrand file NØIZØP/PRØGS into the user accessible area of the magnetic storage drum, called the 'Program Complex File' (PCF). The next card, XQT NØIZØP, directs that the object module called NØIZØP/CØDE (which would have been generated from a symbolic element called NØIZØP, i.e., the FØRTRAN deck of the main program) be treated as a main program, assembling all the subroutines that it requires, loading it into core, and starting execution.

For the next example, let us assume that we wish to generate a secondary print in FASBAC, to use the absolute element NØIZØP/UCCABS for executing the program, and that the Fastrand file SPØKAN/LØW contains card images of all the data we wish to supply to NØIZØP except the first card. Then, the deck would be set up in the following manner:

```
@ RUN,D INTID,XXXYYY,3,100                     8ZZZVVVD
@ MSG INPUT FRØM SPØKAN/LØW
@ DIR 7=1/37(NØISEC)
@ FCL AUXPR,AUXPR
PRINTER 8,ALTERNATE FILE 1
@ XQT CUR
FSTIN SPØKAN/LØW
@ NØIZØP XQT
T  8
@I ADD SPØDLØ
@@
```

The ADD command with the 'I'-option is transparent, i.e., it will not be echoed on the primary print like all the other control cards, but simply gives the instruction to add the symbolic card images contained in the PCF element SPØDLØ as if they all had been put into the run deck at this point. SPØDLØ would have been an element of the Fastrand file SPØKAN/LØW which was loaded into the PCF earlier by the FSTIN command after XQT CUR.

4.2 Two Dimensions with Type 15 Countermeasures

Section 2.2 gives a general description of the type 15 countermeasure, and also a short example of how it can be used to simulate a two-dimensional cost function. Two dimensional means that the effect (noise reduction) depends on two expenditures. More details and a different application are discussed here.

The mathematically minded reader will notice that there is a restriction imposed on the form the two-dimensional cost function can take; it must be a product of functions, each depending only on one expenditure:

$$F(s,t) = f(s)g(t) \qquad (4\text{-}1)$$

where F is the two-dimensional function, s and t are expenditures on two type 15 countermeasures, and f and g are one-dimensional functions of s and t, respectively.

A special problem arises when f(s) and g(t) are originally given in terms of 'decibels versus cost'. Remembering that the type 15 countermeasure accepts only information of the kind 'fractional application versus cost' (i.e., apply a constant noise reduction device to a fraction of a fleet of vehicles), a transformation of scale must be performed before the cost function is suitable for input to the computer program.

Let the range of f be from 0 to fmax. If we wanted to implement the 'fractional application' kind of countermeasure, then the noise reduction (NR) as a function of the fraction treated (a) would be:

```
NR(a,fmax) =
  -10*log{[a+(1-a)*10**(fmax/10)]*10**(-fmax/10)}              (4-2)
```

where a single asterisk denotes multiplication, and a double asterisk denotes 'raise to the power'.

However, if we want to implement the 'decibel versus cost' kind of countermeasure, f (the actual decibel noise reduction) is given directly as a function of cost s, whereas the type 15 countermeasure accepts only fractional application a versus cost s, a must therefore be calculated for any given f(s) from the inverted equation (4-2), setting NR equal to f(s):

$$a = \frac{10^{**}(fmax/10)*[1-10^{**}(-f(s)/10)]}{10^{**}(fmax/10) - 1} \quad (4\text{-}3)$$

As an illustration, Figure 4-1 shows a as a function of s if f(s) is linear. A practical example is given in Figure 4-2. There, f(s) is given as a piecewise linear function. a(f(s)) would consist of pieces of curved functions which, for purposes of input to NOIZOP, are again approximated by linear segments.

Figure 4-2 also indicates on the right-most scale another feature of the simulation of two-dimensional cost functions. The example in Section 2.2, type 15, mentions that the fractions of noise energy contributed by each partial fleet must be known for the baseline case. In the example used in Figure 4-2, the total fleet is the fleet of all trucks; the partial fleet under consideration is the fleet of 'existing' or 'old' trucks, which, say, make up 53.1 percent of the fleet, and contribute 56.4 percent of the noise energy (details of how this number is obtained are not discussed here). The other partial fleet ('new' trucks) therefore contributes 100 - 56.4 = 43.6 percent of the noise energy. The feasible range for the old trucks countermeasure would therefore be 0. to 0.564; this is shown on the right-most scale of Figure 4-2.

Two type 15 countermeasures would be defined, both to apply to the source 'trucks' as a whole, but each dealing with a partial fleet. How the cost functions would be transformed has been shown above for one countermeasure.

It is easily seen that this concept can be generalized to three- and more-dimensional cost functions as long as they can be written as products of one-dimensional cost functions. Also, note that 'decibel versus cost' and 'fractional application versus cost' can be mixed.

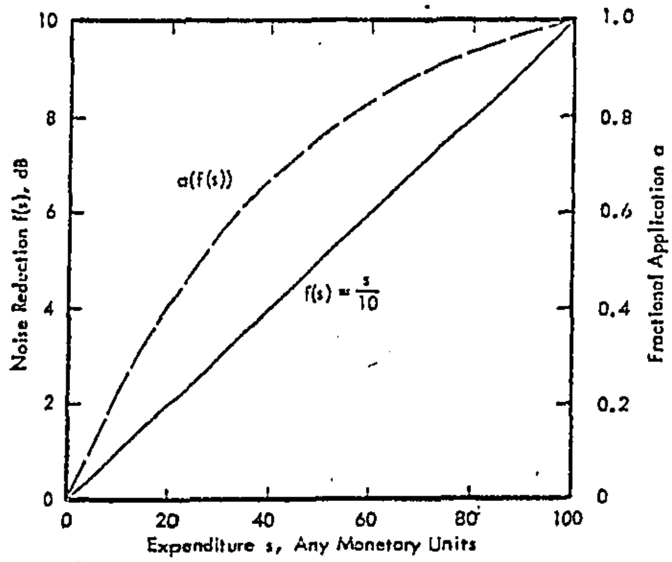

Figure 4-1. Illustration of Scale Transformation for Type 15 Countermeasure

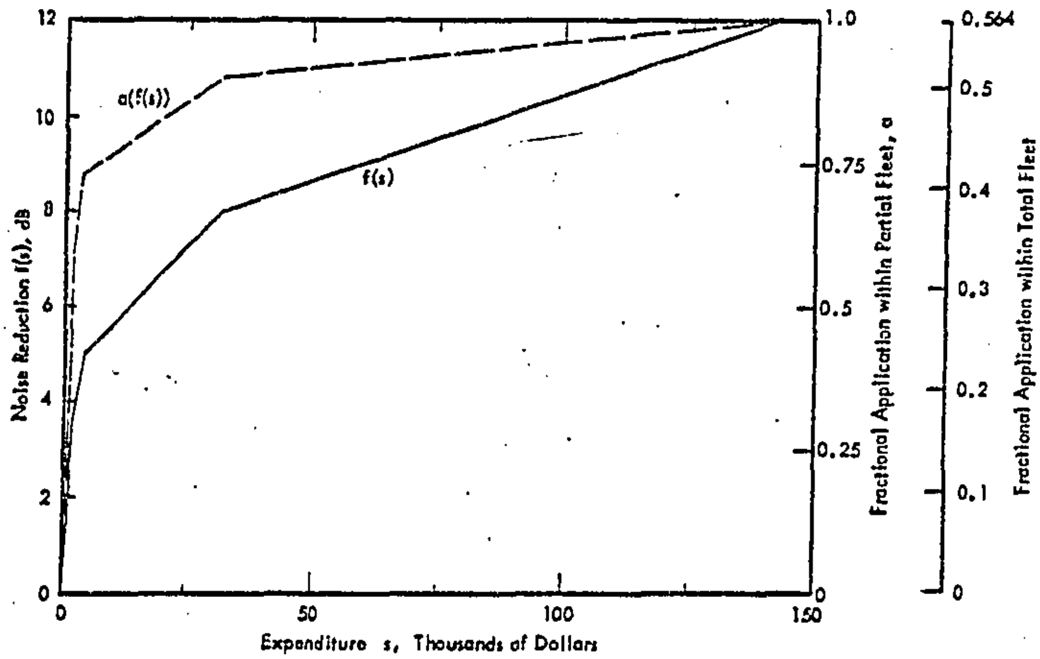

Figure 4-2. Practical Example of Scale Transformation for Type 15 Countermeasure

CHAPTER 5

EXAMPLES OF NOIZOP DATA INPUT

5.1 A Simple Demonstration Case

This example is a purely hypothetical demonstration case, i.e., it is not based on any real data. Particular numbers were chosen to test and demonstrate many capabilities of NOIZOP 2.1. The input stream is shown in Figure 5-1, the resulting output in Figure 5-2. The following chart relates input stream lines of Figure 5-1 to the page number where the resulting output may be found.

LINES IN INPUT STREAM	OUTPUT CREATED PAGE NUMBER(S)	REFER TO SECTION NUMBER
1	5-4	2.0
2-3	all	2.0
4-23	5-6	2.1
24-41	5-7	2.2
42-67	5-8	2.3
68-74	5-9	2.5
75-80	5-10	2.6
81-87	5-11	2.4
88	5-11	2.9
89	5-12	2.10
90-92	5-13 to 5-17	2.11.1
93	5-17	2.12

```
T  8
SHORT EXAMPLE CASE
TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
DTA  1  THREE CELL EXAMPLE CASE
AUTOMOBILES                          FRACTIONAL RAILROAD ENERGY AT NIGHT
TRUCK TIRES                          SOURCE LEVEL RED. FROM AUTO MUFFLERS
BUSSES                               SOURCE LEVEL RED. FROM QUIET TRUCK TIRES
RAILROAD                             STATIONARY SOURCE NUMBER
AIRCRAFT
STATIONARY SOURCE
REROUTED AIRCRAFT

 1 1 1 1 1 1 0
  1   1   1    100.    500.    100.     45.     1.
  1   1   2     60.     55.             50.    52.     65.     48.
  1   1   4   3800.210200.210200.        1.
  1101    1    200.    500.    100.     40.     1.
  1101    2     55.     50.             45.    52.     60.     48.
  1101    4   3800.210200.208200.        1.
  2   1   1    400.    800.    200.     55.     5.
  2   1   2     70.     68.     72.     65.    55.     65.     60.
  2   1   4   3800.216200.210200.        2.

CM      COUNTERMEASURES FOR EXAMPLE CASE
MUFFLERS ON CARS
   10    1          2
QUIET TRUCK TIRES
   15    2          3
LEQ REDUCTION OF BUSSES
   12    3
AIRCRAFT REROUTING
    1    5    7
NIGHT FLIGHT CURFEW OF AIRCRAFT
    3    5    7
SWITCHING NIGHT RAILROAD ACTIVITY TO DAY
    5    4          1
STATIONARY SOURCE REDUCTION
   18    6          4
BARRIERS AND SOUNDPROOFING
   20

COST    SAMPLE NUMBERS TO SIMULATE COSTS
COSTS TO INSTALL MUFFLERS ON CARS
0.        1.
0.        1.
0.        100.
COSTS FOR QUIET TRUCK TIRES
0.        1.
0.        1.
0.        200.
COSTS FOR QUIETING BUSSES
0.        5.
0.        5.
0.        500.
REROUTING COSTS
0.        1.
0.        1.
0.        5000.
```

Figure 5-1. Input Stream for Simple Demonstration Case. The left-most column is not part of the input data; it provides a line count for this figure.

```
NIGHT FLIGHT CURFEW COSTS
0.        1.
0.        1.
0.        1000.
RAILROAD CURFEW SWITCHING COSTS
0.        1.
0.        1.
0.        200.

PARE    PATH-RECEIVER INPUT
TEST VALUES FOR SOUNDPROOFING
    1    1    1    1    1    1    1    1    1    1    1    1
    5   10   15
         1.        2.        3.
   10   20   30
         2.        4.        5.
STAS    STATIONARY SOURCE INPUT
STATIONARY SOURCE SAMPLE INPUT
    1    1    1    1    1    1
  1                3.        5.        20.       30.       40.       100.
  2                6.        6. -      20.       30.       40.       100.

BAR  1  SAMPLE BARRIERS FOR EXAMPLE
BARRIER DEFINITION WITH NO SECONDARY CELLS
   1.  1.  1. .65  0.  1.
   1.  1.  1. .05  0.  1.
   1      20.      40.  1 1   5.  10.
   2      10.      20.  2 1   5.  10.

BASE    BASELINE EVALUATION
RANK    ILLUSTRATIVE SOURCE LEVELS ONLY
OPT      500K OPT RUN

         .5        10.       1.
END
```

Figure 5-1. (Continued)

```
JOB DESCRIPTION:
TEST DATA FOR SHORT SAMPLE CASE INCLUDIN
G STATIONARY SOURCE
---- DTA   1-0
DATA ENTERED FOR    3 CELLS
---- CM   -0-0
  8 COUNTERMEASURES DEFINED
---- COST -0-0
  6 COST FUNCTIONS READ
---- PARE -0-0
INPUT OF SOUNDPROOFING DATA COMPLETE
---- STAS -0-0
DATA READ FOR  2 STATIONARY SOURCES
---- BAR   1-0
DATA READ FOR   2 BARRIERS
---- BASE -0-0
BASELINE NII =  .588147
---- RANK -0-0
MOST OFFENDING SOURCES:
     1  STATIONARY SOURCE                    ( 6)
     2  BUSSES                               ( 3)
     3  AUTOMOBILES                          ( 1)
     4  TRUCK TIRES                          ( 2)
     5  HAILRUAD                             ( 4)
     6  AIRCRAFT                             ( 5)
---- OPT  -0-0
 STEP  CM  TOTAL (ALL CM)   NII
   1    0             .00   .588147
   2    8        10000.00   .498579
   3    8        20000.00   .411951
   4    8        40000.00   .371385
   5    8        60000.00   .338580
   6    8       160000.00   .292322
   7    8       260000.01   .246192
   8    7       280000.00   .236992
   9    7       290000.01   .232913
  10    8       390000.01   .208841
  11    7       410000.00   .204301
  12    1       420000.00   .202624
  13    1       430000.01   .200910
  14    1       440000.01   .199159
  15    1       450000.00   .197369
  16    1       460000.01   .195538
  17    1       470000.01   .193665
  18    1       480000.00   .191746
  19    1       490000.00   .189780
  20    1       500000.00   .187765
FINAL EXPENDITURES:
$     90000. $         0. $         0. $         0. $         0.
$         0. $     50000. $    360000. $         0. $         0.
$         0. $         0. $         0. $         0. $         0.
$         0. $         0. $         0. $         0. $         0.
FINAL NII =   .187765-00
---- END  -0-0
```

Figure 5-2. Short Form Output of Simple Demonstration Case. The left-most column provides a line count which does not usually appear.

```
****************************************
*                                      *
*    COMMUNITY NOISE OPTIMIZATION      *
*              PROGRAM                 *
*         NOIZOP VERSION 2.1           *
*    ----------------------------      *
*        WYLE  LABORATORIES            *
*                                      *
****************************************

***************
TITLE- DATA SET:      SHORT EXAMPLE CASE
JOB DESCRIPTION:      TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
***************
```

```
***************
TITLE- DATA SET:      SHORT EXAMPLE CASE
JOB DESCRIPTION:      TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
***************

*********
DTA   1-0        THREE CELL EXAMPLE CASE
*********

         SOURCES                              INDICATORS
         -------                              ----------

 1 AUTOMOBILES                    1 FRACTIONAL RAILROAD ENERGY AT NIGHT
 2 TRUCK TIRES                    2 SOURCE LEVEL RED. FROM AUTO MUFFLERS
 3 BUSSES                         3 SOURCE LEVEL RED. FROM QUIET TRUCK TIRES
 4 RAILROAD                       4 STATIONARY SOURCE NUMBER
 5 AIRCRAFT
 6 STATIONARY SOURCE
 7 REROUTED AIRCRAFT

SOURCE CONTRIBUTION ELEMENTS FOR BASELINE INDEX:

 1 1 1 1 1 1 0-0-0-0-0-0-0-0-0-0-0-0-0-0

DATA ENTERED FOR   3 CELLS
```

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
1	1	62.5	500.	100.	45	1	60.0	55.0	.0	50.0	52.0	65.0	48.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							3800	216200	210200	1	0	0	0	0	0	0
							0	0	0	0	0	0	0	0	0	0
1	101	75.0	500.	100.	40	1	55.0	50.0	.0	45.0	52.0	60.0	40.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							3800	210200	200200	1	0	0	0	0	0	0
							0	0	0	0	0	0	0	0	0	0
2	1	250.0	800.	200.	55	5	70.0	68.0	72.0	65.0	55.0	65.0	60.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							3800	216200	210200	2	0	0	0	0	0	0
							0	0	0	0	0	0	0	0	0	0

```
****************
TITLE- DATA SET:          SHORT EXAMPLE CASE
JOB DESCRIPTION:          TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
****************


*********
CM   -0-0        COUNTERMEASURES FOR EXAMPLE CASE
*********

--------- MUFFLERS ON CARS
COUNTERMEASURE  1 TYPE 10 'PART IRT' APPLIES TO: AUTOMOBILES                       INDICATOR NO.  2

--------- QUIET TRUCK TIRES
COUNTERMEASURE  2 TYPE 15 'EXCL TRT' APPLIES TO: TRUCK TIRES                       INDICATOR NO.  3

--------- LEQ REDUCTION OF BUSSES
COUNTERMEASURE  3 TYPE 12 'DB  RED ' APPLIES TO: BUSSES                            INDICATOR NO. -0

--------- AIRCRAFT REROUTING
COUNTERMEASURE  4 TYPE  1 'RED FREQ' APPLIES TO: AIRCRAFT                          INDICATOR NO. -0
                                                 REROUTED AIRCRAFT                               -0

--------- NIGHT FLIGHT CURFEW OF AIRCRAFT
COUNTERMEASURE  5 TYPE  3 'NITE RED' APPLIES TO: AIRCRAFT                          INDICATOR NO. -0
                                                 REROUTED AIRCRAFT                               -0

--------- SWITCHING NIGHT RAILROAD ACTIVITY TO DAY
COUNTERMEASURE  6 TYPE  5 'CURFEW  ' APPLIES TO: RAILROAD                          INDICATOR NO.  1

--------- STATIONARY SOURCE REDUCTION
COUNTERMEASURE  7 TYPE 18 'STA SORS' APPLIES TO: STATIONARY SOURCE                 INDICATOR NO.  4

--------- BARRIERS AND SOUNDPROOFING
COUNTERMEASURE  8 TYPE 20 'P-R MOD ' APPLIES TO: ALL SOURCES                       INDICATOR NO. -0
```

```
***************
TITLE- DATA SET:        SHORT EXAMPLE CASE
JOB DESCRIPTION:        TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
***************

*********
COST -0-0          SAMPLE NUMBERS TO SIMULATE COSTS
*********

--------- COSTS TO INSTALL MUFFLERS ON CARS
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        1.000
NOISE RED PARAMETER:          .00          1.00        -.00      -.00      -.00      -.00      -.00      -.00
CORRESPONDING COSTS:          .00        100.00        -.00      -.00      -.00      -.00      -.00      -.00

--------- COSTS FOR QUIET TRUCK TIRES
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        1.000
NOISE RED PARAMETER:          .00          1.00        -.00      -.00      -.00      -.00      -.00      -.00
CORRESPONDING COSTS:          .00        200.00        -.00      -.00      -.00      -.00      -.00      -.00

--------- COSTS FOR QUIETING BUSSES
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        5.000
NOISE RED PARAMETER:          .00          5.00        -.00      -.00      -.00      -.00      -.00      -.00
CORRESPONDING COSTS:          .00        500.00        -.00      -.00      -.00      -.00      -.00      -.00

--------- REROUTING COSTS
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        1.000
NOISE RED PARAMETER:          .00          1.00        -.00      -.00      -.00      -.00      -.00      -.00
CORRESPONDING COSTS:          .00       5000.00        -.00      -.00      -.00      -.00      -.00      -.00

--------- NIGHT FLIGHT CURFEW COSTS
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        1.000
NOISE RED PARAMETER:          .00          1.00        -.00      -.00      -.00      -.00      -.00      -.00
CORRESPONDING COSTS:          .00       1000.00        -.00      -.00      -.00      -.00      -.00      -.00

--------- RAILROAD CURFEW SWITCHING COSTS
FEASIBLE RANGE OF CM VARIABLE:          .000 TO        1.000
NOISE RED PARAMETER:          .00          1.00        -.00      -.00      -.00      -.00      -.00      -.00
CORRESPONDING COSTS:          .00        200.00        -.00      -.00      -.00      -.00      -.00      -.00


SUMMARY OF ALLOWED COST RANGES ($000'S):

COUNTERMEASURE
    NUMBER                   RANGE
--------------      ----------------------

      1             $     .00 TO $    100.00
      2             $     .00 TO $    200.00
      3             $     .00 TO $    500.00
      4             $     .00 TO $   5000.00
      5             $     .00 TO $   1000.00
      6             $     .00 TO $    200.00
```

```
****************
TITLE- DATA SET:          SHORT EXAMPLE CASE
JOB DESCRIPTION:          TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
****************


**********
PAGE -0-0        PATH-RECEIVER INPUT
**********



---------- TEST VALUES FOR SOUNDPROOFING

P/R NUD OVERRIDE ARRAY:
    1    1    1    1    1    1    1    1    1    1    1    1

RESIDENTIAL SOUNDPROOFING AND COST FACTORS ($/SQ FT):

    5.00     10.00     15.00
    1.00      2.00      3.00

COMMERCIAL  SOUNDPROOFING AND COST FACTORS ($/SQ FT):

   10.00     20.00     30.00
    2.00      4.00      5.00
```

```
****************
TITLE- DATA SET:        SHORT EXAMPLE CASE
JOB DESCRIPTION:        TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
****************


*********
STAS -0-0       STATIONARY SOURCE INPUT
*********



--------- STATIONARY SOURCE SAMPLE INPUT

STATIONARY SOURCE OVERRIDE ARRAY:
    1    1    1    1    1    1

STATIONARY SOURCES-
                                                 COSTS IN THOUSANDS
             MIN.      MAX.        MIN.         MAX.        ELIM.        ELIM.
SOURCE       REQ.      REQ.        REQ.         REQ.        NIGHT        SOURCE
-------------------------        ---------------------------------------------

  1           3.        5.        20.00        30.00        40.00        100.00
  2           6.        8.        20.00        30.00        40.00        100.00
```

```
****************
TITLE- DATA SET:       SHORT EXAMPLE CASE
JOB DESCRIPTION:       TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
****************


*********
BAR   1-0          SAMPLE BARRIERS FOR EXAMPLE
*********

--------- BARRIER DEFINITION WITH NO SECONDARY CELLS

BARRIER EFFECTIVENESS RATIOS:
                                               LOW   HIGH

     1 AUTOMOBILES                             1.00  1.00
     2 TRUCK TIRES                             1.00  1.00
     3 BUSSES                                  1.00  1.00
     4 RAILROAD                                 .85   .85
     6 STATIONARY SOURCE                       1.00  1.00

             COSTS(-$1000'S)       PRIMARY CELL          SECONDARY CELLS -->
ANBR *        HT 1      HT 2  *  ID     DB1   DB2  *  ID     DB1    DB2  *  ID     DB1    DB2  *  ID     DB1    DB2  *
-------------------------------------------------------------------------------------------------------------------------
* 1 *        20.0      40.0  *  1  1   5.0  10.0  *  -0 -0   -.0    -.0  *  -0 -0   -.0    -.0  *  -0 -0   -.0    -.0  *
* 2 *        10.0      20.0  *  2  1   5.0  10.0  *  -0 -0   -.0    -.0  *  -0 -0   -.0    -.0  *  -0 -0   -.0    -.0  *



****************
TITLE- DATA SET:       SHORT EXAMPLE CASE
JOB DESCRIPTION:       TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
****************


*********
BASE -0-0          BASELINE EVALUATION
*********

FOR AN AVE POPULATION OF    388. PERSONS, THE BASELINE NOISE IMPACT INDEX IS:      .586147
```

```
****************
TITLE- DATA SET:        SHORT EXAMPLE CASE
JOB DESCRIPTION:        TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
****************

*********
RANK -0-0        ILLUSTRATIVE SOURCE LEVELS ONLY
*********

POPULATION WEIGHTED AVE INDICES FOR SOURCE RANKING:           SOURCES (1-10) / (11-20)

  .129882  .067981  .171503  .030709  .013390  .175102  .000000  .000000  .000000  .000000
  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000


FRACTIONAL CONTRIBUTION TO NOISE IMPACT INDEX:                SOURCES (1-10) / (11-20)

  .220832  .114735  .291599  .052213  .022766  .297494  .000000  .000000  .000000  .000000
  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000

MOST OFFENDING SOURCES:                         SOURCE NO.

        1  STATIONARY SOURCE                     ( 6)
        2  BUSSES                                ( 3)
        3  AUTOMOBILES                           ( 1)
        4  TRUCK TIRES                           ( 2)
        5  RAILROAD                              ( 4)
        6  AIRCRAFT                              ( 5)
```

```
****************
TITLE- DATA SET:        SHORT EXAMPLE CASE
JOB DESCRIPTION:        TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
****************

*********
OPT  -0-0          500K OPT RUN
*********

ADJUSTED INPUT EXPENDITURES:

        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
                                                                                TOTAL= $        0.

TOTAL BUDGET =                  $      500000.00
GRADIENT STEPSIZE =             $       10000.00
INITIAL MAX. EXPENDITURE RATIO =            1.00

 STEP                       EXPENDITURES (1-10) / (11-20)  /  GRADIENTS (1-10) / (11-20)
------ -----------------------------------------------------------------------------------------------

     1 .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
       .237716-06 .528934-07 .747038-07 .695505-09 -.224255-08 -.188663-07 .776938-06 .895678-05 .000000   .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
INDEX=    .588147          SUM= $          .00

     2 .000000    .000000    .000000    .000000    .000000    .000000    .000000    .100000+05 .000000    .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
       .232051-06 .514644-07 .723862-07 .966718-09 .224255-08 .000000    .776938-06 .866274-05 .000000    .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
INDEX=    .498579          SUM= $     10000.00

     3 .000000    .000000    .000000    .000000    .000000    .000000    .000000    .200000+05 .000000    .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
       .220582-06 .485692-07 .675270-07 .174344-08 .224255-08 .000000    .776938-06 .202829-05 .000000    .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
INDEX=    .411951          SUM= $     20000.00

     4 .000000    .000000    .000000    .000000    .000000    .000000    .000000    .400000+05 .000000    .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
       .212816-06 .475252-07 .675275-07 .268801-08 .583112-08 .000000    .776938-06 .164028-05 .000000    .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
INDEX=    .371385          SUM= $     40000.00

     5 .000000    .000000    .000000    .000000    .000000    .000000    .000000    .600000+05 .000000    .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
       .198505-06 .456080-07 .675275-07 .443883-08 .118526-07 .000000    .460001-06 .462571-06 .000000    .000000
       .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000    .000000
INDEX=    .338580          SUM= $     60000.00
```


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STEP	EXPENDITURES (1-10) / (11-20) / GRADIENTS (1-10) / (11-20)								
6	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.160000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.198504-06	.456075-07	.675270-07	.443854-08	.118526-07	.000000	.460000-06	.461301-06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.292322	SUM= $	160000.00							
7	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.260000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.198504-06	.456075-07	.675270-07	.443858-08	.118524-07	.000000	.460000-06	.373518-06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.246192	SUM= $	260000.01							
8	.000000	.000000	.000000	.000000	.000000	.000000	.200000+05	.260000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.209915-06	.470903-07	.675275-07	.520760-08	.141811-07	.000000	.407920-06	.281513-06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.236992	SUM= $	280000.00							
9	.000000	.000000	.000000	.000000	.000000	.000000	.300000+05	.260000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.216137-06	.478941-07	.675270-07	.560266-08	.152950-07	.000000	.226997-06	.240721-06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.232913	SUM= $	290000.01							
10	.000000	.000000	.000000	.000000	.000000	.000000	.300000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.158405-06	.403078-07	.675273-07	.117813-08	-.000000	.000000	.226997-06	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.208841	SUM= $	340000.01							
11	.000000	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.167747-06	.426665-07	.714845-07	.124027-08	-.000000	.000000	.646758-07	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.204301	SUM= $	410000.00							
12	.100000+05	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.171336-06	.435717-07	.730044-07	.127411-08	-.000000	.000000	.662107-07	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.202624	SUM= $	420000.00							
13	.200000+05	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.175086-06	.445175-07	.745936-07	.130241-08	-.246110-12	.000000	.678210-07	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.200910	SUM= $	430000.01							
14	.300000+05	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.178998-06	.455029-07	.762472-07	.132601-08	-.738328-12	.000000	.695134-07	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.199159	SUM= $	440000.01							

STEP	EXPENDITURES (1-10) / (11-20) / GRADIENTS (1-10) / (11-20)								
15	.400000+05	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.183093-06	.465159-07	.779815-07	.136074-08	-.000000	.000000	.712891-07	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.197369		SUM= $	450000.00						
16	.500000+05	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.187374-06	.476170-07	.797941-07	.139224-08	-.000000	.000000	.731599-07	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.195538		SUM= $	460000.01						
17	.600000+05	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.191871-06	.487474-07	.816946-07	.142424-08	-.000000	.000000	.751302-07	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.193665		SUM= $	470000.01						
18	.700000+05	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.196582-06	.499336-07	.836858-07	.145869-08	-.246110-12	.000000	.777101-07	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.191746		SUM= $	480000.00						
19	.800000+05	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.201530-06	.511799-07	.857775-07	.149561-08	-.246110-12	.000000	.794088-07	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.189780		SUM= $	490000.00						
20	.900000+05	.000000	.000000	.000000	.000000	.000000	.500000+05	.360000+06	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.206737-06	.524900-07	.879790-07	.153478-08	.246110-12	.000000	.000000	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.187765		SUM= $	500000.00						

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PATH-RECEIVER BREAKDOWN BY CELL:

ZONE	CELL	LND USE	CELL POP.	TOTAL ADV. AFF. NO P-R MODS	REMAINING ADV. AFF. W/ P-R MODS	PER-CENT ADV. AFF. NO P-R MODS	PER-CENT ADV. AFF. W/ P-R MODS	P-R MOD TYPE	P-R MOD EXPENDITURE
1	1	1	137.5	65.2	-.0	47.445	-.000	12	340000.00
2	1	5	250.0	140.0	72.8	56.007	29.104	5	20000.00

PATH-RECEIVER MODS COST BREAKDOWN:

SP-1	SP-2	SP-3	B-1	B-2	RELOCATE	SP-1/B-1	SP-2/B-1	SP-3/B-1	SP-1/B-2	SP-2/B-2	SP-3/B-2
0.	0.	0.	0.	20000.	0.	0.	0.	0.	0.	0.	340000.

PATH-RECEIVER EXPENDITURE = $ 360000.01

COST OF NEXT P-R MEASURE = $ 400000.01

STATIONARY SOURCE SUMMARY:

SOURCE	CH TYPE	EXPENSE
1	2	$ 30000.00
2	1	$ 20000.00

STATIONARY SOURCE EXPENDITURE = $ 50000.

COST OF NEXT STATIONARY SOURCE MEASURE = $ 10000.00

```
FINAL EXPENDITURES:

    90000.        0.         0.         0.         0.         0.     50000.    360000.        0.         0.
       0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
                                                                          TOTAL= $    500000.

FINAL COUNTERMEASURE VARIABLES:

 .900000-00 -.000000   -.000000   -.000000   -.000000   -.000000    .500000+05  .360000+06  .000000    .000000
 .000000     .000000    .000000    .000000    .000000    .000000    .000000     .000000    .000000    .000000


IMPACT GRADIENT VECTOR (REDUCTION IN NII/$):

 .206737-06  .524900-07  .879790-07  .153474-08  .246110-12  .000000    .000000    .000000    .000000    .000000
 .000000     .000000     .300000     .000000     .000000     .000000    .000000    .000000    .000000    .000000
                                                        GRADIENT MAGNITUDE =   .230734-06

COUNTERMEASURE RANKING:  1  3  2  4  5  0  7  6
SPENDING LIMIT REACHED:  0  0  0  0  0  0  0  0

                                                        --------------------------------

                                                        NOISE IMPACT INDEX =   .187765-00
                                                        RED. FROM BASELINE =   .400382-00
                                                        COST/BENEFIT RATIO =   .322213+04    $/PERSON

                                                        --------------------------------


****************
TITLE- DATA SET:        SHORT EXAMPLE CASE
JOB DESCRIPTION:        TEST DATA FOR SHORT SAMPLE CASE INCLUDING STATIONARY SOURCE
****************

*********
END  -0-0
*********
```

5.2 Example: San Francisco Bay Region Study Area II

This example was taken from work for the Motor Vehicle Manufacturers Association of the United States on improvements of the community noise countermeasures model, and on their application to two study areas in the San Francisco Bay Region. Figure 5-3 is a listing of the input data stream. With the exception of the STAS codeword ('stationary sources') all codewords are made use of. The output produced by NOIZOP 2.1 will be shown and discussed later. First, some of the input data which may not be understandable upon inspection is discussed in more detail. Only items specific to the use of this computer program are discussed, and not such things as the computation of baseline noise levels from traffic or aircraft, or the preparation of basic countermeasure cost functions.

The cell individual data is contained in lines 18 through 217 of Figure 5-3. Either 2 or 4 data cards are used per cell. Four cards are required only if the cell is affected by aircraft noise, i.e., has a positive noise level associated with source number 11 (the existence of 11 sources is indicated by the names given to these sources in the first halves of lines 5 - 15 of Figure 5-3). Discussing, as an example, the first cell, lines 18 through 21, we see on card 1 that the cell contains 228 people, that it would cost 1.75 million dollars to relocate the people (this high number includes the cost of real estate property), that the cell contains 50,000 square feet of floor area, that the lower criterion level is not specified (see line 328), and that the land use code is 11, i.e., a school (see line 339). On card 2 (line 18), are specified the noise levels due to the first 10 sources, starting with 46.5 dB for the first source (automobiles low speed). It may be seen that this cell is not affected by sources 2, 5, 9, and 10 (zero noise level specified; fields may also have been left blank). Card 3 contains 53.6 dB for the eleventh source.

The existence of 7 countermeasure indicators is signalled by the names given to these indicators on the second halves of lines 5 through 11 of Figure 5-3. Only countermeasure indicator number 6 (aircraft noise reduction due to SAM treatment) had to be specified on a cell individual basis. Card 4 (line 21) contains this indicator in the sixth position in the form 208200 indicating a 4 dB reduction (2 times 4 equals 8, see Section 2.2, type 10 countermeasure) due to countermeasure 9 specified in lines 244 through 245. All other indicators were the same at all cells and could therefore be specified using the 'IND' option (line 219 of Figure 5-3). These indicators were the same because they all refer to surface transport sources the noise level reductions of which do not vary with location. Card type 5 is never required because indicators 8 through 20 are never used.

Countermeasures are defined in lines 227 through 254 of Figure 5-3. Countermeasure type 15 occurs four times: countermeasure numbers 1, 3, 4, and 5. Numbers 1 and 3 constitute a two-dimensional cost function as explained in Sections 2.2 and 4.2, applicable to automobiles. Numbers 4 and 5 constitute a two-dimensional cost function applicable to trucks. The cost function for new trucks (lines 268 to 271 of Figure 5-3) is the one of the example of Section 4.2, Figure 4-2.

For the calculation of the baseline noise energy contributions of the new and old automobile fleets for 1981, it was assumed that new and old vehicles would have the same fleet noise levels (Leq's). The noise energy is then divided the same way as the number of vehicles in the partial fleets which was determined to be 56.8 percent for old vehicles, and 43.2 percent for new vehicles. Hence the upper bounds of the feasible countermeasure variable range in lines 257 and 265.

For the calculation of the baseline noise energy contributions for the new and old truck fleets for 1981 a yearly old vehicle retention rate of 90 percent was used. Let x be a number proportional to the noise energy from the old fleet, y the one from the new fleet, and t the one from the total fleet. Also, let Lx be the fleet noise level in dB for the old trucks, Ly the one for the new ones. Then:

x + y = t

x = fx * 10**(Lx/10) ,   y = (1 - fx) * 10**(Ly/10)

where fx is the fraction of old vehicles in the 1981 truck fleet. One asterisk signifies multiplication, two asterisks signify 'raise to the power'. The noise energy contributions nx (old trucks) and ny (new trucks) can then be obtained:

nx = x/t ,   ny = y/t

In the present case, Lx=82.96 dB, Ly=82.29 dB (these values were available from other concurrent work by Wyle Research). fx=0.9**6 (6 years instead of 5 years because Lx was applicable to 1975 and not to 1976). This results in nx=0.564 and ny=0.436 (see lines 273 and 269 of Figure 5-3).

EXAMPLES

The data factoring facility (line 359) was used to simulate noisier conditions than would be expected for 1981 if one assumes less noise enforcement effort than is currently the case in California. For motorcycles, the calculated fleet noise level increase for no enforcement was 2.366 dB; hence the factor 10**0.2366=1.7244. The numbers for trucks and automobiles were:

```
Trucks:       3.5 dB,  10**0.35 = 2.2387
Automobiles:  5.5 dB,  10**0.55 = 3.548
```

In many instances, values in the input data were entered with more decimal places than would be reasonable considering the available and necessary accuracy. this was done in order to make it easier to trace certain numbers at a later date.

When NOIZOP 2.1 is fed with the input of Figure 5-3 the secondary output of Figure 5-4 results. The associated primary output is shown in Figure 5-6 (41 pages long, appearing at the end of this chapter).

The outputs are largely self-explanatory. Section 2.11.3 may be consulted together with Figure 5-4., and Section 2.11.2 may be consulted together with Figure 5-6. Figure 5-5 shows the change of the Noise Impact Index with expenditures for the case of this example, and for a run where the gradient step size and the initial expenditure ratio were significantly larger. The drastic change in the slope with increasing expenditures indicates that, as expected, the noise reduction efficiency per dollar spent decreases. The large expenditure jumps are due to expenditures on the path-receiver countermeasure (mostly barriers). Its discontinuous character has been discussed in the last paragraph of Section 2.11.1: Only a whole barrier can be built, only a whole cell can be soundproofed at a time, and only all people can be relocated from one cell at a time. Partial jobs are not allowable.

It may be seen that the case with the larger step size and initial expenditure ratio uses much less steps, initially shows higher noise impact indices, but ends up at the same optimal point.

```
T  8
MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
DTA  1 1MASTER DATA FOR SA II, LOW RELOC. COSTS
AUTOMOBILES LOW  SPEED LINE SRC NEW AUTOS LO SP+LOC.TRAFF.SRC.RED.,CM #1
AUTOMOBILES HIGH SPEED LINE SRC EXIST.AUTOS LO SP+LOC.TRAFF.SC.RED.CM #3
AUTOMOBILES LOCAL TRAFFIC SOURCETRUCKS LO SP NEW VEH SOURCE RED., CM #4.
TRUCKS      LOW  SPEED LINE SRC.TRUCKS LO SP ENFORC.+RETROF.SC.RED.CM #5
TRUCKS      HIGH SPEED LINE SRC.TRUCK TIRES SOURCE RED., CM = 6
MOTORCYCLES LOW  SPEED LINE SRC.AIRCRAFT SAM TREATMENT, CM = 9
MOTORCYCLES LOCAL TRAFFIC SOURCERAILROAD LOCO SOURCE RED, CM = 12
BUSES       LOW  SPEED LINE SRC.
RAILROAD    LOCOMOTIVES, LINE S.
RAILROAD    CARS, LINE SOURCE
AIRCRAFT    COMMERCIAL, FLIGHT

 1 1 1 1 1 1 1 1 1 1 1
001001   1226.   1750.0 50.00             11.
001001   2   46.5    0.0   43.7   48.7   0.0   54.1   59.0   37.3   0.0   0.0
001001   3   52.6
001001   4                                   208200
001101   10.     1750.0 50.00             11.
001101   2   40.5    0.0   37.3   42.7   0.0   48.1   53.0   0.0   0.0   0.0
001101   3   45.5
001101   4                                   212200
002001   16.     66.3   4.13              4.
002001   2   56.5    0.0   43.7   59.9   0.0   62.6   59.0   0.0   0.0   0.0
002001   3   52.8
002001   4                                   208200
002101   110.    66.3   4.13              4.
002101   2   50.5    0.0   37.3   53.9   0.0   56.6   53.0   0.0   0.0   0.0
002101   3   45.6
002101   4                                   212200
003001   1270.   9999999350.0             5.
003001   2   48.6    0.0   43.7   55.0   0.0   54.8   59.0   31.9   61.5   52.7
003001   3   48.3
003001   4                                   206200
003101   115.    9999999350.0             5.
003101   2   42.6    0.0   37.3   49.0   0.0   48.1   53.0   0.0   57.4   47.2
003101   3   40.5
003101   4                                   208200
004001   133.    235.1  15.38             1.
004001   2   51.8    0.0   43.7   54.0   0.0   59.7   59.0   45.6   0.0   0.0
004001   3   52.5
004001   4                                   208200
004101   154.    235.1  15.38             1.
004101   2   45.8    0.0   37.3   48.0   0.0   53.7   53.0   0.0   0.0   0.0
004101   3   45.3
004101   4                                   212200
004002   143.    316.6  20.63             1.
004002   2   39.1    0.0   43.7   41.2   0.0   46.8   59.0   32.6   55.2   51.2
004002   3   52.5
004002   4                                   208200
004102   170.    316.6  20.63             1.
004102   2   33.1    0.0   37.3   35.2   0.0   40.8   53.0   0.0   50.4   46.4
004102   3   45.3
004102   4                                   214200
005001   163.    1319.3 79.13             1.
```

Figure 5–3. Input Stream for San Francisco Example. The left-most column is not part of the input data; it provides a line count for this figure.

```
000059    005001  2   60.8    0.0   43.7   64.3   0.0   67.0   59.0   45.6   0.0    0.0
000060    005001  3   51.0
000061    005001  4                                   208200
000062    005101  1136.   1319.3 79.13         1.
000063    005101  2   54.8    0.0   37.3   58.3   0.0   61.0   53.0   0.0    0.0    0.0
000064    005101  3   43.8
000065    005101  4                                   210200
000066    005002  166.    921.8  42.75         1.
000067    005002  2   41.1    0.0   43.7   43.3   0.0   48.8   59.0   35.6   0.0    0.0
000068    005102  1107.   921.8  42.75         1.
000069    005102  2   35.1    0.0   37.3   37.3   0.0   42.8   53.0   0.0    0.0    0.0
000070    006001  145.    518.4  28.50         1.
000071    006001  2   49.3    0.0   43.7   51.6   0.0   56.6   59.0   45.2   65.7   61.7
000072    006101  174.    518.4  28.50         1.
000073    006101  2   43.3    0.0   37.3   45.6   0.0   50.6   53.0   0.0    60.9   56.9
000074    006002  115.    151.0  8.25          1.
000075    006002  2   37.0    0.0   43.7   39.2   0.0   43.9   59.0   0.0    52.7   47.9
000076    006102  124.    151.0  8.25          1.
000077    006102  2   31.0    0.0   37.3   33.2   0.0   37.9   53.0   0.0    48.0   43.2
000078    007001  124.    301.7  15.38         1.
000079    007001  2   61.0    0.0   43.7   64.4   0.0   67.1   59.0   45.6   0.0    0.0
000080    007101  139.    301.7  15.38         1.
000081    007101  2   58.4    0.0   37.3   58.4   0.0   61.1   53.0   0.0    0.0    0.0
000082    007002  141.    504.2  28.50         1.
000083    007002  2   39.9    0.0   43.7   42.1   0.0   47.3   59.0   35.6   0.0    0.0
000084    007102  167.    504.2  28.50         1.
000085    007102  2   33.9    0.0   37.3   36.1   0.0   41.3   53.0   0.0    0.0    0.0
000086    008001  1132.   1176.3 78.75         1.
000087    008001  2   63.9    0.0   43.7   64.4   0.0   69.9   59.0   45.6   0.0    0.0
000088    008001  3   49.7
000089    008001  4                                   206200
000090    008101  1217.   1176.3 78.75         1.
000091    008101  2   57.9    0.0   37.3   58.4   0.0   61.9   53.0   0.0    0.0    0.0
000092    008101  3   42.3
000093    008101  4                                   210200
000094    008002  118.    209.1  12.00         1.
000095    008002  2   51.7    0.0   43.7   55.3   0.0   63.8   59.0   32.6   0.0    0.0
000096    008002  3   51.1
000097    008002  4                                   208200
000098    008102  129.    209.1  12.00         1.
000099    008102  2   45.7    0.0   37.3   49.3   0.0   57.8   53.0   0.0    0.0    0.0
000100    008102  3   43.9
000101    008102  4                                   210200
000102    009001  183.    1758.5 62.25         1.
000103    009001  2   0.0     0.0   43.7   0.0    0.0   0.0    59.0   0.0    71.8   62.4
000104    009001  3   48.5
000105    009001  4                                   206200
000106    009101  1136.   1758.5 62.25         1.
000107    009101  2   0.0     0.0   37.3   0.0    0.0   0.0    53.0   0.0    67.8   56.3
000108    009101  3   41.0
000109    009101  4                                   208200
000110    009002  127.    480.2  24.00         1.
000111    009002  2   48.5    0.0   43.7   52.1   0.0   54.8   59.0   32.6   63.6   53.5
000112    009002  3   51.4
000113    009002  4                                   208200
000114    009102  145.    480.2  24.00         1.
000115    009102  2   42.5    0.0   37.3   46.1   0.0   48.8   53.0   0.0    59.6   47.4
000116    009102  3   44.3
000117    009102  4                                   212200
000118    010001  118.    496.9  10.50         1.
```

Figure 5–3 (Continued)

```
000119     010001  2   0.0    0.0   43.7   0.0   0.0   0.0  59.0   0.0  71.8  67.8
000120     010001  3  47.8
000121     010001  4                                  206200
000122     010101  129.    496.9  10.50            1.
000123     010101  2   0.0    0.0   37.3   0.0   0.0   0.0  55.0   0.0  62.4  56.3
000124     010101  3  40.2
000125     010101  4                                  208200
000126     010002  13.     67.5   2.65             1.
000127     010002  2  50.1    0.0   43.7  53.0   0.0  57.0  59.0  37.7   0.0   0.0
000128     010102  15.     67.5   2.63             1.
000129     010102  2  44.1    0.0   37.3  47.0   0.0  51.0  53.0   0.0   0.0   0.0
000130     011001  110.    322.3  8.25             1.
000131     011001  2  58.0    0.0   43.7  60.3   0.0  66.0  59.0  50.7   0.0   0.0
000132     011101  116.    322.3  8.25             1.
000133     011101  2  52.0    0.0   37.3  54.3   0.0  60.0  53.0   0.0   0.0   0.0
000134     011002  18.     283.9  6.00             1.
000135     011002  2  49.2    0.0   43.7  52.0   0.0  56.2  59.0  40.5   0.0   0.0
000136     011102  113.    283.9  6.00             1.
000137     011102  2  43.2    0.0   37.3  46.0   0.0  50.2  53.0   0.0   0.0   0.0
000138     012001  1228.   1750.0 50.00            11.
000139     012001  2  46.4    0.0   43.7  48.6   0.0  54.0  59.0  39.2   0.0   0.0
000140     012101  10.     1750.0 50.00            11.
000141     012101  2  40.4    0.0   37.3  42.6   0.0  48.0  53.0   0.0   0.0   0.0
000142     013001  171.    1766.0 54.75            1.
000143     013001  2  55.8    0.0   43.7  58.1   0.0  63.7  59.0  48.9   0.0   0.0
000144     013101  1116.   1766.0 54.75            1.
000145     013101  2  49.8    0.0   37.3  52.1   0.0  57.7  53.0   0.0   0.0   0.0
000146     013002  124.    558.0  16.50            1.
000147     013002  2  45.7    0.0   43.7  47.9   0.0  53.4  59.0  37.7   0.0   0.0
000148     013102  139.    558.0  16.50            1.
000149     013102  2  39.7    0.0   37.3  41.9   0.0  47.4  53.0   0.0   0.0   0.0
000150     014001  1341.   40000.0800.00           12.
000151     014001  2  49.0   49.2   43.7  50.5  53.3  55.9  59.0  33.4   0.0   0.0
000152     014101  1269.   40000.0800.00           12.
000153     014101  2  43.0   43.2   37.3  44.5  47.3  49.9  53.0   0.0   0.0   0.0
000154     015001  126.    692.4  23.25            1.
000155     015001  2  53.8    0.0   43.7  56.1   0.0  61.7  59.0  48.5   0.0   0.0
000156     015101  143.    692.4  23.25            1.
000157     015101  2  47.8    0.0   37.3  50.1   0.0  55.7  53.0   0.0   0.0   0.0
000158     015002  127.    578.6  21.38            1.
000159     015002  2  51.2    0.0   43.7  52.8   0.0  57.2  59.0  48.5   0.0   0.0
000160     015102  184.    578.6  21.38            1.
000161     015102  2  45.2    0.0   37.3  46.8   0.0  51.2  53.0   0.0   0.0   0.0
000162     015003  1219.   5056.5 200.63           1.
000163     015003  2  43.0    0.0   43.7  44.5   0.0  50.3  59.0  38.5   0.0   0.0
000164     015103  1359.   5056.5 200.63           1.
000165     015103  2  37.0    0.0   37.3  38.5   0.0  44.3  53.0   0.0   0.0   0.0
000166     016001  1117.   2661.4 94.13            4.
000167     016001  2   0.0    0.0   43.7   0.0   0.0   0.0  59.0   0.0  71.6  62.4
000168     016101  1191.   2661.4 94.13            4.
000169     016101  2   0.0    0.0   37.3   0.0   0.0   0.0  53.0   0.0  67.8  56.3
000170     017001  152.    422.9  29.63            1.
000171     017001  2  00.0    0.0   43.7   0.0   0.0   0.0  59.0   0.0  65.9  61.9
000172     017101  186.    422.9  29.63            1.
000173     017101  2   0.0    0.0   37.3   0.0   0.0   0.0  53.0   0.0  61.1  57.1
000174     017002  158.    437.1  30.38            1.
000175     017002  2  55.6   57.9   43.7  55.2  62.0  66.4  59.0   0.0  52.7  48.0
000176     017102  195.    437.1  30.38            1.
000177     017102  2  50.6   52.9   37.3  50.2  56.0  58.4  53.0   0.0  47.9  43.2
000178     018001  134.    523.9  27.00            1.
```

Figure 5-3 (Continued)

```
018001   2  62.1    0.0   45.7   65.5   0.0   68.2   59.0   50.4   0.0   0.0
018101   155.    523.9 27.00            1.
018101   2  56.1    0.0   37.3   59.5   0.0   62.2   53.0   0.0    0.0   0.0
018002   139.    657.0 32.63            1.
018002   2  41.7    0.0   43.7   43.8   0.0   49.3   59.0   35.9   0.0   0.0
018102   165.    657.0 32.63            1.
018102   2  35.7    0.0   37.3   37.8   0.0   43.3   53.0   0.0    0.0   0.0
019001   1228.   1750.0 50.00           11.
019001   2  40.0    0.0   43.7   42.1   0.0   47.6   59.0   0.0    0.0   0.0
019101   10.     1750.0 50.00           11.
019101   2  34.0    0.0   37.3   36.1   0.0   41.6   53.0   0.0    0.0   0.0
020001   117.    268.4 16.13            4.
020001   2  67.2   64.5   43.7   66.5   73.3   74.2   59.0   0.0    0.0   0.0
020101   129.    268.4 16.13            4.
020101   2  61.2   63.5   37.3   60.5   67.3   68.2   53.0   0.0    0.0   0.0
021001   179.    1096.6 57.75           1.
021001   2  67.2   69.5   43.7   66.5   73.3   74.2   59.0   45.9   0.0   0.0
021101   1130.   1096.6 57.75           1.
021101   2  62.2   63.5   37.3   60.5   67.3   68.2   53.0   0.0    0.0   0.0
021002   1117.   1619.9 88.13           1.
021002   2  55.8   57.9   43.7   55.6   62.0   62.9   59.0   35.9   0.0   0.0
021102   1191.   1619.9 88.13           1.
021102   2  49.8   51.9   37.3   49.6   56.0   56.9   53.0   0.0    0.0   0.0
021003   159.    992.6 48.38            1.
021003   2  52.5   54.3   43.7   52.6   58.4   60.5   59.0   34.2   0.0   0.0
021103   196.    992.6 48.38            1.
021103   2  46.5   48.3   37.3   46.6   52.4   54.5   53.0   0.0    0.0   0.0
022001   1126.   949.5 68.25            1.
022001   2  67.2   69.5   43.7   66.5   73.3   74.2   59.0   0.0    0.0   0.0
022101   1207.   949.5 68.25            1.
022101   2  61.2   63.5   37.3   60.5   67.3   68.2   53.0   0.0    0.0   0.0
022002   1125.   1017.9 72.75           1.
022002   2  57.1   57.9   43.7   58.3   62.0   60.0   59.0   35.5   0.0   0.0
022102   1205.   1017.9 72.75           1.
022102   2  51.1   51.9   37.3   52.3   56.0   58.0   53.0   0.0    0.0   0.0
023001   1228.   1750.0 50.00           11.
023001   2  60.6   62.9   43.7   60.2   67.0   67.7   59.0   0.0    0.0   0.0
023101   10.     1750.0 50.00           11.
023101   2  54.6   56.9   37.3   54.2   61.0   61.7   53.0   0.0    0.0   0.0

IND
   1     207207  MAX. REDUCTION IS 3.5 DB APPLYING TO SOURCES 1 AND 3
   2     207207  MAX. REDUCTION IS 3.5 DB APPLYING TO SOURCES 1 AND 3
   3     222200  MAX. RED. IS 11 DB APPLYING TO SOURCE 4
   4     224200  MAX. RED. IS 12 DB APPLYING TO SOURCE 4
   5     210200  THE PER TRUCK REDUCTION IS 5 DB APPLYING TO SOURCE 5
   7     212200  THE PER LOCOMOTIVE REDUCTION IS 6 DB APPLYING TO SOURCE 9

CM       SA II COUNTERMEASURE DEFINITIONS
AUTOMOBILES LOW  SPEED NEW VEHICLES SOURCE REDUCTION
   15    1    3    1
AUTOMOBILES LOW  SPEED DOS ENFORCEMENT
   12    1    3
AUTOMOBILES LOW  SPEED EXISTING VEHICLES RETROFIT SOURCE REDUCTION
   15    1    3    2
TRUCKS      LOW  SPEED NEW VEHICLES SOURCE REDUCTION
   15    4         3
TRUCKS      LOW  SPEED DOS ENFORCEMENT AND RETROFIT SOURCE REDUCTION
   15    4         4
TRUCKS      HIGH SPEED TIRE NOISE REDUCTION
```

Figure 5-3 (Continued)

```
           10     5          5
       BUSES         LOW  SPEED SOURCE REDUCTION, NEW AND EXISTING VEHICLES
           12     8
       MOTORCYCLES LOW  SPEED OOS ENFORCEMENT
           12     6    7
       AIRCRAFT      SOUND ABSORPTION MATERIAL NACELLE TREATMENT SOURCE REDUCTION
           10    11          6
       AIRCRAFT      FLIGHT PATH REROUTING (EFFECTIVELY A FLIGHT FREQUENCY RED.)
            1    11
       AIRCRAFT      REDUCTION OF NIGHT OPERATIONS
            3    11
       RAILROAD      LOCOMOTIVE MUFFLERS, SOURCE REDUCTION
           10     9          7
       PATH-RECEIVER CONTROL: INSULATION, BARRIERS, LAND ACQ, AND PEOPLE RELOC.
           20

       COST    SA II (MENLO PARK) LOW COST FUNCTIONS
       COST FUNCTION FOR AUTOMOBILES LOW SPEED NEW VEHICLES SOURCE RED., CASE 3
                 0       0.432
                 0       0.161      0.266      0.389      0.432
                 0      14.315     47.715    162.231    248.118
       COST FUNCTION FOR AUTOMOBILES LOW SPEED OOS ENFORCEMENT
                 0         6.2
                 0         4.5        5.5        5.8        6.2
                 0   .25448 .76344      3.11738  12.43771
       COST FUNCTION FOR AUTOMOBILES LOW SP. EXIST. VEH. RETROFIT, CASE 2
                 0       0.568
                 0       0.211      0.379      0.512      0.568
                 0 .064        .213        .731       1.113
       COST FUNCTION FOR TRUCKS LOW SPEED NEW VEH. SOURCE REDUCTION
                 0       0.436
                 0       0.236      0.355      0.407      0.436
             0       31.81      63.62      103.175    222.670
       COST FUNCTION FOR TRUCKS LOW SPEED OOS ENFORCEMENT AND RETROFIT SOURCE R
                 0       0.564
                 0       0.333      0.412      0.507      0.564
                 0 .095        4.         32.        143.
       COST FUNCTION FOR TRUCKS HI SPEED TIRE NOISE REDUCTION
                 0           1
                 0           1
              0    92.08995
       COST FUNCTION FOR BUSES LOW SP. SOURCE RED., NEW AND EXIST. VEHICLES
                 0        6.78
                 0        0.23       2.35       6.78
                 0 .03181      1.78136   16.2231
       COST FUNCTION FOR MOTORCYCLES LOW SPEED OOS ENFORCEMENT
                 0          17
                 0        5.04       9.46      12.75         17
                 0 .01591      .06362     .15905     .49624
       COST FUNCTION FOR AIRCRAFT SAM SOURCE REDUCTION
                 0           1
                 0           1
                 0 19.27666
       COST FUNCTION FOR AIRCRAFT FLIGHT PATH REROUTING (=FREQ. REDUCTION)
                 0           1
                 0           1
                 0 9.06585
       COST FUNCTION FOR AIRCRAFT NIGHT OPERATIONS REDUCTION
                 0           1
                 0           1
```

Figure 5-3 (Continued)

```
               0 32.7643
COST FUNCTION FOR LOCOMOTIVE MUFFLERS, SOURCE REDUCTION
               0          1
               0          1
               0 16.2231

BAR      BARRIER DATA  SA II  LOW COST
BARRIERS FOR STUDY AREA II (MENLO PARK), LOW COST
1.251.25 .0 1.0 1.1 1.25 .0 1.0  .5 1.5  .0
1.5 1.5  .0 1.4 1.5 1.5  .0 1.4 1.  1.5  .0
   1    37.6    55.8 23 1    8    8
   2   167.2   248.4 22 1   10   10 22 2    8    8
   3   167.2   248.4 21 1   10   10 21 2    8    8 21 3    6    8
   4    51.9    77.1 20 1   10   10
   6   192.9   289.7  6 1   10   10  6 2    8    8
   7   505.3   759.0 17 1   10   10 17 2    8    8
   8   257.0   386.0 10 1   10   10
   9   432.7   649.9  9 1   10   10  9 2    8    8
  10   171.3   257.3 16 1   10   10

PARE
SOUNDPROOFING DATA SA II (MENLO PARK), LOW COST ESTIMATES; ALL PR OPTIONS
    1    1    1    1    1    1    1    1    1    1    1    1
   5   10   15
     2.25       6.44       11.66
   5   10   15
     2.25       6.44       11.66
CRIT   $ALLOW MORE THAN 100 PERC. ADV. EFFECT
    1    1
CRIT 0 0TRANSF.FCT. FOR SFO STUDY, 20 DB RANGE
     57    49   SINGLE FAMILY RESIDENTIAL         D/N LOWER CRITERION LEVELS
                NOT USED
                NOT USED
     62    49   MULTIFAMILY RESIDENTIAL           D/N LOWER CRITERION LEVELS
     62    62   COMMERCIAL                        D/N LOWER CRITERION LEVELS
                NOT USED
                NOT USED
     70    70   INDUSTRIAL                        D/N LOWER CRITERION LEVELS
                NOT USED
                NOT USED
     57         SCHOOLS, NIGHT NOT USED           DAY LOWER CRITERION LEVEL
     60    57   HOSPITALS AND NURSING HOMES       D/N LOWER CRITERION LEVELS
                NOT USED
                NOT USED
                NOT USED
     77    69   SINGLE FAMILY RESIDENTIAL         D/N UPPER CRITERION LEVELS
                NOT USED
                NOT USED
     82    69   MULTIFAMILY RESIDENTIAL           D/N UPPER CRITERION LEVELS
     82    82   COMMERCIAL                        D/N UPPER CRITERION LEVELS
                NOT USED
                NOT USED
     90    90   INDUSTRIAL                        D/N UPPER CRITERION LEVELS
                NOT USED
                NOT USED
     77         SCHOOLS, NIGHT NOT USED           DAY UPPER CRITERION LEVEL
     80    77   HOSPITALS AND NURSING HOMES       D/N UPPER CRITERION LEVELS
                NOT USED
                NOT USED
                NOT USED
```

Figure 5-3 (Continued)

```
FAC  1  SFO SA II (MENLO PARK)
SIMULATE BASELINE MOTOR VEHICLE LEVELS (I.E., FOR NO ENFORCEMENT)

          1        1
  3.5481           1  3.5481  2.2387       1  1.7244  1.7244       1       1       1
          1
BASE
RANK
OPT


  .763440        5.        2.
END
```

Figure 5-3 (Continued)

```
 20 JOB DESCRIPTION:
 30 STUDY AREA II  LOW  COST FUNCTIONS, NEW
 40 AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
 50 ---- DTA    1 1
 60 DATA ENTERED FOR   78 CELLS
 70 ---- CM    -0-0
 80  13 COUNTERMEASURES DEFINED
 90 ---- COST -0-0
100  12 COST FUNCTIONS READ
110 ---- BAR   -0-0
120 DATA READ FOR    9 BARRIERS
130 ---- PARE -0-0
140 INPUT OF SOUNDPROOFING DATA COMPLETE
150 ---- CRIT -0 3
160 TRANSFER FUNCTION TYPE 1 BULGE FACTOR =  1.00
170 ---- CRIT  0 0
180 CRITERION LEVELS CHANGED
190 ---- FAC   1-0
200 DATA FACTORING COMPLETE
210 ---- HASE -0-0
220 BASELINE NII =  .579245
230 ---- RANK -0-0
240 MOST OFFENDING SOURCES:
250       1  MOTORCYCLES LOW  SPEED LINE SRC. ( 6)
260       2  MOTORCYCLES LOCAL TRAFFIC SOURCE ( 7)
270       3  RAILROAD    LOCOMOTIVES, LINE S. ( 9)
280       4  AUTOMOBILES LOW  SPEED LINE SRC  ( 1)
290       5  TRUCKS      LOW  SPEED LINE SRC. ( 4)
300       6  TRUCKS      HIGH SPEED LINE SRC. ( 5)
310       7  AUTOMOBILES HIGH SPEED LINE SRC  ( 2)
320       8  RAILROAD    CARS, LINE SOURCE    (10)
330       9  AUTOMOBILES LOCAL TRAFFIC SOURCE ( 3)
340      10  AIRCRAFT    COMMERCIAL, FLIGHT   (11)
350      11  BUSES       LOW  SPEED LINE SRC. ( 8)
360 ---- OPT  -0-0
370  STEP  CM  TOTAL (ALL CM)   NII
380    1    0             .00   .579245
390    2    8          496.24   .393895
400    3    2         6485.01   .357453
410    4    5        16478.51   .336765
420    5    3        17591.51   .331039
430    6   12        27375.66   .313280
440    7   12        33814.61   .298176
450    8   13        71414.61   .279297
460    9    4        77819.92   .276659
470   10    4        84505.46   .273787
480   11    4        91521.90   .270629
490   12    4        98885.17   .267159
500   13    4       106029.78   .264358
510   14   13       124229.78   .258602
520   15   13       291429.78   .212905
530   16   10       296569.04   .211593
540   17    4       301799.18   .210295
550   18    4       307162.69   .208930
560   19    4       312671.39   .207491
570   20    4       318320.01   .205981
580   21    4       324079.58   .204410
590   22   13       491279.58   .164944
```

Figure 5-4. San Francisco Example Secondary Output. The left-most column provides a line count which does not usually appear.

```
 600   23   10    495206.16     .164013
 610   24    6    500206.16     .163132
 620   25    6    505206.16     .162231
 630   26    6    510206.16     .161311
 640   27    6    515206.16     .160369
 650   28    6    520206.16     .159406
 660   29    6    525206.16     .158419
 670   30    6    530206.16     .157409
 680   31    6    535206.16     .156534
 690   32    6    540206.16     .155810
 700   33    6    545206.16     .155065
 710   34    6    550206.15     .154300
 720   35    6    555206.15     .153513
 730   36    6    560206.15     .152703
 740   37    6    565206.15     .151987
 750   38    6    570206.15     .151252
 760   39    6    575206.15     .150492
 770   40    6    580206.15     .149706
 780   41    6    585206.15     .148890
 790   42    6    587296.11     .148541
 800   43    2    592296.10     .147828
 810   44    2    593745.05     .147631
 820   45    5    598745.04     .146348
 830   46    4    603745.04     .145823
 840   47    5    608745.05     .144537
 850   48    5    613745.04     .143211
 860   49    5    618745.04     .141873
 870   50    1    623745.04     .141180
 880   51    1    628745.04     .140476
 890   52   13    709945.05     .133280
 900   53    1    714945.04     .132619
 910   54   13    738570.04     .130968
 920   55    7    743570.04     .130639
 930   56    4    748570.05     .130370
 940   57    4    753570.04     .130100
 950   58    4    758570.05     .129828
 960   59    4    763440.00     .129561
 970 FINAL EXPENDITURES:
 980 $      15000. $      12438. $       1113. $      66996. $      29993.
 990 $      92090. $       5000. $        496. $          0. $       9066.
1000 $          0. $      16223. $     495025. $          0. $          0.
1010 $          0. $          0. $          0. $          0. $          0.
1020 FINAL NII =    .129561-00
1030 ---- END   -0-0
```

Figure 5-4 (Continued)

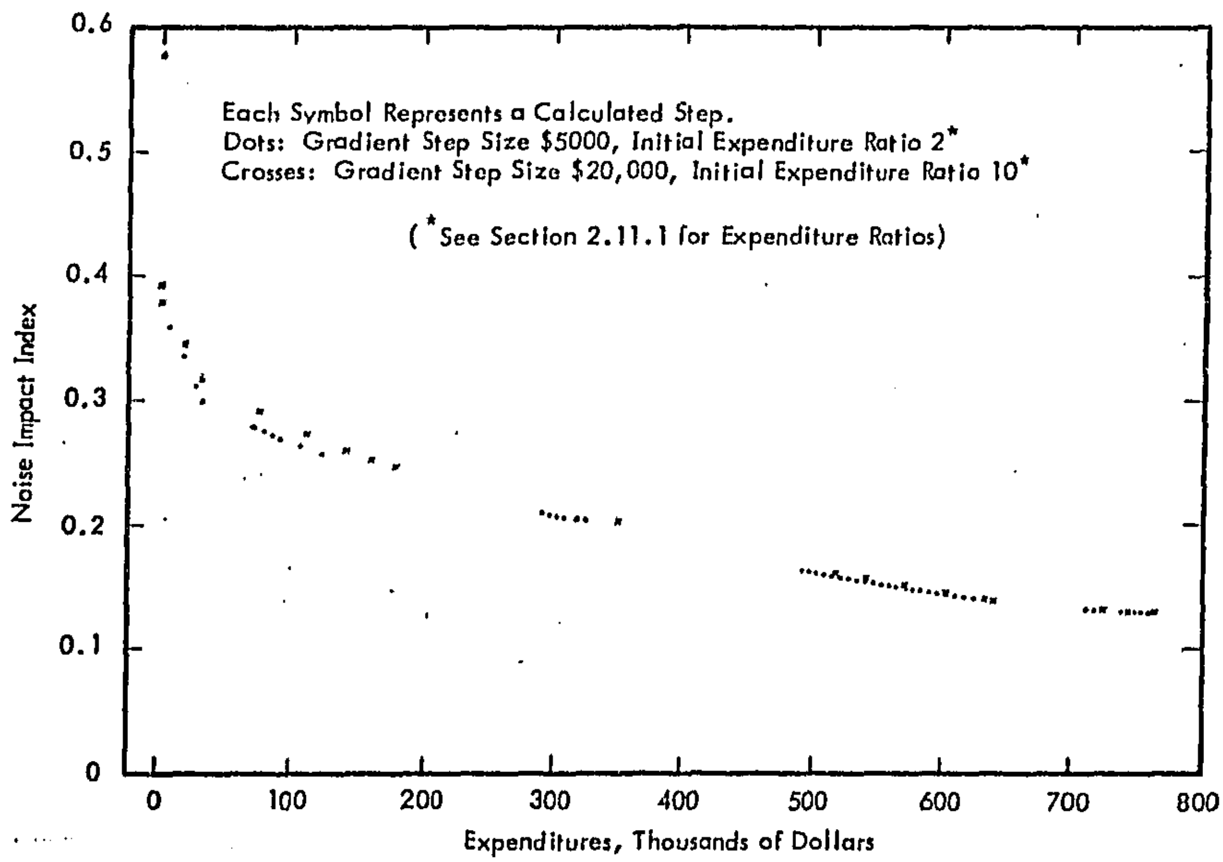

Figure 5-5. Noise Impact Index Versus Expenditures

```
*****************************************
*                                       *
*    COMMUNITY NOISE OPTIMIZATION       *
*              PROGRAM                  *
*         NOIZOP VERSION 2.1            *
*    ---------------------------        *
*        WYLE  LABORATORIES             *
*                                       *
*****************************************


****************
TITLE- DATA SET:     MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION. 1974 COSTS.
JOB DESCRIPTION:     STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
****************
```

Figure 5-6. Output of San Francisco Example. (Figure 5-3 shows the input data that generated this output. Consult Chapter 2 in this manual for detailed explanation.)

```
****************
TITLE- DATA SET:        MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION:        STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
****************


*********
DTA   1 1       MASTER DATA FOR SA II, LOW RELOC. COSTS
*********


        SOURCES                                  INDICATORS
        -------                                  ----------

 1 AUTOMOBILES LOW  SPEED LINE SRC    1 NEW AUTOS LO SP+LOC.TRAFF.SRC.RED.,CM #1
 2 AUTOMOBILES HIGH SPEED LINE SRC    2 EXIST.AUTOS LO SP+LOC.TRAFF.SC.RED,CM #3
 3 AUTOMOBILES LOCAL TRAFFIC SOURCE   3 TRUCKS LO SP NEW VEH SOURCE RED., CM #4.
 4 TRUCKS      LOW  SPEED LINE SRC.   4 TRUCKS LO SP ENFORC.+RETROF.SC.RED,CM #5
 5 TRUCKS      HIGH SPEED LINE SRC.   5 TRUCK TIRES SOURCE RED., CM = 6
 6 MOTORCYCLES LOW  SPEED LINE SRC.   6 AIRCRAFT SAM TREATMENT, CM = 9
 7 MOTORCYCLES LOCAL TRAFFIC SOURCE   7 RAILROAD LOCO SOURCE RED, CM = 12
 8 BUSES       LOW  SPEED LINE SRC.
 9 RAILROAD    LOCOMOTIVES, LINE S.
10 RAILROAD    CARS, LINE SOURCE
11 AIRCRAFT    COMMERCIAL, FLIGHT

SOURCE CONTRIBUTION ELEMENTS FOR BASELINE INDEX:

 1 1 1 1 1 1 1 1 1 1 1-0-0-0-0-0-0-0-0-0

DATA ENTERED FOR  70 CELLS
```

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
1	1	142.5	1750.	50.	0	11	46.5	.0	43.7	48.7	.0	54.1	59.0	37.3	.0	.0
							52.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
1	101	.0	1750.	50.	0	11	40.5	.0	37.3	42.7	.0	48.1	53.0	.0	.0	.0
							45.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	212200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
2	1	3.8	66.	4.	0	4	56.5	.0	43.7	59.9	.0	62.6	59.0	.0	.0	.0
							52.8	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
2	101	3.8	66.	4.	0	4	50.5	.0	37.3	53.9	.0	56.6	53.0	.0	.0	.0
							45.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	212200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
3	1	160.89999999.		350.	0	5	46.6	.0	43.7	55.0	.0	54.8	59.0	31.9	61.5	52.7
							48.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
3	101	5.69999999.		350.	0	5	42.6	.0	37.3	49.0	.0	48.1	53.0	.0	57.4	47.2
							40.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
4	1	20.6	235.	15.	0	1	51.8	.0	43.7	54.0	.0	59.7	59.0	45.6	.0	.0
							52.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
4	101	20.3	235.	15.	0	1	45.8	.0	37.3	48.0	.0	53.7	53.0	.0	.0	.0
							45.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	212200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
4	2	26.9	317.	21.	0	1	39.1	.0	43.7	41.2	.0	46.8	59.0	32.6	55.2	51.2
							52.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
4	102	26.5	317.	21.	0	1	33.1	.0	37.3	35.2	.0	40.8	53.0	.0	50.4	46.4
							45.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	214200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

BEST COPY AVAILABLE

ZONE	CELL	EFF. POP.	REL. COST (1000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
5	1	51.9	1319.	79.	0	1	60.8	.0	43.7	64.3	.0	67.0	59.0	45.6	.0	.0
							51.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
5	101	51.0	1319.	79.	0	1	54.0	.0	37.3	58.3	.0	61.0	53.0	.0	.0	.0
							43.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	210200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
5	2	41.5	922.	43.	0	1	41.1	.0	43.7	43.3	.0	48.8	59.0	35.6	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
5	102	40.1	922.	43.	0	1	35.1	.0	37.3	37.3	.0	42.8	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
6	1	28.1	510.	29.	0	1	49.3	.0	43.7	51.6	.0	56.6	59.0	45.2	65.7	61.7
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
6	101	27.8	510.	29.	0	1	43.3	.0	37.3	45.6	.0	50.6	53.0	.0	60.9	56.9
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
6	2	9.4	151.	8.	0	1	37.0	.0	43.7	39.2	.0	43.9	59.0	.0	52.7	47.9
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	.0	0	0	0	0	0	0	0	0
6	102	9.0	151.	8.	0	1	31.0	.0	37.3	33.2	.0	37.9	53.0	.0	40.0	43.2
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
7	1	15.0	302.	15.	0	1	61.0	.0	43.7	64.4	.0	67.1	59.0	45.6	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
7	101	14.6	302.	15.	0	1	58.4	.0	37.3	58.4	.0	61.1	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
7	2	25.6	504.	29.	0	1	34.9	.0	43.7	42.1	.0	47.3	59.0	35.6	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
7	102	25.1	504.	29.	0	1	31.9	.0	37.3	36.1	.0	41.3	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
8	1	82.5	1176.	79.	0	1	63.9	.0	43.7	64.4	.0	69.9	59.0	45.6	.0	.0
							49.7	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
8	101	81.4	1176.	79.	0	1	57.9	.0	37.3	58.4	.0	63.9	53.0	.0	.0	.0
							42.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	210200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
8	2	11.3	209.	12.	0	1	51.7	.0	43.7	55.3	.0	63.8	59.0	32.6	.0	.0
							51.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
8	102	10.9	209.	12.	0	1	45.7	.0	37.3	49.3	.0	57.8	53.0	.0	.0	.0
							43.9	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	210200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
9	1	51.9	1159.	62.	0	1	.0	.0	43.7	.0	.0	.0	59.0	.0	71.8	62.4
							48.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
9	101	51.0	1159.	62.	0	1	.0	.0	37.3	.0	.0	.0	53.0	.0	67.0	56.3
							41.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
9	2	16.9	480.	24.	0	1	48.5	.0	43.7	52.1	.0	54.8	59.0	32.6	63.6	53.5
							51.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
9	102	16.9	480.	24.	0	1	42.5	.0	37.3	46.1	.0	48.8	53.0	.0	59.6	47.4
							44.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	212200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
10	1	11.3	497.	10.	0	1	.0	.0	43.7	.0	.0	.0	59.0	.0	71.0	67.6
							47.8	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
10	101	10.4	497.	10.	0	1	.0	.0	37.3	.0	.0	.0	53.0	.0	62.4	56.3
							40.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
10	2	1.9	67.	3.	0	1	50.1	.0	43.7	53.0	.0	57.0	59.0	37.7	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
10	102	1.9	67.	3.	0	1	44.1	.0	37.3	47.0	.0	51.0	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
11	1	6.3	322.	8.	0	1	58.0	.0	43.7	60.3	.0	66.0	59.0	50.7	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
11	101	6.0	322.	8.	0	1	52.0	.0	37.3	54.3	.0	60.0	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
11	2	5.0	204.	6.	0	1	49.2	.0	43.7	52.0	.0	56.2	59.0	40.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
11	102	4.9	204.	6.	0	1	43.2	.0	37.3	46.0	.0	50.2	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
12	1	142.5	1750.	50.	0	11	46.8	.0	43.7	48.6	.0	54.0	59.0	39.2	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
12	101	.0	1750.	50.	0	11	40.4	.0	37.3	42.6	.0	40.0	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

BEST COPY AVAILABLE

ZONE	CELL	EFF. POP.	MEL. COST (1000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
13	1	44.4	1766.	55.	0	1	55.8	.0	43.7	58.1	.0	63.7	59.0	48.9	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
13	101	43.5	1766.	55.	0	1	49.8	.0	37.3	52.1	.0	57.7	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
13	2	15.0	550.	16.	0	1	45.7	.0	43.7	47.9	.0	53.4	59.0	37.7	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
13	102	14.6	550.	16.	0	1	39.7	.0	37.3	41.9	.0	47.4	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
14	1	213.1	40000.	800.	0	12	49.0	49.2	43.7	50.5	55.3	55.9	59.0	33.4	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
14	101	100.9	40000.	800.	0	12	43.0	43.2	37.3	44.5	47.3	49.9	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	1	16.3	692.	23.	0	1	53.8	.0	43.7	56.1	.0	61.7	59.0	40.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	101	16.1	692.	23.	0	1	47.8	.0	37.3	50.1	.0	55.7	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	2	16.9	579.	21.	0	1	51.2	.0	43.7	52.0	.0	57.2	59.0	40.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	102	16.5	579.	21.	0	1	45.2	.0	37.3	46.0	.0	51.2	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
15	1	136.9	5056.	201.	0	1	43.0	.0	43.7	44.5	.0	50.3	59.0	30.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	101	134.6	5056.	201.	0	1	37.0	.0	37.3	38.5	.0	44.3	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
16	1	73.1	2661.	94.	0	4	.0	.0	43.7	.0	.0	.0	59.0	.0	71.0	62.4
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
16	101	71.6	2661.	94.	0	4	.0	.0	37.3	.0	.0	.0	53.0	.0	67.6	56.3
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
17	1	32.5	423.	30.	0	1	.0	.0	43.7	.0	.0	.0	59.0	.0	65.9	61.9
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
17	101	32.2	423.	30.	0	1	.0	.0	37.3	.0	.0	.0	53.0	.0	61.1	57.1
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
17	2	36.2	437.	30.	0	1	55.6	57.9	43.7	55.2	62.0	64.4	59.0	.0	52.7	40.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
17	102	35.6	437.	30.	0	1	50.6	52.9	37.3	50.2	56.0	58.4	53.0	.0	47.9	43.2
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
18	1	21.2	524.	27.	0	1	62.1	.0	43.7	65.5	.0	68.2	59.0	50.4	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
18	101	20.6	524.	27.	0	1	56.1	.0	37.3	59.5	.0	62.2	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
18	2	24.4	657.	33.	0	1	41.7	.0	43.7	43.8	.0	49.3	59.0	35.9	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
18	102	24.4	657.	33.	0	1	35.7	.0	37.3	37.8	.0	43.3	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
19	1	142.5	1750.	50.	0	11	40.0	.0	43.7	42.1	.0	47.6	59.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
19	101	.0	1750.	50.	0	11	34.0	.0	37.3	36.1	.0	41.6	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
20	1	10.6	268.	16.	0	4	67.2	69.5	43.7	66.5	73.3	74.2	59.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
20	101	10.9	268.	16.	0	4	61.2	63.5	37.3	60.5	67.3	68.2	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
21	1	49.4	1097.	50.	0	1	67.2	69.5	43.7	66.5	73.3	74.2	59.0	45.9	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
21	101	40.7	1097.	50.	0	1	62.2	63.5	37.3	60.5	67.3	68.2	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
21	2	73.1	1620.	88.	0	1	55.8	57.9	43.7	55.6	62.0	62.9	59.0	35.9	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
21	102	71.6	1620.	88.	0	1	49.8	51.9	37.3	49.6	56.0	56.9	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

BEST COPY AVAILABLE

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
21	1	36.9	993.	44.	0	1	52.5	54.3	43.7	52.6	56.4	60.5	59.0	34.2	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
21	101	36.0	993.	40.	0	1	46.5	48.3	37.3	46.6	52.4	54.5	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
22	1	70.7	950.	60.	0	1	67.2	69.5	43.7	66.5	71.3	74.2	59.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
22	101	77.6	950.	60.	0	1	61.2	63.5	37.3	60.5	67.3	68.2	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
22	2	78.1	1010.	75.	0	1	57.1	57.9	43.7	58.3	62.0	64.0	59.0	35.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
22	102	76.9	1010.	73.	0	1	51.1	51.9	37.3	52.3	56.0	58.0	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
23	1	142.5	1750.	50.	0	11	60.6	62.9	43.7	60.2	67.0	67.7	59.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
23	101	.0	1750.	50.	0	11	54.6	56.9	37.3	54.2	61.0	61.7	53.0	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

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TITLE- DATA SET:        MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION:        STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
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*********
CM    -0-0        SA II COUNTERMEASURE DEFINITIONS
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---------- AUTOMOBILES LOW  SPEED NEW VEHICLES SOURCE REDUCTION
COUNTERMEASURE  1 TYPE 15 'EXCL TRT' APPLIES TO: AUTOMOBILES LOW  SPEED LINE SRC     INDICATOR NO.  1
                                                 AUTOMOBILES LOCAL TRAFFIC SOURCE                  -0

---------- AUTOMOBILES LOW  SPEED OOS ENFORCEMENT
COUNTERMEASURE  2 TYPE 12 'OD  RED ' APPLIES TO: AUTOMOBILES LOW  SPEED LINE SRC     INDICATOR NO. -0
                                                 AUTOMOBILES LOCAL TRAFFIC SOURCE                  -0

---------- AUTOMOBILES LOW  SPEED EXISTING VEHICLES RETROFIT SOURCE REDUCTION
COUNTERMEASURE  3 TYPE 15 'EXCL TRT' APPLIES TO: AUTOMOBILES LOW  SPEED LINE SRC     INDICATOR NO.  2
                                                 AUTOMOBILES LOCAL TRAFFIC SOURCE                  -0

---------- TRUCKS       LOW  SPEED NEW VEHICLES SOURCE REDUCTION
COUNTERMEASURE  4 TYPE 15 'EXCL TRT' APPLIES TO: TRUCKS       LOW  SPEED LINE SRC.   INDICATOR NO.  3

---------- TRUCKS       LOW  SPEED OOS ENFORCEMENT AND RETROFIT SOURCE REDUCTION
COUNTERMEASURE  5 TYPE 15 'EXCL TRT' APPLIES TO: TRUCKS       LOW  SPEED LINE SRC.   INDICATOR NO.  4

---------- TRUCKS       HIGH SPEED TIRE NOISE REDUCTION
COUNTERMEASURE  6 TYPE 10 'PART TRT' APPLIES TO: TRUCKS       HIGH SPEED LINE SRC.   INDICATOR NO.  5

---------- BUSES        LOW  SPEED SOURCE REDUCTION, NEW AND EXISTING VEHICLES
COUNTERMEASURE  7 TYPE 12 'OD  RED ' APPLIES TO: BUSES        LOW  SPEED LINE SRC.   INDICATOR NO. -0

---------- MOTORCYCLES LOW  SPEED OOS ENFORCEMENT
COUNTERMEASURE  8 TYPE 12 'OD  RED ' APPLIES TO: MOTORCYCLES LOW  SPEED LINE SRC.    INDICATOR NO. -0
                                                 MOTORCYCLES LOCAL TRAFFIC SOURCE                  -0

---------- AIRCRAFT    SOUND ABSORPTION MATERIAL NACELLE TREATMENT SOURCE REDUCTION
COUNTERMEASURE  9 TYPE 10 'PART TRT' APPLIES TO: AIRCRAFT    COMMERCIAL, FLIGHT      INDICATOR NO.  6

---------- AIRCRAFT    FLIGHT PATH REROUTING (EFFECTIVELY A FLIGHT FREQUENCY RED.)
COUNTERMEASURE 10 TYPE  1 'RED FREQ' APPLIES TO: AIRCRAFT    COMMERCIAL, FLIGHT      INDICATOR NO. -0
```

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---------- AIRCRAFT    REDUCTION OF NIGHT OPERATIONS
COUNTERMEASURE 11 TYPE  3 'NITE RED' APPLIES TO: AIRCRAFT     COMMERCIAL, FLIGHT     INDICATOR NO. -0

---------- RAILROAD    LOCOMOTIVE MUFFLERS, SOURCE REDUCTION
COUNTERMEASURE 12 TYPE 10 'PART THT' APPLIES TO: RAILROAD     LOCOMOTIVES, LINE S.   INDICATOR NO.  7

---------- PATH-RECEIVER CONTROL: INSULATION, BARRIERS, LAND ACQ. AND PEOPLE RELOC.
COUNTERMEASURE 13 TYPE 20 'P-R MOD ' APPLIES TO: ALL SOURCES                         INDICATOR NO. -0
```

```
****************
TITLE= DATA SET:        MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION:        STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
****************


*********
COST -0-0       SA II (MENLO PARK) LOW COST FUNCTIONS
*********

********* COST FUNCTION FOR AUTOMOBILES LOW SPEED NEW VEHICLES SOURCE RED., CASE 3
FEASIBLE RANGE OF CM VARIABLE:        .000 TO         .432
NOISE RED PARAMETER:         .00         .16          .29         .39         .43        -.00        -.00        -.00
CORRESPONDING COSTS:         .00       14.31        47.72      162.23      248.12        -.00        -.00        -.00

********* COST FUNCTION FOR AUTOMOBILES LOW SPEED OUS ENFORCEMENT
FEASIBLE RANGE OF CM VARIABLE:        .000 TO        6.200
NOISE RED PARAMETER:         .00        4.50         5.50        5.80        6.20        -.00        -.00        -.00
CORRESPONDING COSTS:         .00         .25          .76        3.12       12.48        -.00        -.00        -.00

********* COST FUNCTION FOR AUTOMOBILES LOW SP. EXIST. VEH. RETROFIT, CASE 2
FEASIBLE RANGE OF CM VARIABLE:        .000 TO         .568
NOISE RED PARAMETER:         .00         .21          .38         .51         .57        -.00        -.00        -.00
CORRESPONDING COSTS:         .00         .06          .21         .73        1.11        -.00        -.00        -.00

********* COST FUNCTION FOR TRUCKS LOW SPEED NEW VEH. SOURCE REDUCTION
FEASIBLE RANGE OF CM VARIABLE:        .000 TO         .436
NOISE RED PARAMETER:         .00         .24          .35         .41         .44        -.00        -.00        -.00
CORRESPONDING COSTS:         .00       31.81        63.62      143.15      222.67        -.00        -.00        -.00

********* COST FUNCTION FOR TRUCKS LOW SPEED OUS ENFORCEMENT AND RETROFIT SOURCE R
FEASIBLE RANGE OF CM VARIABLE:        .000 TO         .564
NOISE RED PARAMETER:         .00         .33          .41         .51         .56        -.00        -.00        -.00
CORRESPONDING COSTS:         .00         .09         4.00       32.00      143.00        -.00        -.00        -.00

********* COST FUNCTION FOR TRUCKS HI SPEED TIRE NOISE REDUCTION
FEASIBLE RANGE OF CM VARIABLE:        .000 TO        1.000
NOISE RED PARAMETER:         .00        1.00         -.00        -.00        -.00        -.00        -.00        -.00
CORRESPONDING COSTS:         .00       92.09         -.00        -.00        -.00        -.00        -.00        -.00

********* COST FUNCTION FOR BUSES LOW SP. SOURCE RED., NEW AND EXIST. VEHICLES
FEASIBLE RANGE OF CM VARIABLE:        .000 TO        6.700
NOISE RED PARAMETER:         .00         .23         2.35        6.70        -.00        -.00        -.00        -.00
CORRESPONDING COSTS:         .00         .03         1.78       16.22        -.00        -.00        -.00        -.00
```

```
********** COST FUNCTION FOR MOTORCYCLES LOW SPEED OBS ENFORCEMENT
FEASIBLE RANGE OF CM VARIABLE:         .000 TO      17.000
NOISE RED PARAMETER:          .00        5.04        9.46        12.75        17.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00         .02         .06          .16          .50        -.00        -.00        -.00

********** COST FUNCTION FOR AIRCRAFT SAN SOURCE REDUCTION
FEASIBLE RANGE OF CM VARIABLE:         .000 TO       1.000
NOISE RED PARAMETER:          .00        1.00        -.00         -.00         -.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00       19.28        -.00         -.00         -.00        -.00        -.00        -.00

********** COST FUNCTION FOR AIRCRAFT FLIGHT PATH REROUTING (=FREQ. REDUCTION)
FEASIBLE RANGE OF CM VARIABLE:         .000 TO       1.000
NOISE RED PARAMETER:          .00        1.00        -.00         -.00         -.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00        9.07        -.00         -.00         -.00        -.00        -.00        -.00

********** COST FUNCTION FOR AIRCRAFT NIGHT OPERATIONS REDUCTION
FEASIBLE RANGE OF CM VARIABLE:         .000 TO       1.000
NOISE RED PARAMETER:          .00        1.00        -.00         -.00         -.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00       32.76        -.00         -.00         -.00        -.00        -.00        -.00

********** COST FUNCTION FOR LOCOMOTIVE MUFFLERS, SOURCE REDUCTION
FEASIBLE RANGE OF CM VARIABLE:         .000 TO       1.000
NOISE RED PARAMETER:          .00        1.00        -.00         -.00         -.00        -.00        -.00        -.00
CORRESPONDING COSTS:          .00       16.22        -.00         -.00         -.00        -.00        -.00        -.00
```

SUMMARY OF ALLOWED COST RANGES ($000'S):

COUNTERMEASURE NUMBER	RANGE
1	$ .00 TO $ 240.12
2	$ .00 TO $ 12.44
3	$ .00 TO $ 1.11
4	$ .00 TO $ -222.67
5	$ .00 TO $ 143.00
6	$ .00 TO $ 92.09
7	$ .00 TO $ 16.22
8	$ .00 TO $ .50
9	$ .00 TO $ 19.28
10	$ .00 TO $ 9.07
11	$ .00 TO $ 32.76
12	$ .00 TO $ 16.22

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****
TITLE- DATA SET: MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION: STUDY AREA II LOW COST FUNCTIONS, NEW AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
****

****
BAR -0-0 BARRIER DATA' SA II LOW COST
****

--------- BARRIERS FOR STUDY AREA II (MENLO PARK), LOW COST

BARRIER EFFECTIVENESS RATIOS:

		LOW	HIGH
1	AUTOMOBILES LOW SPEED LINE SRC	1.25	1.50
2	AUTOMOBILES HIGH SPEED LINE SRC	1.25	1.50
4	TRUCKS LOW SPEED LINE SRC.	1.00	1.40
5	TRUCKS HIGH SPEED LINE SRC.	1.10	1.50
6	MOTORCYCLES LOW SPEED LINE SRC.	1.25	1.50
8	BUSES LOW SPEED LINE SRC.	1.00	1.40
9	RAILROAD LOCOMOTIVES, LINE S.	.50	1.00
10	RAILROAD CARS, LINE SOURCE	1.50	1.90

ANBR	COSTS(=$1000'S) HT 1	HT 2	PRIMARY CELL ID		OB1	OB2	SECONDARY CELLS --> ID		OB1	OB2	ID		OB1	OB2	ID		OB1	OB2
1	37.6	55.0	23	1	0.0	0.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0
2	167.2	248.4	22	1	10.0	10.0	22	2	0.0	0.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0
3	167.2	248.4	21	1	10.0	10.0	21	2	0.0	0.0	21	3	6.0	0.0	-0	-0	-.0	-.0
4	51.9	77.1	20	1	10.0	10.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0
6	192.9	289.7	6	1	10.0	10.0	6	2	0.0	0.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0
7	505.3	759.0	17	1	10.0	10.0	17	2	0.0	0.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0
8	257.0	386.0	10	1	10.0	10.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0
9	432.7	649.9	9	1	10.0	10.0	9	2	0.0	0.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0
10	171.3	257.3	16	1	10.0	10.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0	-0	-0	-.0	-.0

```
****************
TITLE- DATA SET:        MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION:        STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
****************

*********
PAGE -0-0
*********


---------- SOUNDPROOFING DATA SA II (MENLO PARK), LOW COST ESTIMATES; ALL PR OPTION

P/R MOD OVERRIDE ARRAY:
    1    1    1    1    1    1    1    1    1    1    1    1

RESIDENTIAL SOUNDPROOFING AND COST FACTORS ($/SQ FT):

    5 DB      10 DB      15 DB
    2.25       6.44      11.60

COMMERCIAL  SOUNDPROOFING AND COST FACTORS ($/SQ FT):

    5 DB      10 DB      15 DB
    2.25       6.44      11.60
```

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****************
TITLE- DATA SET:      MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION:      STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTONOM, CASE 3, AUTO RETROFIT CASE 2.
****************


**********
CRIT -0 3      ALLOW MORE THAN 100 PERC. ADV. EFFECT
**********


TRANSFER FUNCTION TYPE 1 IN EFFECT WITH BULGE FACTOR OF  1.00


LINEAR FUNCTION ALLOWING MORE THAN 100 PERCENT ADVERSE EFFECT
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****************
TITLE- DATA SET:       MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION:       STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTUMUR, CASE 3, AUTO RETROFIT CASE 2.
****************


*********
CRIT  0 0       TRANSF.FCT. FOR SFO STUDY, 20 DB RANGE
*********


LOWER CRITERION LEVELS OF  60 CELLS TYPE  1 CHANGED TO  57 DBA(D) AND  49 DBA(N)
LOWER CRITERION LEVELS OF   6 CELLS TYPE  4 CHANGED TO  62 DBA(D) AND  49 DBA(N)
LOWER CRITERION LEVELS OF   2 CELLS TYPE  5 CHANGED TO  62 DBA(D) AND  62 DBA(N)
LOWER CRITERION LEVELS OF   0 CELLS TYPE  6 CHANGED TO  70 DBA(D) AND  70 DBA(N)
LOWER CRITERION LEVELS OF   8 CELLS TYPE 11 CHANGED TO  57 DBA(D) AND  60 DBA(N)
LOWER CRITERION LEVELS OF   2 CELLS TYPE 12 CHANGED TO  60 DBA(D) AND  57 DBA(N)


UPPER CRITERION LEVELS OF ALL CELLS TYPE  1 CHANGED TO  77 DBA(D) AND  69 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  2 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  3 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  4 CHANGED TO  82 DBA(D) AND  69 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  5 CHANGED TO  82 DBA(D) AND  82 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  6 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  7 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  8 CHANGED TO  90 DBA(D) AND  90 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE  9 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 10 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 11 CHANGED TO  77 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 12 CHANGED TO  80 DBA(D) AND  77 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 13 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 14 CHANGED TO   0 DBA(D) AND   0 DBA(N)
UPPER CRITERION LEVELS OF ALL CELLS TYPE 15 CHANGED TO   0 DBA(D) AND   0 DBA(N)
```

NOTE: This example case did not use the suggested criterion levels from Table 2-2.

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****************
TITLE- DATA SET:        MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS,
JOB DESCRIPTION:        STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTUMUH, CASE 3, AUTO RETROFIT CASE 2.
****************


*********
FAC   1-0        SFO SA II (MENLO PARK)
*********


---------- SIMULATE BASELINE MOTOR VEHICLE LEVELS (I.E., FOR NO ENFORCEMENT)

THE FOLLOWING FACTORS APPLY TO ZONES:   1- 23 AND CELLS:     1-  78
                              LAND USES: ALL

POPULATION AND PROPERTY VALUE FACTORS:

  1.000000  1.000000

EXPOSURE FACTORS:

  3.580100  1.000000  3.580100  2.230700  1.000000  1.728400  1.728400  1.000000  1.000000  1.000000
  1.000000  -.000000  -.000000  -.000000  -.000000  -.000000  -.000000  -.000000  -.000000  -.000000
```

ZONE	CELL	EFF. POP.	HEL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
1	1	142.5	1750.	50.	57	11	52.0	.0	49.2	52.2	.0	56.5	61.4	37.3	.0	.0
							52.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
1	101	.0	1750.	50.	0	11	46.0	.0	42.0	46.2	.0	50.5	55.4	.0	.0	.0
							45.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	212200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
2	1	5.0	66.	4.	62	4	62.0	.0	49.2	63.4	.0	65.0	61.4	.0	.0	.0
							52.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
2	101	3.0	66.	4.	49	4	56.0	.0	42.0	57.4	.0	59.0	55.6	.0	.0	.0
							45.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	212200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
3	1	160.0	9999999.	350.	62	5	54.1	.0	49.2	58.5	.0	57.2	61.4	31.9	61.5	52.7
							40.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
3	101	5.6	9999999.	350.	62	5	48.1	.0	42.0	52.5	.0	50.5	55.4	.0	57.4	47.2
							40.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
4	1	20.6	235.	15.	57	1	57.3	.0	49.2	57.5	.0	62.1	61.4	45.6	.0	.0
							52.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
4	101	20.3	235.	15.	49	1	51.3	.0	42.0	51.5	.0	56.1	55.4	.0	.0	.0
							45.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	212200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
4	2	26.9	317.	21.	57	1	44.6	.0	49.2	44.7	.0	49.2	61.4	32.6	55.2	51.2
							52.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
4	102	26.3	317.	21.	49	1	30.6	.0	42.0	38.7	.0	43.2	55.4	.0	50.4	46.4
							45.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	214200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
5	1	51.4	1319.	79.	57	1	66.3	.0	49.2	67.8	.0	69.4	61.4	45.6	.0	.0
							51.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
5	101	51.0	1319.	79.	49	1	60.3	.0	42.8	61.8	.0	63.4	55.4	.0	.0	.0
							43.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	210200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
5	2	41.3	922.	43.	57	1	46.6	.0	49.2	46.8	.0	51.2	61.4	35.6	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
5	102	40.1	922.	43.	49	1	40.6	.0	42.8	40.8	.0	45.2	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
6	1	26.1	510.	29.	57	1	54.8	.0	49.2	55.1	.0	59.0	61.4	45.2	65.7	61.7
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	6100	6100
6	101	27.0	510.	29.	49	1	48.6	.0	42.8	49.1	.0	53.0	55.4	.0	60.9	56.9
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	6100	6100
6	2	9.4	151.	8.	57	1	42.5	.0	49.2	42.7	.0	46.3	61.4	.0	52.7	47.9
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	6080	6080
6	102	9.0	151.	8.	49	1	36.5	.0	42.8	36.7	.0	40.3	55.4	.0	40.0	43.2
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	6080	6080
7	1	15.0	302.	15.	57	1	66.5	.0	49.2	67.9	.0	69.5	61.4	45.6	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
7	101	14.6	302.	15.	49	1	63.9	.0	42.8	61.9	.0	63.5	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
7	2	25.6	504.	29.	57	1	45.4	.0	49.2	45.6	.0	49.7	61.4	35.6	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
7	102	25.1	504.	29.	49	1	39.4	.0	42.8	39.6	.0	43.7	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
8	1	82.5	1176.	79.	57	1	69.4	.0	49.2	67.9	.0	72.3	61.4	45.6	.0	.0
							49.7	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
8	101	81.4	1176.	79.	49	1	63.4	.0	42.8	61.9	.0	66.3	55.4	.0	.0	.0
							42.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	210200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
8	2	11.3	209.	12.	57	1	57.2	.0	49.2	58.8	.0	66.2	61.4	32.6	.0	.0
							51.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
8	102	10.9	209.	12.	49	1	51.2	.0	42.8	52.8	.0	60.2	55.0	.0	.0	.0
							43.9	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	210200	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
9	1	51.9	1759.	62.	57	1	.0	.0	49.2	.0	.0	.0	61.4	.0	71.0	62.4
							48.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	9100	9100
9	101	51.0	1759.	62.	49	1	.0	.0	42.8	.0	.0	.0	55.4	.0	67.0	56.3
							41.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	208200	212200	0	0	0
							0	0	0	0	0	0	0	0	9100	9100
9	2	16.9	480.	24.	57	1	54.0	.0	49.2	55.6	.0	57.2	61.4	32.6	63.6	53.5
							51.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	9080	9080
9	102	16.9	480.	24.	49	1	48.0	.0	42.8	49.6	.0	51.2	55.4	.0	59.6	47.4
							44.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	212200	212200	0	0	0
							0	0	0	0	0	0	0	0	9080	9080

BEST COPY AVAILABLE

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
10	1	11.3	497.	10.	57	1	.0	.0	49.2	.0	.0	.0	61.4	.0	71.0	67.0
							47.8	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	8100	8100
10	101	10.9	497.	10.	49	1	.0	.0	42.8	.0	.0	.0	55.4	.0	62.4	56.3
							40.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	206200	212200	0	0	0
							0	0	0	0	0	0	0	0	8100	8100
10	2	1.9	67.	5.	57	1	55.6	.0	49.2	56.5	.0	59.4	61.4	37.7	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
10	102	1.9	67.	5.	49	1	49.6	.0	42.8	50.5	.0	53.4	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
11	1	6.3	322.	8.	57	1	63.5	.0	49.2	63.8	.0	68.4	61.4	50.7	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
11	101	6.0	322.	8.	49	1	57.5	.0	42.8	57.8	.0	62.4	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
11	2	5.0	204.	6.	57	1	54.7	.0	49.2	55.5	.0	58.6	61.4	40.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
11	102	4.9	204.	6.	49	1	48.7	.0	42.8	49.5	.0	52.6	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
12	1	142.5	1750.	50.	57	11	51.9	.0	49.2	52.1	.0	56.4	61.4	39.2	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
12	101	.0	1750.	50.	0	11	45.9	.0	42.8	46.1	.0	50.4	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

ZONE	CELL	EFF. POP.	REL. COST (1000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
13	1	44.4	1766.	55.	57	1	61.3	.0	49.2	61.6	.0	66.1	61.4	40.9	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207201	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
13	101	43.5	1766.	55.	49	1	55.1	.0	42.8	55.6	.0	60.1	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207201	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
13	2	15.0	558.	16.	57	1	51.2	.0	49.2	51.4	.0	55.8	61.4	37.7	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207201	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
13	102	14.6	558.	16.	49	1	45.2	.0	42.8	45.4	.0	49.5	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207201	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
14	1	213.1	40000.	800.	60	12	54.5	49.2	49.2	54.0	53.3	58.3	61.4	33.4	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207201	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
14	101	100.4	40000.	800.	57	12	48.5	43.2	42.8	48.0	47.3	52.3	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207201	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	1	16.3	692.	23.	57	1	59.3	.0	49.2	59.6	.0	64.1	61.4	40.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207201	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	101	16.1	692.	23.	49	1	53.3	.0	42.8	53.6	.0	58.1	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207201	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	2	16.9	579.	21.	57	1	56.7	.0	49.2	56.3	.0	59.6	61.4	40.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	102	16.5	579.	21.	49	1	50.7	.0	42.8	50.3	.0	53.6	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207201	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
15	1	136.9	5056.	201.	57	1	48.5	.0	49.2	48.0	.0	52.7	61.4	38.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
15	101	134.6	5056.	201.	49	1	42.5	.0	42.8	42.0	.0	46.7	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
16	1	73.1	2661.	94.	62	4	.0	.0	49.2	.0	.0	.0	61.4	.0	71.8	62.4
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	10100	10100
16	101	71.6	2661.	94.	49	4	.0	.0	42.8	.0	.0	.0	55.4	.0	67.8	56.3
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	10100	10100
17	1	32.5	423.	30.	57	1	.0	.0	49.2	.0	.0	.0	61.4	.0	65.9	61.9
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	7100	7100
17	101	32.2	423.	30.	49	1	.0	.0	42.8	.0	.0	.0	55.4	.0	61.1	57.1
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	7100	7100
17	2	36.2	437.	30.	57	1	61.1	57.9	49.2	58.7	62.0	66.0	61.4	.0	52.7	48.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	7080	7080
17	102	35.6	437.	30.	49	1	56.1	52.9	42.8	53.7	56.0	60.8	55.4	.0	47.9	43.2
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	7080	7080
18	1	21.2	524.	27.	57	1	67.6	.0	49.2	69.0	.0	70.6	61.4	50.4	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
18	101	20.6	524.	27.	49	1	61.6	.0	42.6	63.0	.0	64.6	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
18	2	24.4	657.	33.	57	1	47.2	.0	49.2	47.3	.0	51.7	61.4	35.9	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
18	102	24.4	657.	33.	49	1	41.2	.0	42.8	41.3	.0	45.7	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
19	1	142.5	1750.	50.	57	11	45.5	.0	49.2	45.6	.0	50.0	61.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
19	101	.0	1750.	50.	0	11	39.5	.0	42.8	39.6	.0	44.0	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	0	0
20	1	10.6	268.	16.	62	4	72.7	69.5	49.2	70.0	73.3	76.6	61.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	4100	4100
20	101	10.9	268.	16.	49	4	66.7	63.5	42.8	64.0	67.3	70.6	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	4100	4100
21	1	49.4	1097.	50.	57	1	72.7	69.5	49.2	70.0	73.3	76.6	61.4	45.9	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	3100	3100
21	101	40.7	1097.	50.	49	1	67.7	63.5	42.8	64.0	67.3	70.6	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	3100	3100
21	2	73.1	1620.	88.	57	1	61.3	57.9	49.2	59.1	62.0	65.3	61.4	35.9	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	3080	3080
21	102	71.6	1620.	88.	49	1	55.3	51.9	42.8	53.1	56.0	59.3	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	3000	3080

ZONE	CELL	EFF. POP.	REL. COST ($000'S)	FLR. AREA SQ. FT. (000'S)	CL	LND USE	SOURCES (1-10) / (11-20) / INDICATORS (1-10) / (11-20)									
21	3	36.9	993.	48.	57	1	58.0	54.3	49.2	56.1	58.4	62.9	61.8	38.2	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	3060	3060
21	103	36.0	993.	40.	49	1	52.0	48.3	42.8	50.1	52.0	56.9	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	3060	3060
22	1	78.7	950.	60.	57	1	72.7	69.5	49.2	70.0	73.3	76.6	61.8	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	2100	2100
22	101	77.6	950.	60.	49	1	66.7	65.5	42.8	64.0	67.3	70.6	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	2100	2100
22	2	78.1	1018.	73.	57	1	62.6	57.9	49.2	61.8	62.0	66.4	61.8	35.5	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	2000	2000
22	102	76.9	1018.	73.	49	1	56.6	51.9	42.8	55.8	56.0	60.4	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	2000	2000
23	1	142.5	1750.	50.	57	11	66.1	62.9	49.2	63.7	67.0	70.1	61.8	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	1000	1000
23	101	.0	1750.	50.	0	11	60.1	56.9	42.8	57.7	61.0	64.1	55.4	.0	.0	.0
							.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
							207207	207207	222200	224200	210200	0	212200	0	0	0
							0	0	0	0	0	0	0	0	1000	1000

```
****************
TITLE- DATA SET:        MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1961 POPULATION, 1976 COSTS.
JOB DESCRIPTION:        STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
****************

*********
BASE -0-0
*********

FOR AN AVE POPULATION OF    3345. PERSONS, THE BASELINE NOISE IMPACT INDEX IS:      .579245
```

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****************
TITLE- DATA SET:      MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA 11, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION:      STUDY AREA 11  LOW  COST FUNCTIONS, NEW AUTOMOB. CASE 3, AUTO RETROFIT CASE 2.
****************


*********
RANK -0-0
*********

POPULATION WEIGHTED AVE INDICES FOR SOURCE RANKING:              SOURCES (1-10) / (11-20)

  .067116  .015178  .005290  .043056  .034825  .183512  .122751  .000376  .081579  .008599
  .001963  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000


FRACTIONAL CONTRIBUTION TO NOISE IMPACT INDEX:                   SOURCES (1-10) / (11-20)

  .115860  .026203  .009132  .091595  .068753  .316813  .211916  .000650  .140836  .034045
  .003309  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000  .000000

MOST OFFENDING SOURCES:                             SOURCE NO.

        1  MOTORCYCLES LOW  SPEED LINE SRC.      ( 6)
        2  MOTORCYCLES LOCAL TRAFFIC SOURCE      ( 7)
        3  RAILROAD    LOCOMOTIVES, LINE S.      ( 9)
        4  AUTOMOBILES LOW  SPEED LINE SRC       ( 1)
        5  TRUCKS      LOW  SPEED LINE SRC.      ( 4)
        6  TRUCKS      HIGH SPEED LINE SRC.      ( 5)
        7  AUTOMOBILES HIGH SPEED LINE SRC       ( 2)
        8  RAILROAD    CARS, LINE SOURCE         (10)
        9  AUTOMOBILES LOCAL TRAFFIC SOURCE      ( 3)
       10  AIRCRAFT    COMMERCIAL, FLIGHT        (11)
       11  BUSES       LOW  SPEED LINE SRC.      ( 8)
```

```
****************
TITLE- DATA SET:       MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION:       STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTOMON, CASE 3, AUTO RETROFIT CASE 2.
****************

*********
OPT  -0-0
*********

ADJUSTED INPUT EXPENDITURES:

        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.

                                                                               TOTAL= $        0.

TOTAL BUDGET =                    $      763440.00
GRADIENT STEPSIZE =               $        5000.00
INITIAL MAX. EXPENDITURE RATIO =              2.00
```

STEP — EXPENDITURES (1-10) / (11-20) / GRADIENTS (1-10) / (11-20)

1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.163656-06	.414896-05	.348593-05	.133713-06	.156506-05	.836956-07	.251732-07	.377252-08	.432597-07	.152271-06
	.634941-08	.121289-05	.444519-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.579245	SUM= $	.00							
2	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.496240+03	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.267499-06	.726054-05	.600184-05	.237046-06	.289101-05	.140131-06	.410563-07	.000000	.136364-06	.495806-06
	.160934-07	.153068-05	.504032-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.393895	SUM= $	496.24							
3	.000000	.598477+04	.000000	.000000	.000000	.000000	.000000	.496240+03	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.881563-07	.136583-06	.186549-05	.310690-06	.195293-05	.183803-06	.488382-07	.000000	.633271-07	.217673-06
	.204661-07	.159009-05	.498023-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.357453	SUM= $	6885.01							
4	.000000	.598077+04	.000000	.000000	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.111322-06	.172798-06	.237247-05	.403361-06	.187150-06	.204736-06	.530671-07	.000000	.746765-07	.257694-06
	.246595-07	.164261-05	.502905-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.336765	SUM= $	16478.51							
5	.000000	.598877+04	.111300+04	.000000	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.404000-07	.124568-06	.000000	.427174-06	.197374-06	.212202-06	.528874-07	.000000	.780031-07	.269409-06
	.254551-07	.165110-05	.502122-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.331039	SUM= $	17591.51							

STEP	EXPENDITURES (1-10) / (11-20) / GRADIENTS (1-10) / (11-20)								
6	.000000	.598877+04	.111300+04	.000000	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.978815+04	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.789285-07	.122287-06	.000000	.409576-06	.186868-06	.212668-06	.527350-07	.000000	.789994-07	.236181-06
	.295527-07	.220028-05	.502122-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.313280	SUM= $	27375.66							
7	.000000	.598877+04	.111300+04	.000000	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.162231+05	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.791824-07	.122681-06	.000000	.406508-06	.187783-06	.212969-06	.528655-07	.000000	.691441-07	.222992-06
	.341068-07	.000000	.502122-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.298176	SUM= $	33814.61							
8	.000000	.598877+04	.111300+04	.000000	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.162231+05	.376000+05	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.787686-07	.122039-06	.000000	.410037-06	.189417-06	.213540-06	.528655-07	.000000	.691441-07	.222992-06
	.341068-07	.000000	.320075-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.279297	SUM= $	71414.61							
9	.000000	.598877+04	.111300+04	.640531+04	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.162231+05	.376000+05	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.813293-07	.126196-06	.000000	.427036-06	.182404-06	.216342-06	.553294-07	.000000	.710538-07	.224625-06
	.349099-07	.000000	.319373-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.276659	SUM= $	77819.92							
10	.000000	.598877+04	.111300+04	.130909+05	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.162231+05	.376000+05	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.846436-07	.131349-06	.000000	.447115-06	.174939-06	.219354-06	.581839-07	.000000	.732335-07	.236871-06
	.358259-07	.000000	.318620-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.273767	SUM= $	84505.46							
11	.000000	.598877+04	.111300+04	.201073+05	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.162231+05	.376000+05	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.882371-07	.136942-06	.000000	.468020-06	.165669-06	.222611-06	.615420-07	.000000	.748279-07	.242650-06
	.364066-07	.000000	.317007-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.270629	SUM= $	91521.90							
12	.000000	.598877+04	.111300+04	.274706+05	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.162231+05	.376000+05	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.905956-07	.140617-06	.000000	.452866-06	.152475-06	.226138-06	.655493-07	.000000	.777143-07	.252753-06
	.361324-07	.000000	.316929-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.267159	SUM= $	98885.17							
13	.000000	.598877+04	.111300+04	.346152+05	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.162231+05	.376000+05	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.945080-07	.146707-06	.000000	.254214-06	.144470-06	.228970-06	.690749-07	.000000	.802248-07	.256159-06
	.392196-07	.000000	.316223-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.264358	SUM= $	106029.70							
14	.000000	.598877+04	.111300+04	.346152+05	.999150+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.162231+05	.558000+05	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.957949-07	.148704-06	.000000	.253068-06	.143017-06	.228517-06	.690999-07	.000000	.802248-07	.256159-06
	.392196-07	.000000	.273308-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.258602	SUM= $	124229.70							

STEP	EXPENDITURES (1-10) / (11-20) / GRADIENTS (1-10) / (11-20)								
15	.000000	.598877+04	.111300+04	.346152+05	.999350+04	.000000	.000000	.496240+03	.000000	.000000
	.000000	.162231+05	.223000+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.914405-07	.141951-06	.000000	.249217-06	.141613-06	.207880-06	.644962-07	.000000	.802248-07	.256159-06
	.392196-07	.000000	.237214-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.212405	SUM= $	291429.78							
16	.000000	.598877+04	.111300+04	.346152+05	.999350+04	.000000	.000000	.496240+03	.000000	.513927+04
	.000000	.162231+05	.223000+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.909734-07	.141231-06	.000000	.248132-06	.140989-06	.207880-06	.596898-07	.000000	.323871-07	.233970-06
	.191719-07	.000000	.237214-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.211593	SUM= $	296569.04							
17	.000000	.598877+04	.111300+04	.398453+05	.999350+04	.000000	.000000	.496240+03	.000000	.513927+04
	.000000	.162231+05	.223000+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.920271-07	.144272-06	.000000	.254223-06	.137311-06	.209100-06	.613029-07	.000000	.328994-07	.233893-06
	.194520-07	.000000	.236993-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.210295	SUM= $	301799.18							
18	.000000	.598877+04	.111300+04	.452088+05	.999350+04	.000000	.000000	.496240+03	.000000	.513927+04
	.000000	.162231+05	.223000+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.950463-07	.147574-06	.000000	.260853-06	.133383-06	.210367-06	.630598-07	.000000	.334560-07	.233432-06
	.197572-07	.000000	.236765-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.208930	SUM= $	307162.69							
19	.000000	.598877+04	.111300+04	.507175+05	.999350+04	.000000	.000000	.496240+03	.000000	.513927+04
	.000000	.162231+05	.223000+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.973583-07	.151173-06	.000000	.267218-06	.129172-06	.211684-06	.649799-07	.000000	.340595-07	.234106-06
	.200879-07	.000000	.236530-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.207491	SUM= $	312671.39							
20	.000000	.598877+04	.111300+04	.563661+05	.999350+04	.000000	.000000	.496240+03	.000000	.513927+04
	.000000	.162231+05	.223000+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.984049-07	.153589-06	.000000	.272184-06	.122893-06	.213056-06	.667942-07	.000000	.321312-07	.235443-06
	.204464-07	.000000	.236289-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.205981	SUM= $	318320.01							
21	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.000000	.000000	.496240+03	.000000	.513927+04
	.000000	.162231+05	.223000+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.101632-06	.157834-06	.000000	.117396-06	.118112-06	.214472-06	.690816-07	.000000	.327644-07	.231024-06
	.206370-07	.000000	.236042-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.204410	SUM= $	324079.58							
22	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.000000	.000000	.496240+03	.000000	.513927+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.955400-07	.146391-06	.000000	.114355-06	.115063-06	.176207-06	.679598-07	.000000	.327630-07	.231023-06
	.208356-07	.000000	.116577-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.184944	SUM= $	491279.58							
23	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.000000	.000000	.496240+03	.000000	.406585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.967051-07	.149505-06	.000000	.115835-06	.116552-06	.176207-06	.681364-07	.000000	.912402-12	.000000
	.912402-12	.000000	.116577-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.184013	SUM= $	495206.16							

STEP — EXPENDITURES (1-10) / (11-20) / GRADIENTS (1-10) / (11-20)

STEP										
24	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.500000+04	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.971959-07	.150267-06	.000000	.116298-06	.117017-06	.180056-06	.681473-07	.000000	.456201-12	.000000
	.456201-12	.000000	.115080-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.163132		SUM= $ 500206.16							
25	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.100000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.977096-07	.151065-06	.000000	.116781-06	.117505-06	.184079-06	.681601-07	.000000	.136860-11	.000000
	.136860-11	.000000	.113545-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.162231		SUM= $ 505206.16							
26	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.150000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.982461-07	.151896-06	.000000	.117288-06	.118014-06	.188287-06	.681724-07	.000000	.136860-11	.000000
	.136860-11	.000000	.111970-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.161311		SUM= $ 510206.16							
27	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.200000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.988054-07	.152765-06	.000000	.117818-06	.118546-06	.192692-06	.681852-07	.000000	.912402-12	.000000
	.912402-12	.000000	.110354-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.160369		SUM= $ 515206.16							
28	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.250000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.993935-07	.153676-06	.000000	.118371-06	.119104-06	.197311-06	.681998-07	.000000	.182480-11	.000000
	.182480-11	.000000	.108693-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.159406		SUM= $ 520206.16							
29	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.300000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.100068-06	.154630-06	.000000	.118951-06	.119688-06	.202157-06	.682139-07	.000000	.912402-12	.000000
	.912402-12	.000000	.106987-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.158419		SUM= $ 525206.16							
30	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.350000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.100655-06	.155633-06	.000000	.119563-06	.120301-06	.174946-06	.682294-07	.000000	.136860-11	.000000
	.136860-11	.000000	.105231-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.157409		SUM= $ 530206.16							
31	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.400000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.909570-07	.140597-06	.000000	.112594-06	.113291-06	.144870-06	.682445-07	.000000	-.000000	.000000
	-.000000	.000000	.103424-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.156534		SUM= $ 535206.16							
32	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.450000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.914150-07	.141306-06	.000000	.113081-06	.113780-06	.148024-06	.682618-07	.000000	.456201-12	.000000
	.456201-12	.000000	.101562-06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.155010		SUM= $ 540206.16							

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STEP	EXPENDITURES (1-10) / (11-20) / GRADIENTS (1-10) / (11-20)								
51	.100000+05	.124377+05	.111300+04	.671257+05	.299935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.340200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.862305-07	.000000	.000000	.532608-07	.527136-07	.000000	.648907-07	.000000	.456201-12	.000000
	.456201-12	.000000	.686195-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.140476		SUM $	628745.04						
52	.100000+05	.124377+05	.111300+04	.671257+05	.299935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.471400+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.676602-07	.000000	.000000	.524739-07	.519149-07	.000000	.648910-07	.000000	.684302-12	.000000
	.684302-12	.000000	.709054-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.133280		SUM $	709945.05						
53	.150000+05	.124377+05	.111300+04	.671257+05	.299935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.471400+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.324563-07	.000000	.000000	.532590-07	.527124-07	.000000	.658355-07	.000000	.456201-12	.000000
	.456201-12	.000000	.698936-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.132619		SUM $	714945.04						
54	.150000+05	.124377+05	.111300+04	.671257+05	.299935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.495025+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.324565-07	.000000	.000000	.532594-07	.527129-07	.000000	.658360-07	.000000	.912402-12	.000000
	.912402-12	.000000	.409072-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.130968		SUM $	738570.04						
55	.150000+05	.124377+05	.111300+04	.671257+05	.299935+05	.920899+05	.500000+04	.496240+03	.000000	.906585+04
	.000000	.162231+05	.495025+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.326925-07	.000000	.000000	.537038-07	.531525-07	.000000	.174109-07	.000000	.228101-12	.000000
	.228101-12	.000000	.396166-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.130639		SUM $	743570.04						
56	.150000+05	.124377+05	.111300+04	.721257+05	.299935+05	.920899+05	.500000+04	.496240+03	.000000	.906585+04
	.000000	.162231+05	.495025+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.328912-07	.000000	.000000	.540649-07	.527115-07	.000000	.175109-07	.000000	-.228101-12	.000000
	-.228101-12	.000000	.230896-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.130370		SUM $	748570.05						
57	.150000+05	.124377+05	.111300+04	.771257+05	.299935+05	.920599+05	.500000+04	.496240+03	.000000	.906585+04
	.000000	.162231+05	.495025+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.330928-07	.000000	.000000	.544310-07	.522649-07	.000000	.176541-07	.000000	-.000000	.000000
	-.000000	.000000	.228626-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.130100		SUM $	753570.04						
58	.150000+05	.124377+05	.111300+04	.821257+05	.299935+05	.920899+05	.500000+04	.496240+03	.000000	.906585+04
	.000000	.162231+05	.495025+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.332960-07	.000000	.000000	.548034-07	.518140-07	.000000	.177786-07	.000000	-.228101-12	.000000
	-.228101-12	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.129820		SUM $	758570.05						
59	.150000+05	.124377+05	.111300+04	.869957+05	.299935+05	.920899+05	.500000+04	.496240+03	.000000	.906585+04
	.000000	.162231+05	.495025+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.334991-07	.000000	.000000	.551709-07	.513676-07	.000000	.179009-07	.000000	-.456201-12	.000000
	-.456201-12	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.129561		SUM $	763440.00						

STEP	EXPENDITURES (1-10) / (11-20) / GRADIENTS (1-10) / (11-20)								
42	.000000	.549877+04	.111300+04	.621257+05	.999350+04	.920899+05	.000000	.496240+03	.000000	.906545+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.921880-07	.142512-06	.000000	.113026-06	.111725-06	.000000	.000000	.000000	.000000	.000000
	.114050-11	.000000	.892188-07	.000000	.000000	.000000	.684913-07	.000000	.114050-11	.000000
INDEX=	.148541	SUM= $	587296.11							
43	.000000	.109888+05	.111300+04	.621257+05	.999350+04	.920499+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.863828-07	.134180-06	.000000	.111287-06	.111975-06	.000000	.645032-07	.000000	.159670-11	.000000
	.159670-11	.000000	.893781-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.147828	SUM= $	592296.10							
44	.000000	.124377+05	.111300+04	.621257+05	.999350+04	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.855110-07	.000000	.000000	.111754-06	.112445-06	.000000	.697919-07	.000000	.684302-12	.000000
	.684302-12	.000000	.894232-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.147631	SUM= $	593745.05							
45	.000000	.124377+05	.111300+04	.621257+05	.149935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.877482-07	.000000	.000000	.114964-06	.111914-06	.000000	.711216-07	.000000	.912402-12	.000000
	.912402-12	.000000	.891864-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.146348	SUM= $	598745.04							
46	.000000	.124377+05	.111300+04	.671257+05	.149935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.866751-07	.000000	.000000	.481326-07	.110192-06	.000000	.692860-07	.000000	.456201-12	.000000
	.456201-12	.000000	.890768-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.145823	SUM= $	603745.04							
47	.000000	.124377+05	.111300+04	.671257+05	.199935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.913675-07	.000000	.000000	.445034-07	.109292-06	.000000	.652311-07	.000000	-.000000	.000000
	-.000000	.000000	.888335-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.144537	SUM= $	608745.05							
48	.000000	.124377+05	.111300+04	.671257+05	.249935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.922031-07	.000000	.000000	.502558-07	.105936-06	.000000	.611353-07	.000000	.456201-12	.000000
	.456201-12	.000000	.885856-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.143211	SUM= $	613745.04							
49	.000000	.124377+05	.111300+04	.671257+05	.299935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.947981-07	.000000	.000000	.516170-07	.510877-07	.000000	.629106-07	.000000	.114050-11	.000000
	.114050-11	.000000	.883124-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.141873	SUM= $	618745.04							
50	.500003+04	.124377+05	.111300+04	.671257+05	.299935+05	.920899+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.948816-07	.000000	.000000	.524284-07	.518870-07	.000000	.638846-07	.000000	.684302-12	.000000
	.684302-12	.000000	.884753-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.141100	SUM= $	623745.04							

STEP	EXPENDITURES (1-10) / (11-20) / GRADIENTS (1-10) / (11-20)									
33	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.500000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.914963-07	.142053-06	.000000	.113593-06	.114297-06	.153002-06	.682805-07	.000000	.456201-12	.000000
	.456201-12	.000000	.996406-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.155065		SUM= $	545206.16						
34	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.550000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.924054-07	.142844-06	.000000	.114137-06	.114843-06	.157425-06	.683002-07	.000000	.912402-12	.000000
	.912402-12	.000000	.976574-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.154300		SUM= $	550206.15						
35	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.600000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.929432-07	.143679-06	.000000	.114710-06	.115419-06	.162113-06	.683198-07	.000000	.456201-12	.000000
	.456201-12	.000000	.956076-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.153513		SUM= $	555206.15						
36	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.650000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.898757-07	.138476-06	.000000	.110621-06	.111300-06	.143132-06	.683421-07	.000000	.456201-12	.000000
	.456201-12	.000000	.934868-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.152703		SUM= $	560206.15						
37	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.700000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.895623-07	.138434-06	.000000	.110320-06	.111003-06	.146995-06	.683654-07	.000000	.456201-12	.000000
	.456201-12	.000000	.921653-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.151987		SUM= $	565206.15						
38	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.750000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.900888-07	.139252-06	.000000	.110862-06	.111548-06	.151984-06	.683903-07	.000000	.228101-12	.000000
	.228101-12	.000000	.920504-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.151252		SUM= $	570206.15						
39	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.800000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.906515-07	.140126-06	.000000	.111442-06	.112131-06	.157327-06	.684172-07	.000000	.456201-12	.000000
	.456201-12	.000000	.912883-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.150492		SUM= $	575206.15						
40	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.850000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.912546-07	.141062-06	.000000	.112063-06	.112756-06	.163062-06	.684459-07	.000000	.456201-12	.000000
	.456201-12	.000000	.904740-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.149706		SUM= $	580206.15						
41	.000000	.598877+04	.111300+04	.621257+05	.999350+04	.900000+05	.000000	.496240+03	.000000	.906585+04
	.000000	.162231+05	.390200+06	.000000	.000000	.000000	.000000	.000000	.000000	.000000
	.919031-07	.142069-06	.000000	.112731-06	.113429-06	.169236-06	.684776-07	.000000	.114050-11	.000000
	.114050-11	.000000	.896019-07	.000000	.000000	.000000	.000000	.000000	.000000	.000000
INDEX=	.148890		SUM= $	585206.15						

****
PATH-RECEIVER BREAKDOWN BY CELL:
****

ZONE	CELL	LND USE	CELL POP.	TOTAL ADV. AFF. NO P-R MODS	REMAINING ADV. AFF. W/ P-R MODS	PER-CENT ADV. AFF. NO P-R MODS	PER-CENT ADV. AFF. W/ P-R MODS	P-R MOD TYPE	P-R MOD EXPENDITURE
1	1	11	142.5	.0	.0	.000	.000	0	.00
2	1	4	7.5	.7	.7	9.287	9.287	0	.00
3	1	5	174.4	.0	.0	.000	.000	0	.00
4	1	1	40.9	.0	.0	.000	.000	0	.00
4	2	1	53.1	.3	.3	.554	.554	0	.00
5	1	1	102.9	35.8	35.8	34.752	34.752	0	.00
5	2	1	81.4	.0	.0	.000	.000	0	.00
6	1	1	55.9	24.2	24.2	43.359	43.359	0	.00
6	2	1	18.4	.0	.0	.000	.000	0	.00
7	1	1	29.6	11.5	11.5	38.779	38.779	0	.00
7	2	1	50.8	.0	.0	.000	.000	0	.00
8	1	1	163.9	69.4	69.4	42.335	42.335	0	.00
8	2	1	22.1	.2	.2	.778	.778	0	.00
9	1	1	102.9	62.6	62.6	60.840	60.840	0	.00
9	2	1	33.7	7.5	7.5	22.215	22.215	0	.00
10	1	1	22.1	12.9	7.4	58.483	33.520	1	23625.00
10	2	1	3.0	.0	.0	.000	.000	0	.00
11	1	1	12.2	2.4	2.4	19.452	19.452	0	.00
11	2	1	9.9	.0	.0	.000	.000	0	.00
12	1	11	142.5	.0	.0	.000	.000	0	.00
13	1	1	87.9	7.9	7.9	9.045	9.045	0	.00
13	2	1	29.6	.0	.0	.000	.000	0	.00
14	1	12	314.0	.0	.0	.000	.000	0	.00
15	1	1	32.4	.7	.7	2.109	2.109	0	.00
15	2	1	33.4	.0	.0	.000	.000	0	.00
15	3	1	271.5	.0	.0	.000	.000	0	.00
16	1	4	144.7	69.8	69.8	48.195	48.195	0	.00
17	1	1	64.7	28.1	28.1	43.382	43.382	0	.00
17	2	1	71.9	23.7	23.7	32.950	32.950	0	.00
18	1	1	41.9	17.1	17.1	40.894	40.894	0	.00
18	2	1	46.7	.0	.0	.000	.000	0	.00
19	1	11	142.5	.0	.0	.000	.000	0	.00
20	1	4	21.5	15.9	15.9	74.000	74.000	0	.00
21	1	1	98.1	85.0	28.1	86.614	28.596	4	167200.00
21	2	1	144.7	43.1	-.0	29.770	-.000	4	.00
21	3	1	72.9	9.6	-.0	13.211	-.000	4	.00
22	1	1	150.4	130.9	20.2	86.261	12.916	5	248800.00
22	2	1	155.0	50.6	-.0	32.625	-.000	5	.00
23	1	11	142.5	69.9	-.0	49.003	-.000	5	55000.00

Note: Cells 21-2, 21-3, 23-1 are secondary cells receiving "free" benefit of barrier at primary cell location.

****
PATH-RECEIVER MODS COST BREAKDOWN
****

SP-1	SP-2	SP-3	B-1	B-2	RELOCATE	SP-1/B-1	SP-2/B-1	SP-3/B-1	SP-1/B-2	SP-2/B-2	SP-3/B-2
23625.	0.	0.	167200.	304200.	0.	0.	0.	0.	0.	0.	0.

PATH-RECEIVER EXPENDITURE = $ 495025.00

COST OF NEXT P-R MEASURE = $ 68355.00

```
FINAL EXPENDITURES:

      15000.     12438.      1113.     86996.     29993.     92070.      5000.       496.         0.      9066.
         0.     16223.    495025.         0.         0.         0.         0.         0.         0.         0.

                                                                                        TOTAL= $     763480.

FINAL COUNTERMEASURE VARIABLES:

  .163605-00  .620000+01  .568000-00  .370285-00  .500192-00  .100000+01  .333732+01  .170000+02 -.000000     .100000+01
 -.000000     .100000+01  .495025+06  .000000     .000000     .000000     .000000     .000000     .000000     .000000


IMPACT GRADIENT VECTOR (REDUCTION IN NII/$):

  .334991-07  .000000     .000000     .551709-07  .513676-07  .000000     .179009-07  .000000     -.456201-12  .000000
 -.456201-12  .000000     .000000     .000000     .000000     .000000     .000000     .000000      .000000     .000000
                                                                     GRADIENT MAGNITUDE =    .844102-07

COUNTERMEASURE RANKING:  4  5  1  7 13 12  3 10  2  8  6 11  9
SPENDING LIMIT REACHED:  0  0  0  0  0  1  1  1  1  1  1  0  0


                                                                     --------------------------------

                                                                     NOISE IMPACT INDEX =    .129561-00
                                                                     RED. FROM BASELINE =    .449608-00
                                                                     COST/BENEFIT RATIO =    .507579+03    $/PERSON

                                                                     --------------------------------
```

```
****************
TITLE- DATA SET:        MENLO PARK, SAN FRANCISCO BAY REGION STUDY AREA II, 1981 POPULATION, 1976 COSTS.
JOB DESCRIPTION:        STUDY AREA II  LOW  COST FUNCTIONS, NEW AUTONOM, CASE 1, AUTO RETROFIT CASE 2.
****************

*********
END  =0=0
*********
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APPENDIX A
NOISE OPTIMIZATION PROGRAM

A.1 Introduction

This appendix provides a brief technical description of the Community Noise Countermeasure Cost-Effectiveness Computer Program (called Noizop).* This program ~~is briefly~~ described in the summary statement below.

The acoustic environment of a community is modeled by the definition of small acoustically homogeneous divisions called cells. The source noise levels from up to 20 transportation (moving or stationary) noise sources can be specified at each of up to 200 cell locations. The user may define up to 20 countermeasures (noise reduction strategies) selected from an available list of eight alternate theoretical approaches to abate the noise sources. Additional input consists of the effectiveness and implementation costs for each of the defined countermeasures. The program calculates a single number evaluation of the noise climate in the community called the Noise Impact Index (NII) which is equivalent to the fraction of people in the community who would consider noise to be a significant detriment to their environment. The NII is the objective function which Noizop will seek to minimize using nonlinear optimization techniques. Constraining factors include feasible implementation (expenditure) limits on each countermeasure as well as a total budget for all countermeasures together. The end result is an optimum solution set for expenditure allocation among the countermeasures.

For the preparation of this strategy manual, an earlier version of Noizop was modified and enhanced to provide a tool suitable for use by local governments. The earlier program was referred to as version 2.1. The current version, described herein, is numbered 2.2.

Section A.2 describes each of the modifications to Noizop and serves as an update to the User's and Programmer's Guides.

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*Glenn, P.K., "Community Noise Countermeasures Cost Effectiveness Optimization Computer Program (Noizop)," Wyle Research Report WCR 76-15, Volumes I-III, for the Motor Vehicle Manufacturers Association, Inc., June 1977.

Section A.3 illustrates six hypothetical applications of Noizop on an actual Northern California community. Although these results are test cases and are not intended for implementation, they serve as a partial illustration of the range of potential uses of Noizop to local city governments and planning agencies.

Section A.4 is an application of Noizop to Allentown, Pennsylvania. This application, following directly from the procedures described in earlier sections of this manual, was performed to provide city officials of Allentown with an optimal noise abatement planning strategy.

A.2 Updates to the User's Guide and Programmer's Guide

A.2.1 User's Guide Updates

To furnish a computer utility suitable for local governments and planning agencies, several enhancements and updates were made to an already existing version of Noizop. The following discussion describes all additions and modifications that have been made to the program. Table A-1 summarizes these changes. Parenthetical references are made to section numbers of the User's Guide where the related material is discussed. In the following discussion it is assumed that the reader is familiar with the Noizop User's Guide.

1. Criterion Level Specification

Lower criterion levels (zero percent adverse response) which previously needed to be input with each cell have been given default values. These default values are listed in Table A-2. The user may now leave a blank data field for the lower criterion level specification on the appropriate input data card (Section 2.1).

In addition, the default upper criterion levels (100 percent adverse response) have been revised to agree with EPA-recommended levels (Section 2.7). These are also listed in Table A-2.

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Table A-1

Additions and Modifications to Noizop

Addition or Modification	Related Section(s) in User's Guide
1. Criterion Level Specification	2.1, 2.7
2. Countermeasure Type Numbers	2.2
3. Countermeasure Indicators	2.2
4. Default Transfer Function	2.7
5. Input of User Cost Portions	New Addition
6. Attitudinal Source Level Adjustments	New Addition
7. Gradient Stepsize	2.11.1
8. Optimization Process	2.11
9. Output of Bar Graph Summarizing Results	New Addition

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Table A-2

Default Criterion Levels
(Tables 2-2 and 2-7)

Land Use Code	Suggested Usage	Default Lower Criterion Levels (0% adverse response, dB		Default Upper Criterion Levels (100% adverse response, dB)	
		Day	Night	Day	Night
1	Single and Two-family Residential	54	46	74	66
2	Open for Additional Residential Use	54	46	74	66
3	Single, Two, and Multifamily Residential	54	46	74	66
4	Multifamily Residential	59	46	79	66
5	Business and Commercial	59	59	79	79
6	Wholesale and Warehousing	59	59	79	79
7	Central Business District	59	59	79	79
8	Industrial	70	70	90	90
9	Public and Semi-public Areas	None	None	None	None
10	Parks	55	—	75	—
11	Schools	55	—	75	—
12	Hospitals and Nursing Homes	50	50	70	70
13	Open	None	None	None	None
14	Open	None	None	None	None
15	Open	None	None	None	None

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2. Countermeasure Type Numbers

The countermeasure type numbers have been redefined in order to simplify the notation used in the previous version (Section 2.2). Table A-3 lists the old and new countermeasure type numbers. The user should use the new type numbers on the countermeasure definition data cards.

Table A-3

Countermeasure Type Numbers

Type Number		
Old	New	Countermeasure Definition
1	1	A reduction in the frequency of operation of the noise source. The fractional reduction is the same during the day and at night
3	2	A reduction in the frequency of nighttime operation of the noise source.
5	3	A shifting of the nighttime activity into the daytime period, or vice versa.
10	4	Application of a device that produces a fixed L_{eq} reduction to a portion of the source population.
12	5	An overall L_{eq} reduction.
15	6	Like 10, except that no further modifications are allowed to the treated portion of the source population.
18	7	Stationary source countermeasures.
20	8	Path or receiver modifications.

3. Countermeasure Indicators

Countermeasure types with new numbers 4 and 6 (see Table A-3) require countermeasure manipulation indicators to be defined (Section 2.2). The original version of Noizop permitted decibel reduction values which comprise the indicator to be entered to an accuracy no better than 0.5 dB. For local government application the definition of the indicator has been altered to allow entry of decibel reduction values accurate to 0.1 dB. The new definition is:

$$I = (dB1 \times 10 + 200) \times 1000 + (dB2 \times 10 + 200)$$

where

dB1 = maximum decibel reduction at the cell location for this countermeasure or the primary noise source.

dB2 = maximum decibel reduction at the cell location for this countermeasure on the secondary noise source.

Note that the maximum range of the decibel reductions have been reduced from ±100 dB to ±20 dB.

4. Default Transfer Function

The default transfer function is now linear allowing a value greater than 100 percent adverse response (Section 2.7). The previous default transfer function was also linear but did not allow a value greater than 100 percent adverse response. This change was accomplished by giving the bulge parameter a default value of 1.

5. Input of User Cost Portions

A feature has been added which allows the user (in this case the local government) to specify the fraction of the costs for a countermeasure which he bears. Total costs for a countermeasure are still comprehensive societal costs and these costs still form the basis for the optimization. An additional codeword is now allowed - USER - which is used to enter the cost fractions. The first card following the USER codeword is a title card which may contain any pertinent information. The first 72 columns of the card may be used. The second (also the last) succeeding data card contains the countermeasure cost fractions (i.e., between 0. and 1.). The input format for this card is 20F4.0. The first field (columns 1 through 4) contains the fraction for countermeasure number 1, the tenth field (columns 37-40) contains the fraction for countermeasure number 10, etc. The default values for the user cost fractions are all unity, 1. Default values for user cost portions are initiated by not implementing the USER codeword.

The local government budget for noise abatement measures may be considerably less than the total societal budget. The user may determine the optimum disposition of the countermeasures at the user budget level by finding the optimization procedure step number in the computer output which expended a user cost value equal to the local government budget. The total user cost is printed along with the total societal cost for every step. Again, note that the countermeasures are optimized for the total cost rather than the user cost.

6. Attitudinal Source Level Adjustments

The capability to modify source noise levels for attitudinal biases has been added. The formula for making the adjustment is shown below.

$$L_{eq}\ (\text{new}) = L_{eq}\ (\text{old}) - \text{Corr}$$

The parameter in the above expression, Corr, is input to the program through the use of a new codeword, CORR. The CORR codeword allows an option parameter, a nonzero number in column 6 of the codeword card, which will cause a formatted listing of the main cell data to be printed showing the modified source levels. This printout option is the same option included with the DTA and FAC codewords (Sections 2.1 and 2.8, respectively).

The first data card following the codeword card is a title card of which the first 72 columns may be used. The succeeding data cards have the format as follows:

Field Number	Format	Data Item
1	I5	Noise Source Number
2	F5.0	Corr Value for this Source, dB

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One card is required for each source receiving an attitudinal adjustment. A blank data card must follow the last adjustment data card to return control to the main program.

Note that the adjustment value, Corr, is subtracted from the source levels. Consequently, negative adjustments will increase the apparent levels while positive adjustments will decrease them.

Noizop will print the following diagnostic message if an invalid noise source number (greater than 20) is placed in field number 1 above.

INVALID SOURCE NUMBER IN ATTITUDINAL ADJUSTMENTS

This message will be printed identically in both the main and auxiliary print files.

7. <u>Gradient Stepsize</u>

The gradient stepsize (Section 2.11.1) is given a default value, initiated by a blank field on the appropriate data card, of the total specified budget divided by 100.; not $10,000 as mentioned in the User's Guide.

8. <u>Enhancement of Optimization Process</u>

This discussion complements and updates Section 2.11 of the Noizop User's Guide.

Because of a potential manyfold increase in the volume of output that is produced, the "I" option parameter now controls the printing of the results after each of the steps in the optimization procedure. The options are described in Table A-4.

The input data card containing the optimization control parameters now contains five parameters. The format is 4F10.0, I10:

1. The total budget
2. The gradient stepsize
3. The initial maximum expenditure ratio
4. The expenditure retraction factor
5. The number of refinement stages

Table A-4

First Option Parameter for OPT Codeword

Parameter Value	Effect
-1	Suppresses the printing of each of the steps in the optimization procedure from the main print as well as the auxiliary output file. Only the input expenditures and optimization control parameters are printed. No breakdown of path-receiver measures by cell location is given.
0	This is the default value. All steps in the optimization procedure are printed in both the main and auxiliary output files. A breakdown of path-receiver measures by cell location is provided.
1	Suppress the printing of each of the steps in the optimization process in the main print file. The abbreviated form is still provided in the auxiliary output file.. No breakdown of path-receiver measures by cell location is given.

Parameters 1-3 are described in the Noizop User's Guide. The use of parameters 4 and 5 is explained in the following discussion.

In some instances, the steepest descent path optimization procedure may prove inadequate. This is due to the fact that the gradient testing method is somewhat shortsighted. That is, it determines the optimum point at a short distance (the gradient stepsize) from its current position. In so doing, it commits an expenditure to a countermeasure that it cannot retract. It may turn out that for larger total expenditures, the optimum point exists with a lesser expenditure on a countermeasure than was previously committed to reach an optimum point earlier in the step-by-step optimization process. The previous version of Noizop would fail to find the actual optimum point in such an instance because it did not allow retraction of expenditures on any countermeasure.

The operating theory of Noizop version 2.2 to correct this potential problem is illustrated in Figure A-1.

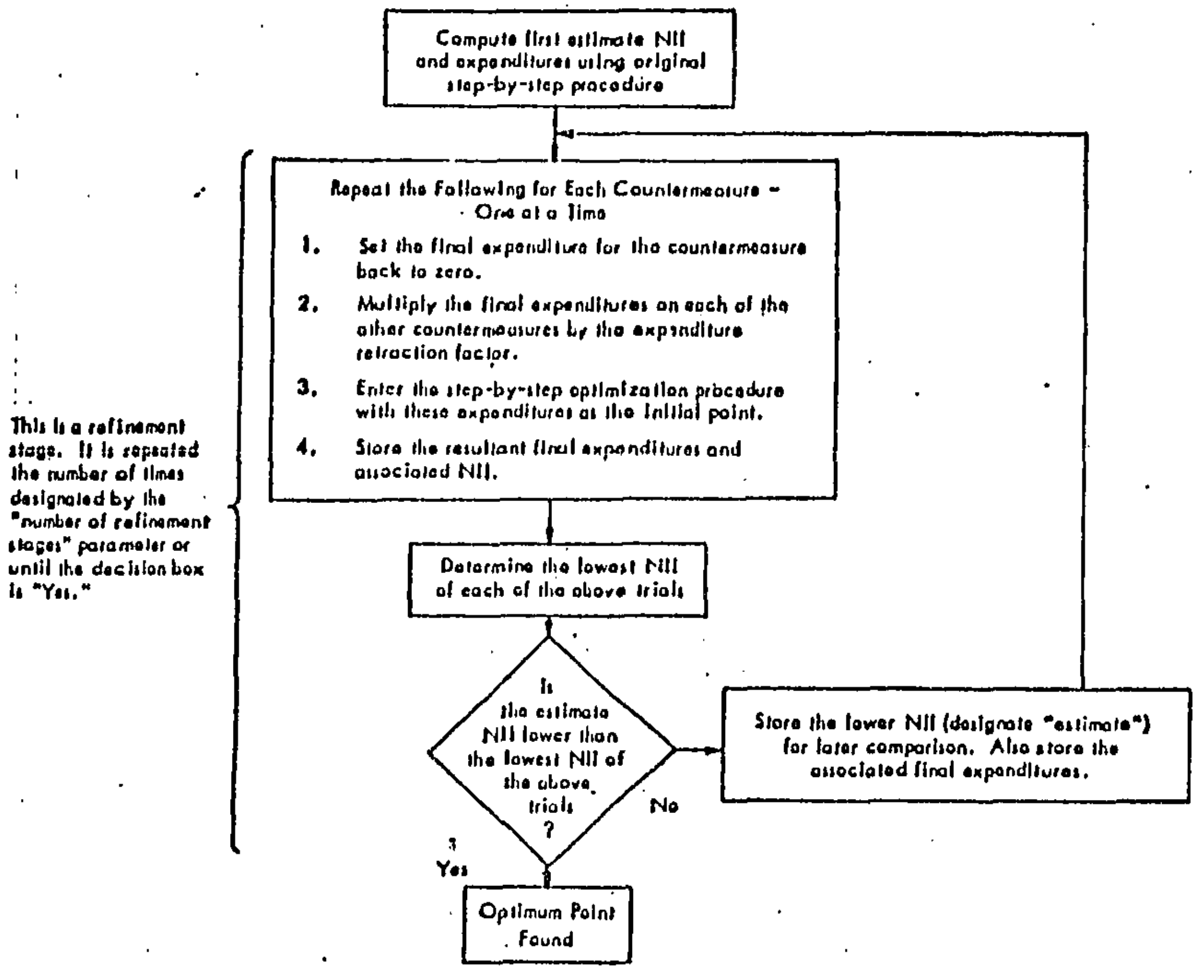

Figure A-1. Functional Flow Diagram Describing Optimization Refinement Stages (Subroutine SEARCH)

As can be seen from Figure A-1, a quantity called the expenditure retraction factor is used to adjust the estimated final expenditures on each of the other countermeasures at the time when one of them is being retracted to zero. A factor less than 1. will reduce the values, a factor greater than 1. will increase them. The default value for this parameter, initiated by a blank field or a zero, is 1. which means that the expenditure values are not altered.

The "number of refinement stages" parameter controls the maximum number of times the expenditures on each countermeasure will be retracted to zero in search of a lower NII. The process will stop automatically in the event that a refinement stage fails to improve on the best value found in the previous refinement stage. The default value for this parameter, initiated by a blank field or a zero, is zero, no refinement stages. With no refinement stages, the results of this version of Noizop will be identical to the results of the earlier version.

9. Output of Bar Graph Summarizing Results

A bar graph is now produced which graphically illustrates the final expenditures on each of the countermeasures. Both total costs (T) and user costs (U) are plotted. Due to the extreme range of dollar values which may be expended, the expenditures axis is on a logarithmic scale. Care should thus be taken in reading this chart due to the nonlinear nature of the scaling. The chart is self-adjusting on both axes; that is, it will compute the range of values that are to be plotted and allow the maximum number of print positions to display the information. A horizontal line at the top of the bar for a countermeasure indicates the spending limit was reached on that countermeasure.

A.2.2 Programmer's Guide Updates

This section updates the Noizop Programmer's Guide to reflect the changes to the program described in the preceding section. (Figure numbers referred to indicate figures in the Programmer's Guide.)

Figure B-1 should show two new paths coming from the main program to describe the subroutine linkage for each of the two new codewords. For codeword USER, the subroutine that is called is named USERRD. For codeword CORR, the subroutine is named ATTCOR. The corrected figure is shown in Figure A-2.

Figure B-2 should indicate the calling levels of the new subroutines, SEARCH, BARGPH, and UFRAC. SEARCH is called directly by the main program (NOIZOP) and controls the manner in which OPTIM, the subroutine which performs the step-by-step optimization, is called. The operation of subroutine SEARCH is illustrated in Figure A-1. The annotated program listing should be consulted for a detailed description of the new subroutines. The corrected Figure B-2 is shown in Figure A-3.

A new COMMON block was added to contain the user cost fractions for each of the 20 possible countermeasures

/CMFRAC/ DIST (20)

Another new COMMON block contains the two new optimization parameters

/PRINT/FRED, NIT

- FRED is the expenditure retraction factor.
- NIT is the number of refinement stages.

A.3 Quantification of Model for Six Sets of Hypothetical Applications

This section describes the application of Noizop to six sets of alternate input data. These cases serve to partially illustrate the application of Noizop to communities of different characteristics and, at the same time, demonstrate the level of sensitivity of optimum countermeasure application to various communities.

The base data that was used represents the quantification of an actual Northern California community. Six cases were derived as variants of that data. They are summarized in Table A-5. Figures A-4 through A-11 and Table A-7 summarize the computer output for the six cases.

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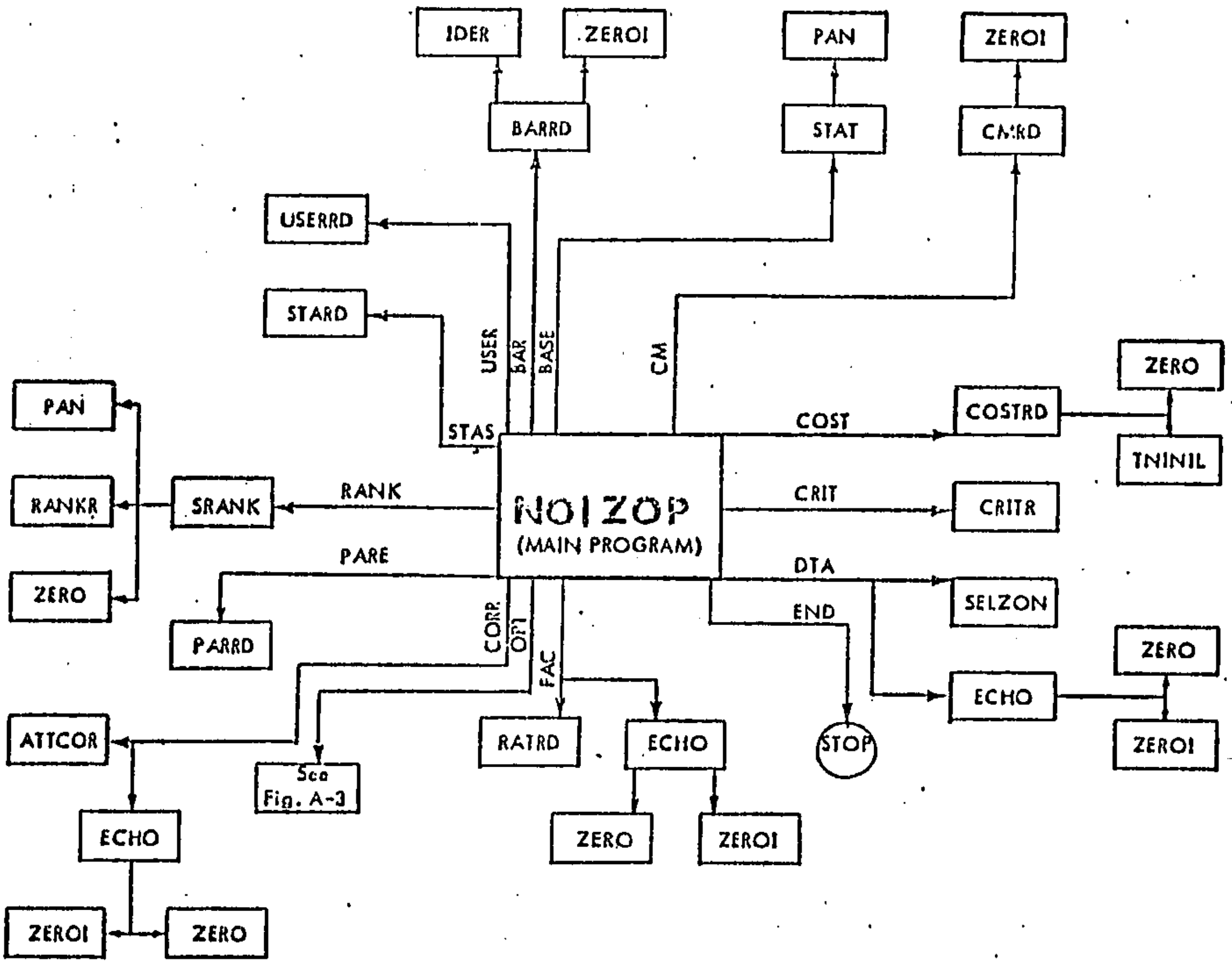

Figure A-2. Subroutine Linkage Diagram Indicating Program Flow by Codeword

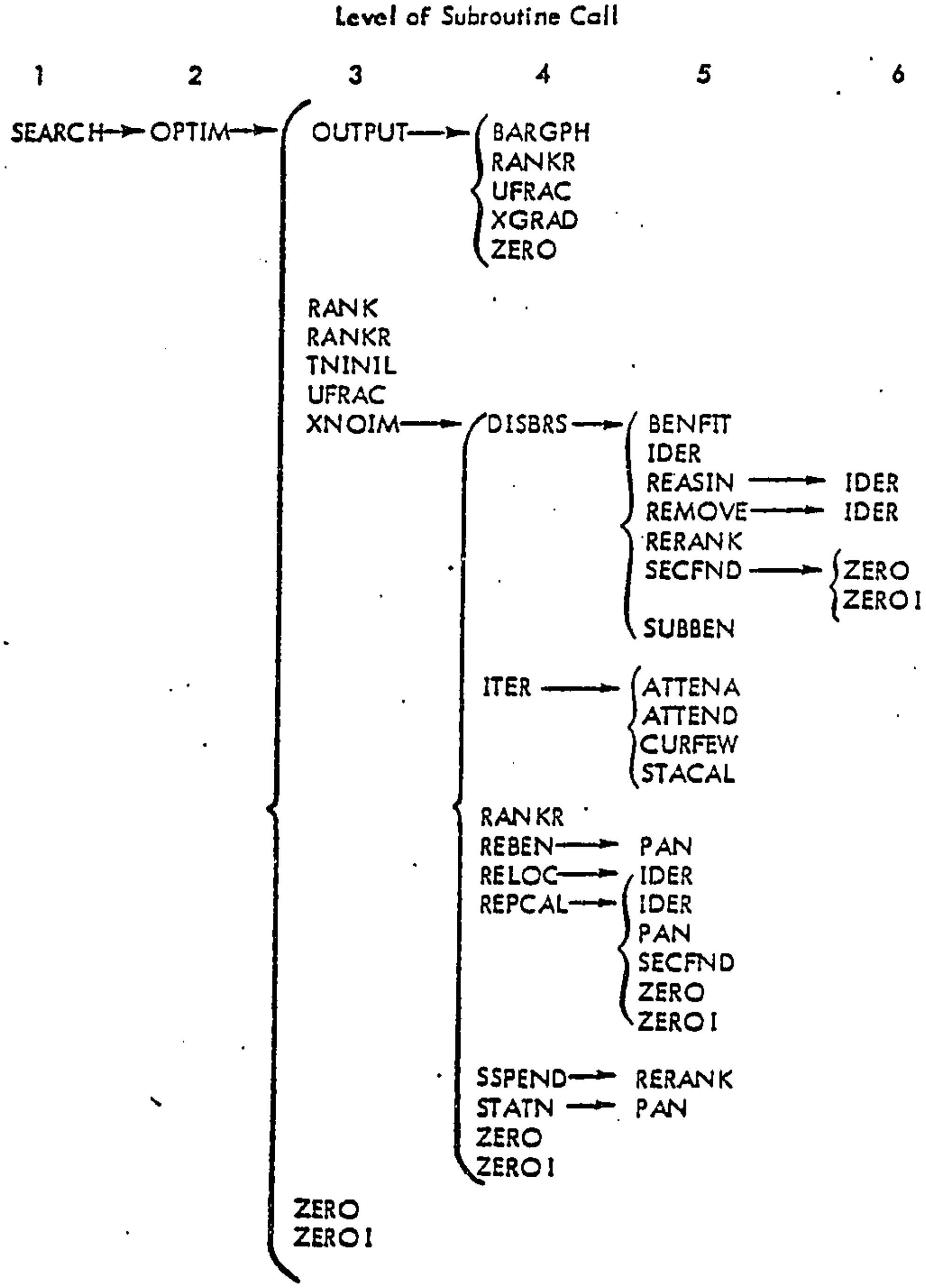

Figure A-3. Subroutine Linkages (Alphabetical Order) for the Main Optimization Process, Codeword OPT.

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Table A-5

Alternatives Analyzed by Noizop

1.	Baseline Case.
2.	Two Times Residential Population Density of Baseline Case.
3.	Community One-Half the Size of the Baseline Case.
4.	Removing the Motorcycle Noise Source and Countermeasure.
5.	Removing the Path-Receiver Countermeasure.
6.	The Baseline Case without the Noise Source Attitudinal Adjustments.

1. Baseline

This case, reanalyzed for this document with a few modifications, is thoroughly described in the User's Guide, Section 5.2, where the input data is described and the complete computer output is presented. The modifications to the input data reflect the changes made to Noizop to include additional capabilities required for application by local governments. The specific changes to the input data are detailed below.

1. The countermeasure type numbers were redefined to reflect the new designations (see Table A-2). The countermeasures used in the analysis of the alternatives are listed in Table A-6.

2. The two-dimensional enforcement type countermeasures were removed; this concept presents an additional complexity beyond the scope of this manual (see User's Guide, Section 4.2).

3. The countermeasure manipulation indicators were redefined according to the new formula.

4. The linear transfer function specification allowing more than 100 percent impact was removed as this option is now default.

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Table A-6

Countermeasures Defined for Noizop Analysis of Alternatives

```
--------- AUTOMOBILES LOW  SPEED NEW VEHICLES SOURCE REDUCTION
COUNTERMEASURE  1 TYPE  6 'EXCL TRT' APPLIES TO: AUTOMOBILES LOW  SPEED LINE SRC
                                                 AUTOMOBILES LOCAL TRAFFIC SOURCE

--------- AUTOMOBILES LOW  SPEED EXISTING VEHICLES RETROFIT SOURCE REDUCTION
COUNTERMEASURE  2 TYPE  6 'EXCL TRT' APPLIES TO: AUTOMOBILES LOW  SPEED LINE SRC
                                                 AUTOMOBILES LOCAL TRAFFIC SOURCE

--------- AUTOMOBILES LOW SPEED DOS ENFORCEMENT
COUNTERMEASURE  3 TYPE  5 'DB  RED ' APPLIES TO: AUTOMOBILES LOW  SPEED LINE SRC
                                                 AUTOMOBILES LOCAL TRAFFIC SOURCE

--------- MOTORCYCLES LOW SPEED DOS ENFORCEMENT
COUNTERMEASURE  4 TYPE  5 'DB  RED ' APPLIES TO: MOTORCYCLES LOW  SPEED LINE SRC.
                                                 MOTORCYCLES LOCAL TRAFFIC SOURCE

--------- TRUCKS       LOW  SPEED NEW VEHICLES SOURCE REDUCTION
COUNTERMEASURE  5 TYPE  4 'PART TRT' APPLIES TO: TRUCKS       LOW  SPEED LINE SRC.

--------- TRUCKS       HIGH SPEED TIRE NOISE REDUCTION
COUNTERMEASURE  6 TYPE  4 'PART TRT' APPLIES TO: TRUCKS       HIGH SPEED LINE SRC.

--------- BUSES        LOW  SPEED SOURCE REDUCTION, NEW AND EXISTING VEHICLES
COUNTERMEASURE  7 TYPE  5 'DB  RED ' APPLIES TO: BUSES        LOW  SPEED LINE SRC.

--------- AIRCRAFT     SOUND ABSORPTION MATERIAL NACELLE TREATMENT SOURCE REDUCTION
COUNTERMEASURE  8 TYPE  4 'PART TRT' APPLIES TO: AIRCRAFT     COMMERCIAL, FLIGHT

--------- AIRCRAFT     FLIGHT PATH REROUTING (EFFECTIVELY A FLIGHT FREQUENCY RED.)
COUNTERMEASURE  9 TYPE  1 'RED FREQ' APPLIES TO: AIRCRAFT     COMMERCIAL, FLIGHT

--------- AIRCRAFT     REDUCTION OF NIGHT OPERATIONS
COUNTERMEASURE 10 TYPE  2 'NITE RED' APPLIES TO: AIRCRAFT     COMMERCIAL, FLIGHT

--------- RAILROAD     LOCOMOTIVE MUFFLERS, SOURCE REDUCTION
COUNTERMEASURE 11 TYPE  4 'PART TRT' APPLIES TO: RAILROAD     LOCOMOTIVES, LINE S.

--------- PATH-RECEIVER CONTROL: INSULATION, BARRIERS, LAND ACQ. AND PEOPLE RELOC.
COUNTERMEASURE 12 TYPE  8 'P-R MOD ' APPLIES TO: ALL SOURCES
```


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5. The specification of upper and lower criterion levels was removed as this information is now default.

6. Attitudinal adjustments with the following parameters were made to low speed arterial and local traffic (collector streets), motorcycle and locomotive and car railroad noise sources (numbers 6, 7, and 9, 10, respectively).

Source	Adjustment, dB
Motorcycles	-6. (Increase)
Railroad	5. (Decrease)

These hypothetical adjustments compensate for the fact that the annoyance reaction to motorcycle noise is indicative of a noise level 6 dB higher than for other sources. The railroad correction illustrates that a noise level of 5 dB greater than for the other sources is required to produce a comparable annoyance reaction.

7. Hypothetical user cost fractions were entered as shown below for countermeasures 1 through 12, respectively.

Countermeasure Number	1	2	3	4	5	6	7	8	9	10	11	12
User Cost Fraction	.01	0.	1.	0.5	.01	0.5	.01	.01	.01	.01	.01	1.

8. The total budget was specified as $1 million and the gradient stepsize and initial maximum expenditure ratio were allowed to default to $10 thousand and 10., respectively. No marginal search (expenditure retraction stages) was initiated.

The results of the optimization procedure are shown in Figure A-4. The path-receiver countermeasure absorbed nearly 80 percent of the total budget. The total user cost is therefore high because the local government, in this hypothetical example, is assumed to be responsible for the entire cost of path-receiver countermeasures (countermeasure number 12 above). Other significant aspects of the optimized baseline expenditures are:

- Maximum amounts were spent on countermeasures for existing automobile retrofit source reduction and enforcement thereof. An equal amount was spent on new vehicle source reduction, but this did not represent the maximum allowed expenditure. The motorcycle countermeasure, an enforcement action to eliminate the very noisy offenders, received the maximum allotment.

- A large amount was spent on both truck noise countermeasures with the high speed tire noise source receiving the maximum allowed expenditure.

- The bus noise countermeasure did not receive any funding but was the highest ranking countermeasure at the end of the optimization process. Therefore, if additional funds were available, the bus noise countermeasure would be the next to receive funding, assuming, of course, that the additional funds would either be insufficient for an additional discrete path-receiver expenditure or that next path-receiver measure would be less effective than the bus noise countermeasure.

- The only aircraft countermeasure selected was flight path routing. The rerouting of all the aircraft accounts for the subsequent ineffectiveness of both the Sound Absorbing Material (SAM) and night curfew countermeasures.

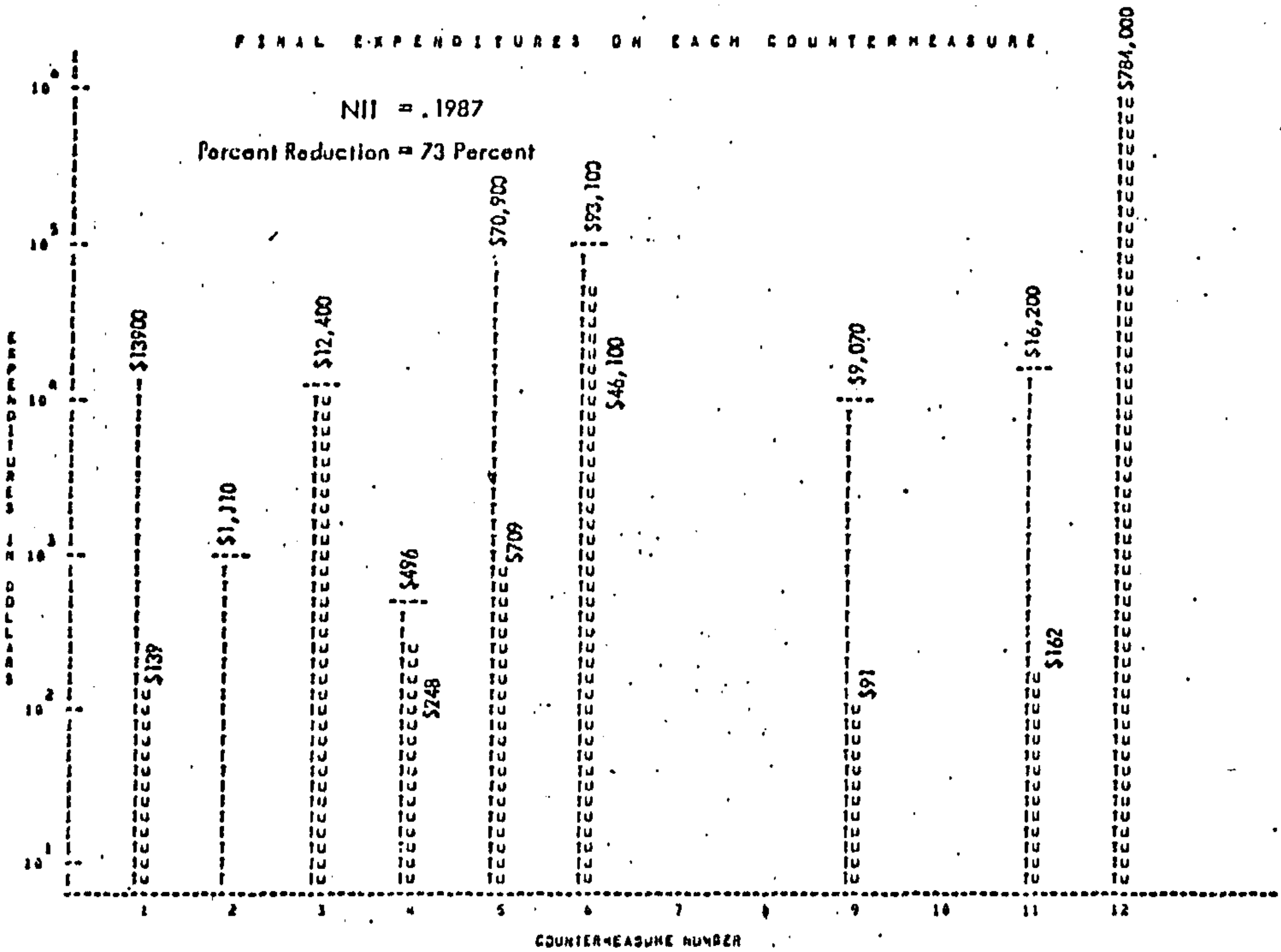

Figure A-4. Baseline Case Optimization Results. T = Total Cost = $1,000,000; U = User Cost = $844,000.

Table A-7

Extent of Countermeasure Application to the Six Hypothetical Examples.
The Countermeasure Application Corresponds to Total Expenditures
on Each Countermeasure as Seen in Figures A-4 through A-7 and A-10 through A-11

Countermeasure	Case 1 Baseline	Case 2 Twice Residential Population Density	Case 3 Community One-Half Size	Case 4 Removing Motorcycle Source and Countermeasure	Case 5 No Path-Receiver Countermeasure, Smaller Budget	Case 6 No Attitudinal Adjustments
1. Percent of Automobiles Receiving 3.5 dB Reduction*	16%	19%	1%	13%	0	20%
2. Percent of Automobiles Receiving 3.5 dB Reduction*	57%	57%	57%	57%	57%	57%
3. Decibel Reduction in Automobile L_{eq} due to Enforcement of Ordinance	6.2 dB	6.2 dB	6.2 dB	6.2 dB	5.9 dB	6.2 dB
4. Decibel Reduction in Motorcycle L_{eq} due to Enforcement of Ordinance	17 dB	17 dB	17 dB	—**	17 dB	17 dB
5. Percent of Trucks Receiving 12 dB Engine Noise Reduction	36%	36%	36%	36%	25%	36%
6. Percent of Trucks Receiving 5 dB Tire Noise Reduction	100%	100%	100%	100%	33%	100%
7. Decibel Reduction in Bus L_{eq}	0	0	0	5.1 dB	0	0
8. Percent of Aircraft Receiving SAM Treatment	0	0	0	0	0	0
9. Percent of Aircraft Rerouted	100%	100%	100%	100%	100%	100%
10. Percent of Aircraft Night Operations Eliminated	0	0	0	0	0	0
11. Percent of Railroad Locomotives Receiving 6 dB Muffler Treatment	100%	100%	100%	100%	100%	100%
12. Total Dollar Expenditure on Barriers and Soundproofing	$784,000	$775,000	$791,000	$775,000	—**	$773,000

*Countermeasures 1 and 2 are mutually exclusive (Countermeasure Type 6). Countermeasure 1 applies to new vehicles, Countermeasure 2 applies to existing vehicles.

**Countermeasure not defined.

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- The railroad countermeasure applying to the locomotive source also received maximum funding which is consistent with the high source ranking of the locomotive noise source (see Figure A-8).

2. Two-Times Residential Population Density of Baseline Case

The data set for this case is identical to the data set for case number 1 with the exception that every cell in a residential land use area has double the baseline population.

The results of this case, shown in Figure A-5 show almost the same results as for case number 1., the difference being that the low speed automobile source received slightly more treatment at the expense of a path-receiver countermeasure.

3. Community One-Half the Size of the Baseline Case

For this alternative, every other cell defined for the baseline case was removed to simulate a smaller community. As can be seen in Figure A-6, the results are quite similar to the baseline case. The detailed disposition of the individual path-receiver measures (i.e., barriers and soundproofing) was, of course, quite different since the configuration of the community and, hence, the relative cost-effectiveness of all the possible individual path-receiver measures is different.

4. Removing the Motorcycle Noise Source and Countermeasure

Removing the motorcycle source has the effect of slightly altering the community so that an expenditure on the bus countermeasure becomes effective. No other significant differences from the baseline case are present. Figure A-7 illustrates the results. Note that the motorcycle countermeasure (number 4) was removed for this case meaning that in Figure A-7, countermeasures numbered 4 through 11 correspond to countermeasures numbered 5 through 12 in the five other cases.

An interesting result of removing the motorcycle source is a change in the population-weighted noise source impact ranking in the community. Figure A-8 is the source ranking for the baseline case, including the motorcycle source. Figure A-9 is the source ranking with the motorcycle source removed.

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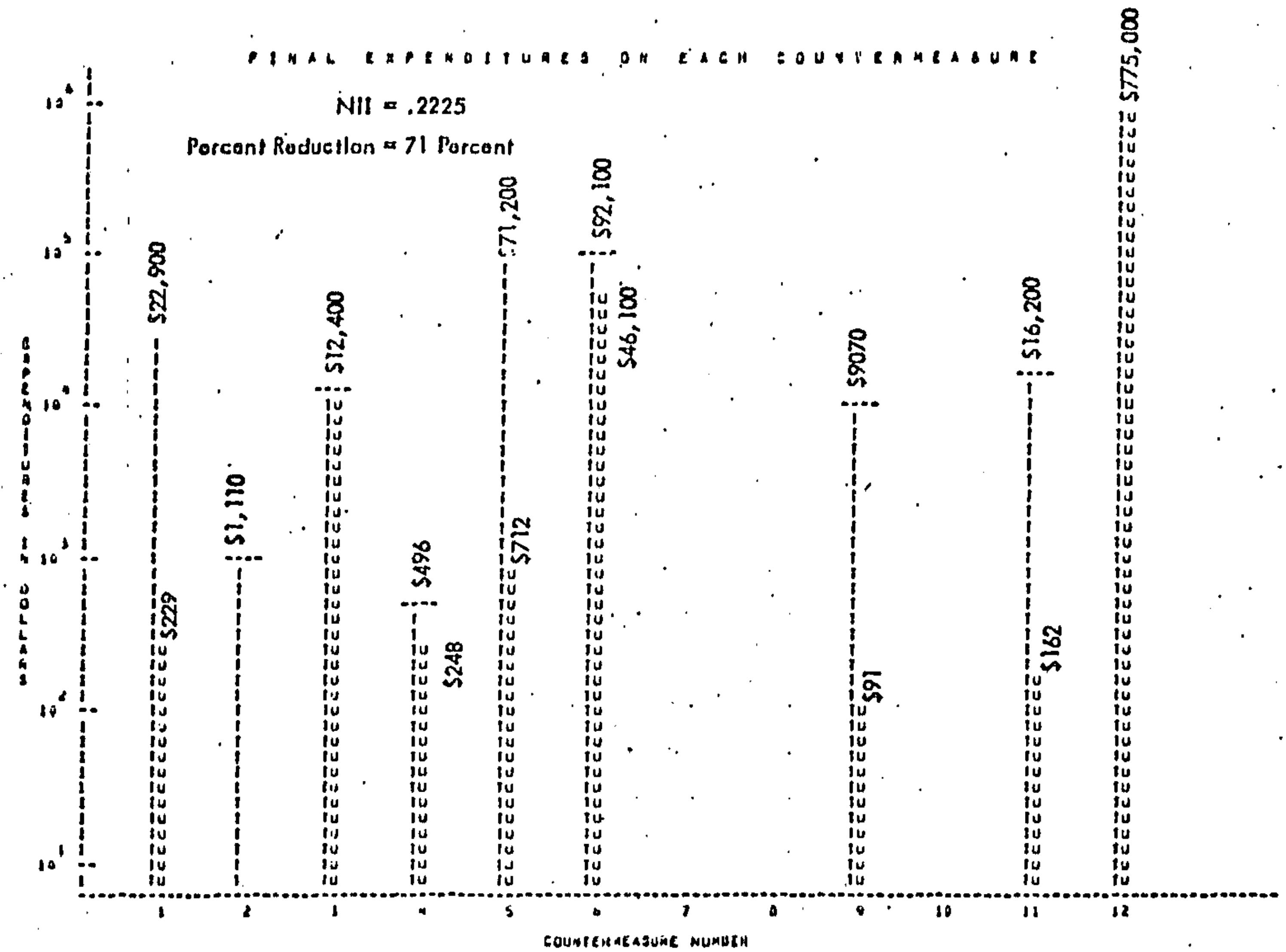

Figure A-5. Final Expenditures for Case Number 2, Two Times Residential Population Density of Baseline Case
Total Cost = $1,000,000; User Cost = $834,000

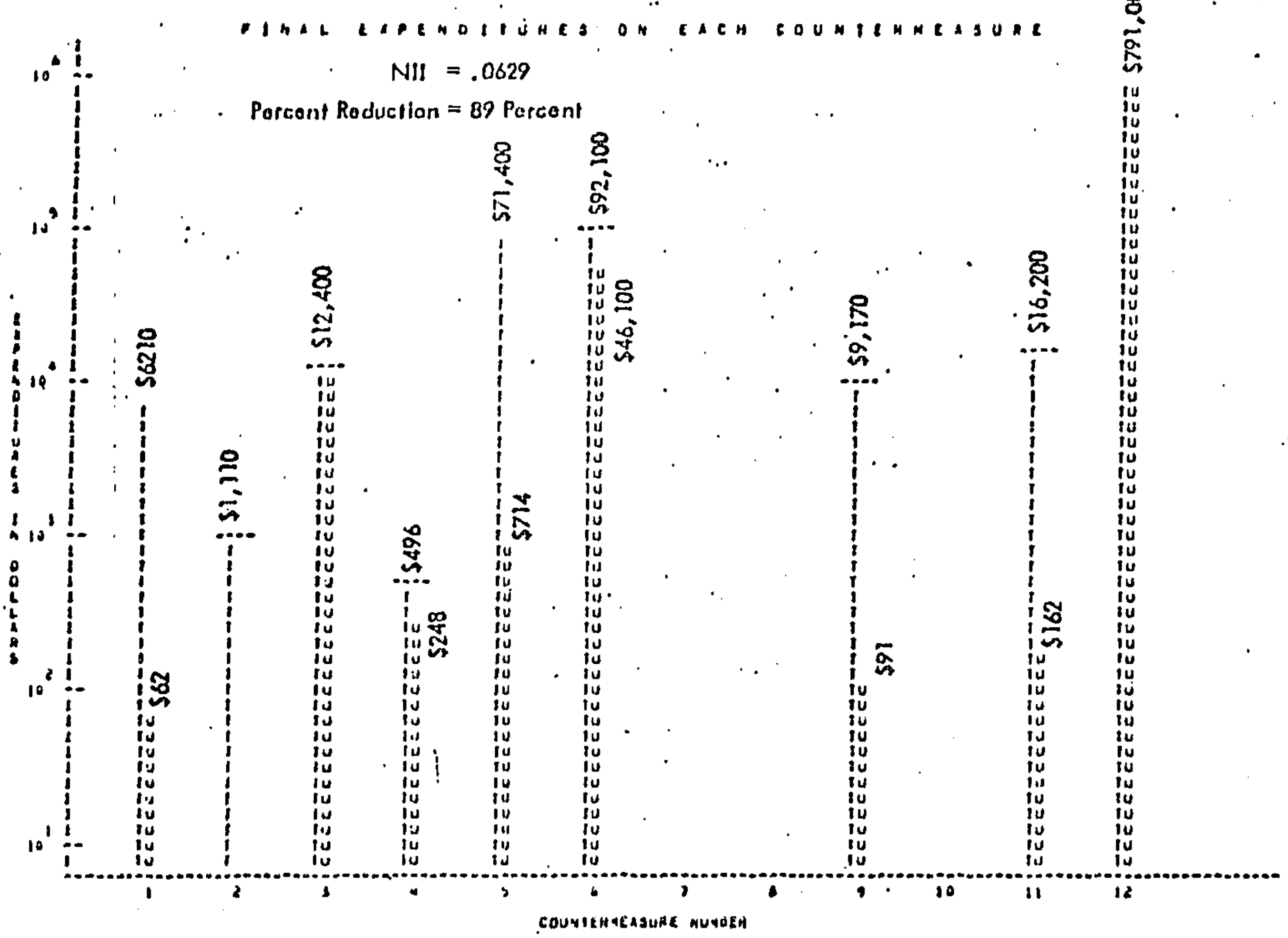

Figure A-6. Final Expenditures for Case Number 3, Community One-Half the Size of the Baseline Case
Total Cost = $1,000,000; User Cost = $851,000

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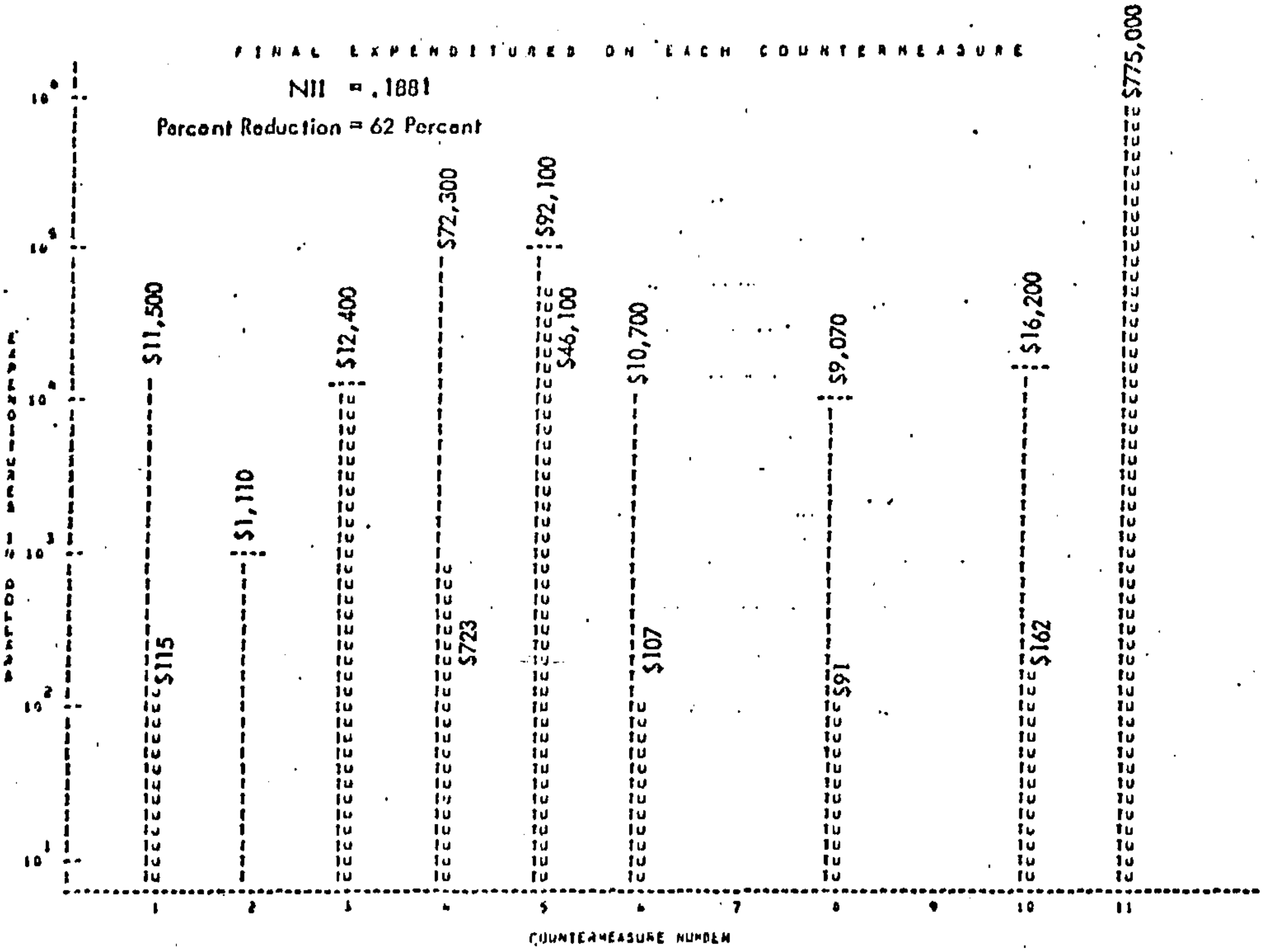

Figure A-7. Final Expenditures for Case Number 4, Removing the Motorcycle Noise Source and Countermeasures Total Cost = $1,000,000; User Cost = $834,000

MOST OFFENDING SOURCES:			SOURCE NO.
1	MOTORCYCLES	LOW SPEED LINE SRC.	(6)
2	MOTORCYCLES	LOCAL TRAFFIC SOURCE	(7)
3	RAILROAD	LOCOMOTIVES, LINE S.	(9)
4	AUTOMOBILES	LOW SPEED LINE SRC	(1)
5	TRUCKS	LOW SPEED LINE SRC.	(4)
6	TRUCKS	HIGH SPEED LINE SRC.	(5)
7	AUTOMOBILES	HIGH SPEED LINE SRC	(2)
8	AUTOMOBILES	LOCAL TRAFFIC SOURCE	(3)
9	RAILROAD	CARS, LINE SOURCE	(10)
10	AIRCRAFT	COMMERCIAL, FLIGHT	(11)
11	BUSES	LOW SPEED LINE SRC.	(8)

Figure A-8. Noise Source Ranking of Baseline Case

MOST OFFENDING SOURCES:			SOURCE NO.
1	AUTOMOBILES	LOW SPEED LINE SRC	(1)
2	TRUCKS	LOW SPEED LINE SRC.	(4)
3	TRUCKS	HIGH SPEED LINE SRC.	(5)
4	RAILROAD	LOCOMOTIVES, LINE S.	(9)
5	AUTOMOBILES	HIGH SPEED LINE SRC	(2)
6	AUTOMOBILES	LOCAL TRAFFIC SOURCE	(3)
7	RAILROAD	CARS, LINE SOURCE	(10)
8	AIRCRAFT	COMMERCIAL, FLIGHT	(11)
9	BUSES	LOW SPEED LINE SRC.	(8)

Figure A-9. Noise Source Ranking with Motorcycle Source Removed

Prior to the removal of the dominant motorcycle sources, the railroad locomotive noise source had a greater impact than the low speed automobile source and both the low and high speed truck noise sources. The counterintuitive result of removing the motorcycle source is that the automobile and truck noise source now have greater impact relative to the railroad locomotive source than they did before.

An apparent explanation is that the presence of the annoying motorcycle source had the effect of masking the automobile and truck sources. In other words, with the motorcycles no longer there, the automobiles and trucks become the dominant sources in areas where traffic is dominant, but the number of areas impacted by railroad noise remains unchanged.

5. No Path-Receiver Countermeasure

Since the path-receiver countermeasures received the preponderance of the expenditure allocation in the other cases, the removal of this countermeasure provides potentially the most interesting variant to the baseline case. For this case, the total budget was reduced to $100 thousand since a $1 million budget would allow maximum application of all the countermeasures and no interesting results would be obtained. Figure A-10 illustrates these results.

Countermeasure number 1, new automobile source reduction, now receives no expenditures while the remainder is disbursed to counteremasures 3, 5, and 6 (see Table A-6). Overall, the disposition of these countermeasures is similar to the baseline case. What this case illustrates is that, for this community, the optimum expenditures among the remaining countermeasures is only slightly altered when the most cost-effective countermeasure is removed.

6. No Attitudinal Adjustments

Removing the attitudinal adjustments had little effect since the motorcycles and railroad noise source predominate even without the attitudinal corrections. The effect of the attitudinal corrections was to increase the apparent motorcycle levels by

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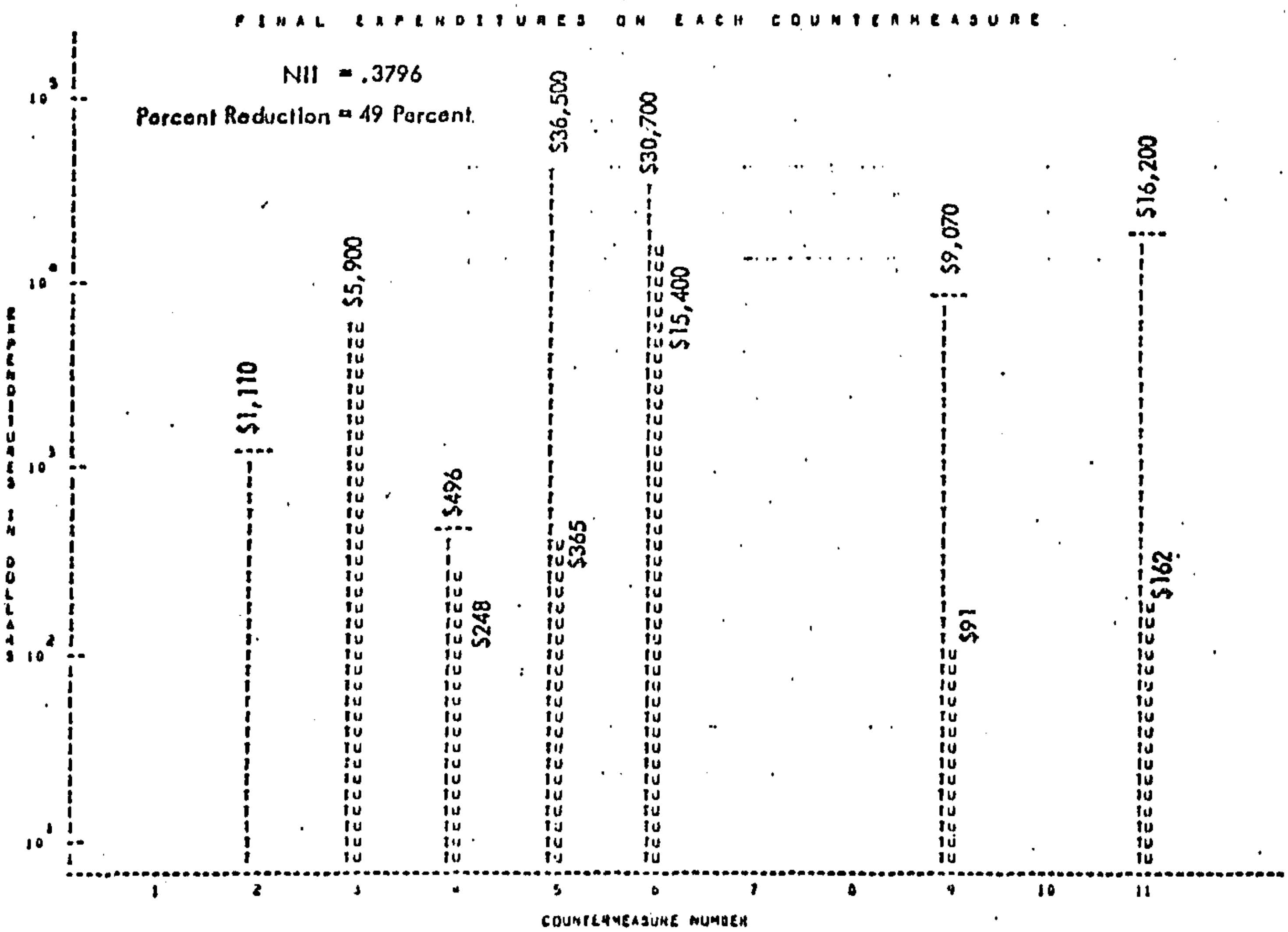

Figure A-10. Final Expenditures for Case Number 5, No Path-Receiver Countermeasure
Total Cost = $100,000; User Cost = $22,100

6 dB, and decrease the apparent railroad source levels by 5 dB. With these adjustments removed, the motorcycle countermeasure still remains very effective and the effectiveness of the railroad countermeasure is not altered sufficiently to make a noticeable difference. Countermeasures 1 and 5 received slightly fore funding at the expense of path-receiver measures. Figure A-11 summarizes the results.

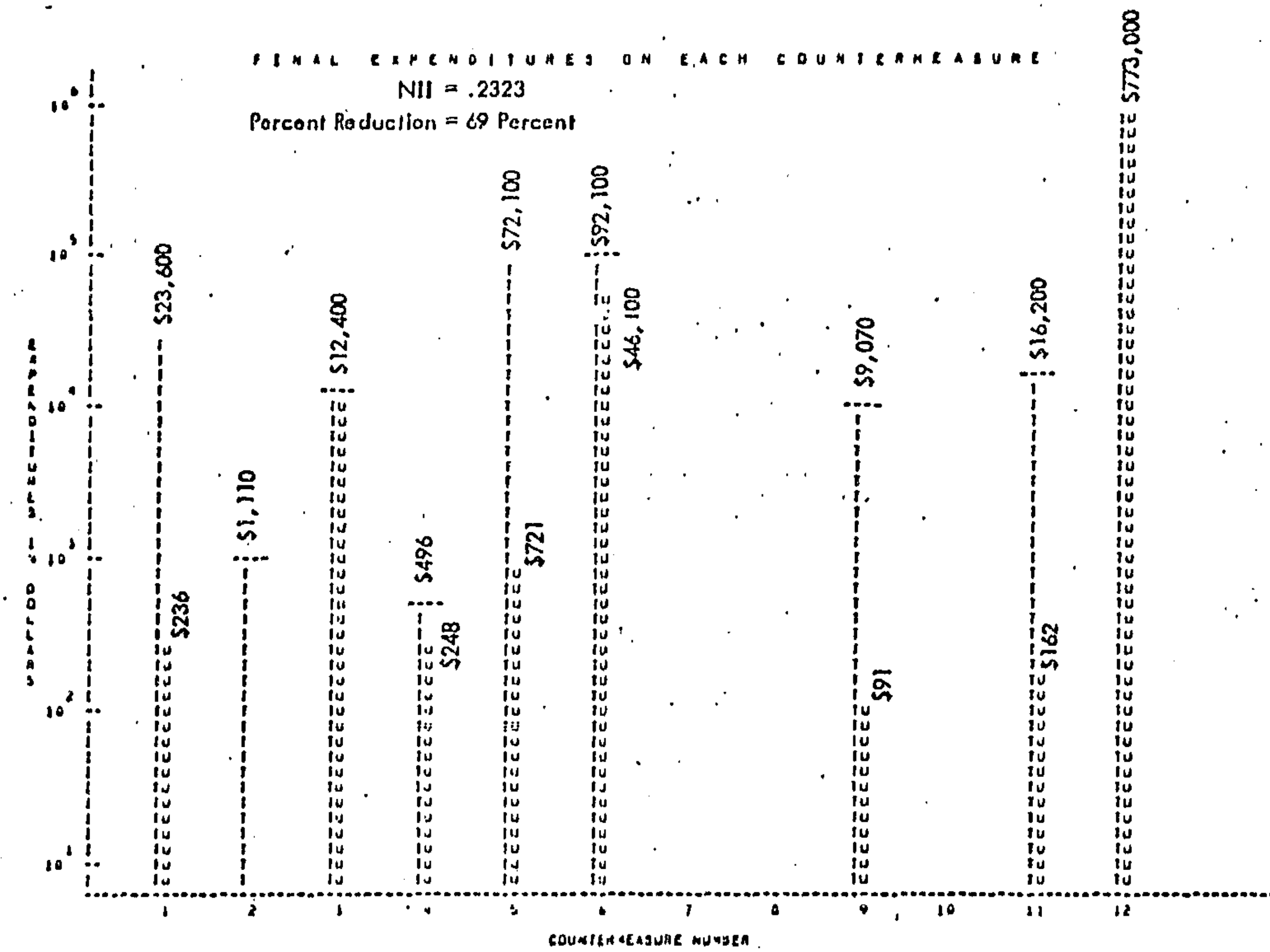

Figure A-11. Final Expenditures for Case Number 6, No Attitudinal Adjustments
Total Cost = $1,000,000; User Cost = $833,000

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A.4 Summary of the Allentown Strategy Analysis

The results of applying methods developed in the Community Noise Strategy Guidelines Manual to the city of Allentown, Pennsylvania, are summarized in this section of Appendix A. In conjunction with EPA and Allentown, problem noise sources were identified on the basis of acoustical, attitudinal, and complaint information, and a list of countermeasures was derived which were felt to be the most promising and practical means of abating these sources. The costs incurred by society and the noise reductions achieved with each of the selected countermeasures were estimated from data supplied by Allentown, using methods described in the Strategy Guidelines Manual.

The noise optimization program, Noizop, was then used to find optimal degrees of societal expenditure on each of the selected countermeasures for various overall spending limits. In particular, optimal expenditure strategies were found which would provide the maximum reduction in impacts from noise (1) in the year 1980 and (2) in the year 1988, for a nominal expected city noise control budget, as suggested by Allentown Quiet Communities Program Staff. These results are presented and discussed below. The main findings are:

- The most cost-effective countermeasures are (1) those which abate emergency vehicles, since the cost of abating this source is very low, and (2) those which abate automobiles, since this source is both the most pervasive in Allentown (as was indicated by the acoustical survey) and also one of the most annoying (according to the attitudinal survey). Although it is not known whether the main problem of automobile noise is caused by a few noise modified vehicles (which are the main target of automobile noise countermeasures in this analysis) or by the more numerous but quieter majority, it is suggested that additional countermeasures not considered in this analysis which can help reduce noise impacts from this source should be investigated in the future.

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- Very little difference is observed between expenditures optimized in 1980 vs. expenditures optimized in 1988, since most countermeasures are expected to take effect immediately (1978) and remain unchanged thereafter.
- A budget which is approximately 1/3 lower than the present budget anticipated by the city of Allentown may be more desirable, as measured in terms of the cost per reduction of noise impacts which can be achieved.

<u>Inputs</u>

The countermeasures analyzed in the optimization program are described below.

1. Property Standard applied to Noise from Garden Equipment and People. This property standard would set noise emission limits at the property line of between 75 and 80 dB for one hour due to noise from garden equipment or activity by people (i.e., playing loud music, etc.)

2. Noise Ordinance Applied to Motorcycles.
   A noise ordinance was considered which would consist of four parts:

   (1) Enforcing the federal new vehicle standard on motorcycles (83 dB in 1978, 80 dB in 1980)*

   (2) Enforcing the Pennsylvania Department of Transportation (Penn DOT) low speed operational regulations on motorcycles (84 dB)

   (3) Enforcing operational controls (reducing excess accelerations)

   (4) Enforcing an equipment standard (e.g., "all motorcycles shall have proper mufflers")

3. Noise Ordinance Applied to Autos.
   A noise ordinance applied to autos was considered which would consist of three parts:

*All regulation limits given are maximum low speed passby levels measured at 15 m.

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(1) Enforcing the Penn DOT low speed operational regulations on autos (84 dB)

(2) Enforcing operational controls (reducing excess accelerations)

(3) Enforcing an equipment standard (e.g., "all autos shall have proper mufflers")

4. Noise Ordinance Applied to Trucks.

A noise ordinance applied to trucks was considered which would consist of four parts:

(1) Enforcing the federal new vehicle standard on trucks (83 dB in 1978, 80 dB in 1980)

(2) Enforcing the Penn DOT low speed operational regulations on trucks (88 dB)

(3) Enforcing operational controls (reducing excess accelerations)

(4) Enforcing an equipment standard (e.g., "all trucks shall have proper mufflers")

5. Noise Ordinance Applied to Buses.

A noise ordinance applied to buses was considered which would consist of four parts:

(1) Enforcing the proposed federal new vehicle standard on buses (83 dB in 1979, 80 dB in 1983, and 77 dB in 1985)

(2) Enforcing the Penn DOT low speed operational regulations on buses (88 dB)

(3) Enforcing operational controls (reducing excess idling near residences)

(4) Enforcing an equipment standard (e.g., "all buses shall have proper mufflers")

6. Operational Controls Applied to Emergency Vehicles.
This countermeasure would reduce the amount of time sirens are used by restricting their use to emergency situations.

7. New Vehicle Standard Applied to Garbage Trucks.
This noise standard would enforce federal noise regulations on newly manufactured garbage trucks (78 dB in 1979, 75 dB in 1982)

8. Mode Transfer from Autos to Buses.
This countermeasure would use education and advertisement media to get more commuters to use buses instead of autos.

9-13. Education and Complaint Mechanism Applied to (9) Autos and Motorcycles, (10) Trucks and Buses, (11) Garbage Trucks and Emergency Vehicles, (12) Garden Equipment and People, and (13) Pets

These countermeasures have to do with informing the public about the causes and effects of community noise and establishing a mechanism such as a noise "hot line" which the public can use to complain about noisy sources such as motorcycles, private parties, or industrial plants.

14. Stationary Source Controls Applied to Fairgrounds.
This countermeasure would reduce noise emissions from equipment and loud music typically found at fairs.

15. Stationary Source Controls Applied to Music Clubs.
This countermeasure would reduce the undesirable source of music clubs propagating into nearby residential areas by requiring owners to provide sound insulation treatment of the exterior walls of their clubs.

16. Building Insulation and Codes.
Twenty areas ("cells") throughout the city were selected as potential candidates for building insulation treatment. The noise optimization program was then allowed to pick the cells which needed insulation.

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In addition to inputs which defined the above potential countermeasures, an annual noise control budget of $123,000 for the city government of Allentown was selected. This number is based on the man-year estimates provided by the city shown in Table A-8.

Table A-8
Manpower Distribution Estimated by Allentown for Various Noise Control Activities, Man-years

	Government Entity Performing Activity			
Noise Control Activity	QCP	Police	Information Services	Community Planners
Stationary Source Control	1/2	-	-	-
Motor Vehicle Noise Enforcement	1	2	-	-
Education and Complaint Activities	1	-	1/2	1/2
Bus Ridership Campaign	1/2	-	-	-
Building Insulation Program	1	-	-	-

Total = 7 man-years

The total costs defined for each countermeasure include all costs incurred by society. To find the costs incurred by Allentown's city government alone, a "City Fraction" was estimated for each countermeasure. These city fractions are shown in Table A-9. Note that some of the countermeasures are expected to be paid for almost entirely by Allentown (such as the Bus Noise Ordinance), while others only involve relatively minor government expense (such as a building insulation program).

Outputs

The optimum total (T) and city government (U) expenditures selected by Noizcp for each countermeasure at the city budget level defined above are shown

Table A-9

Effectiveness of Countermeasures in the Allentown Strategy Analysis

No.	Countermeasure	Noise Source Affected	City(2) Fraction	Cost/Effectiveness (Percent of Maximum Allowable Expenditure) 1980	1988	Comments
1	Property Standard	Garden Equipment, People	0.995	0%	0%	Not very cost/effective
2	Noise Ordinance (1)	Motorcycles	0.25	51	51	Less should be spent on this countermeasure as budget increases
3	Noise Ordinance (1)	Autos	0.84	100	100	Very cost/effective
4	Noise Ordinance (1)	Trucks	0.11	100	49	Cost/Effective – in 1980, additional money should be spent here next
5	Noise Ordinance (1)	Buses	1.00	0	100	Only cost/effective in the long term
6	Operational Control	Emergency Vehicles	1.00	100	100	Very cost/effective
7	New Vehicle Standard	Garbage Trucks	0.09	0	100	Only cost/effective in the long term
8	Mode Transfer	Autos, Buses	1.00	100	100	Very cost/effective
9	Education and Complaint Mechanism	Autos, Motorcycles	1.00	100	100	Very cost/effective
10	Education and Complaint Mechanism	Trucks, Buses	1.00	0	0	Not cost/effective
11	Education and Complaint Mechanism	Garbage Trucks, Emergency Vehicles	1.00	100	100	Very cost/effective
12	Education and Complaint Mechanism	Garden Equipment, People	1.00	85	66	Quite cost/effective
13	Education and Complaint Mechanism	Pets	0.48	100	100	Very cost/effective
14	Stationary Source Controls	Fairgrounds	0.54	0	0	Not cost/effective
15	Stationary Source Controls	Music Clubs	0.37	0	0	Not cost/effective
16	Building Insulation and Codes	All Sources	0.04	5	5	Only cost/effective at high levels of expenditures

(1) Includes: New Vehicle Standard (except for Autos), Operational Standard, Operational Controls, and Equipment Standard

(2) Fraction of countermeasure costs incurred by the City of Allentown.

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in Figures A-12 and A-13 for the years 1980 and 1988, respectively. Note that the costs shown in these figures are "total discounted dollars," with as assumed discount rate of 10 percent. These costs indicate the total amount of money which is needed for each countermeasure, from now until infinity. To find the equivalent annual cost, divide these costs by 11. For example, when the optimization is made in 1980 (Figure A-12), the optimal annual expenditure on Countermeasure No. 2 is 50,000 ÷ 11 = $4550. A discussion of present value analysis and discounted costs is provided in Section 3.4 of the Strategy Guidelines Manual.

As a supplementary submittal, two additional Noizop runs are provided. Figure A-14 shows the optimum expenditure strategy in 1980 if no building insulation program is allowed. The same input data and budget are used here as were used in Figure A-12. Finally, Figure A-15 shows the expenditure pattern at a somewhat reduced budget (an annual city budget of $82,000 instead of $123,000). This budget seems to be a more desirable one for the countermeasures under consideration, since much less reduction in noise impacts can be achieved per dollar above this point. These results are discussed in more detail below.

Discussion of Results

The cost/effectiveness of each countermeasure is evaluated in Table A-8 above in terms of the percent of maximum allowable expenditure which Noizop chose to spend. A maximum allowable expenditure was defined for each countermeasure and supplied as input information, based on practical, technical, and economic grounds. The implications of these cost/effective percentages is discussed below for each countermeasure.

1. Property Standard applied to Garden Equipment and People

- Noizep did not choose this countermeasure in either 1980 or 1988. This is probably due to the fact that noise levels from garden equipment and people were fairly low compared to other noise sources, due to their intermittent and transitory nature. When the building insulation countermeasure is eliminated from consideration, some money is spent on this measure (Figure A-14), but only a relatively small amount ($2640 per year).
- Implication – A property line standard against garden equipment and people noise is not cost effective.

2. Noise Ordinance applied to Motorcycle

- This countermeasure is relatively cost/effective at low expenditure levels, but decreases in comparison with other measures as expenditures increase.
- Implications – A motorcycle noise ordinance is warranted and will be effective even if relatively mild restrictions are enforced. This is because a small percent of the motorcycles produce noise levels which are much higher than the average motorcycle levels. As a result, even a simple equipment standard requiring "proper mufflers" should have immediate benefit, as long as it is adequately enforced.

3. Noise Ordinance applied to Autos

- The maximum allowable expenditure was reached, indicating that automobile noise reduction should be a primary target for the city of Allentown. The maximum expenditure corresponds to an operational regulation level of 74 dB, which is 10 dB lower (more strict) than the present Pennsylvania DOT noise regulation.

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3. Noise Ordinance applied to Autos (Continued)

- Implications – Allentown may wish to establish standards for automobiles more strict than existing state standards. These standards should probably be directed first at autos which have modified, improper, or inadequate exhaust systems. A fairly strict equipment standard which specifies allowable exhaust modifications and minimum insertion loss values for replacement parts may be very effective in this regard. To abate the impacts of the general automobile population, alternate strategies must be used, some of which lie outside the municipal government's domain. These countermeasures might include traffic controls on minor residential streets, rerouting certain major boulevards to less populous areas, and barriers located in strategic positions.

4. Noise Ordinance applied to Trucks

- Maximum expenditure limits were reached in the 1980 run, but other countermeasures were found to be somewhat more cost effective in 1988.
- Implications– A truck noise ordinance, parallelling Federal and State standards, is worthwhile at the present time, but may be deemphasized in the future.

5. Noise Ordinance applied to Buses

- While no expenditures were made for the 1980 case, the maximum expenditure limit was reached in 1988 since more quiet new buses are expected to be operating in the fleet by that time.
- Implications – Allentown should consider enforcing Federal bus noise regulations as they become more strict in the future. (Note: Federal bus noise regulations are still in the proposal stage).

6. Operational Controls applied to Emergency Vehicles

- This countermeasure received maximum allotment in both analysis years, corresponding to a reduction of 20 percent of the time sirens normally are operating.
- Implications – An emergency vehicle operational control should be implemented which would reduce unnecessary siren use as much as possible.

7. New Vehicle Standard applied to Garbage Trucks

- Similar to Countermeasure No. 5 above.
- Implications – Same as No. 5 above.

8. Mode Transfer from Autos to Buses

- It was found that the cost to society is less if commuters use buses rather than autos, therefore this countermeasure has a "negative cost".
- Implications– Commuters should be urged to ride buses through educational campaigns and increased bus service. A doubling of the bus fleet still saves society money, according to this limited analysis.

9,11,13. Education and Complaint Mechanism applied to (9) Autos and Motorcycles, (11) Garbage Trucks and Emergency Vehicles, and (13) Pets.

- The results for each of these countermeasures was the same, namely, the maximum allowable expenditure was reached.
- Implications – Education and complaint programs should be geared to the above 5 sources of noise. Increased manpower assignments may be warranted in this area, compared with the nominal values suggested by Table A-9 above. As with Countermeasures Nos. 2 and 3 above, for automobiles and motorcycles, the most effective results can be achieved

if attention is paid primarily to those vehicles which have modified or inadequate exhaust systems.

10. Education and Complaint Mechanism applied to Trucks and Buses

- No expenditures were made on this countermeasure. This is probably due to the fact that in Allentown, the major truck routes are well defined, therefore trucks and buses do not affect people as much near their homes, where people are more likely to complain, as they do when people are in transit. Similarly, educational programs directed at bus and truck operators are expected to change their operational habits to a lesser degree, and therefore will reduce noise levels to a lesser degree, than programs directed to more alterable causes of noise such as accelerating or modified autos and motorcycles, unnecessary sirens, or barking dogs.

- Implications – Little effort should be expended on this countermeasure other than to support, in a general way, existing State and Federal truck and bus noise regulations.

12. Education and Complaint Mechanism applied to Garden Equipment and People

- Changes resulting from this countermeasure typically cost less money than changes caused by Countermeasure No. 1, which deals with the same noise sources but may require equipment substitution to meet the regulation. In contrast, education and complaints act to achieve nearly the same ends without large expenditures.

- Implications – To reduce noise from garden equipment and people in the most cost effective way (1) people should be educated as to the effect of their (and their equipment's) noise on others, and (2) a means of complaining about annoying neighborhood noises should be established.

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To assist officials in enforcing the reduction of these "annoying noises", as a practical matter, a property standard such as Countermeasure No. 1 may be needed, but the latter should not be implemented in isolation.

14,15. Stationary Source Controls applied to Fairgrounds and Music Clubs

- No expenditures were made on these countermeasures due to their transitory and isolated nature. That is, in comparison with more continuous noise sources such as autos, their average sound levels (L_{eq}) were low. (Note, however, that noise levels for these two sources of noise were estimated without the aid of noise measurements from the acoustical survey.)
- Implications – No substantial noise control activity seems warranted for these two noise sources.

16. Building Insulation and Building Codes

- Only a small portion (5 percent) of the total possible expenditure on this countermeasure was made, since only 5 of 20 possible cells received insulation and the cells which were picked have small floor areas. However, the effort required to insulate these cells amounts to almost 60 percent of the total cost to society at the budget level considered. At lower overall budget levels, such as the more desirable budget used to generate Figure A-15, no expenditure on building insulation is made by the computer program.
- Implications – A building insulation program should be initiated only if (1) the public is willing to help pay for improvements to their own homes (note that as shown in Table A-9, the city government is expected to incur only about 4 percent of the total cost of this countermeasure) and (2) a high degree of expenditure on noise control is desired and possible. If a building insulation program is desired, the noise optimizations for 1980

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and 1988 indicate that the following areas deserve initial attention:

1. Residences near Hanover Street (cells B1 and B3)
2. Residences along garbage truck routes - Bayard Street and Roth Avenue (cells R5 and R7)

<u>Reduction of Noise Impacts Due to Expenditures</u>

Figure A-16 shows the relationship between cost expenditure and percent reduction of the noise impact index* for the 1980 Allentown analysis. This relationship clearly indicates that after a certain point, the cost of additional benefits is much higher than before. This point corresponds to a total discounted cost to society of about 1.1 million dollars, equivalent to an expenditure of about $100,000 annually. The associated discounted cost to the city of Allentown (from now to infinity) would be about 0.9 million dollars, or about $82,000 annually. This represents about a 1/3 reduction of the present anticipated Allentown annual budget, indicating that in the future, a somewhat reduced budget for noise control could be acceptable from the cost effectiveness standpoint.

*The Noise Impact Index (NII) is a measure of the impact of noise on a community. A threshold of impact (NII = 0) is defined for each land use type for both day and night noise levels, and a complete impact (NII = 1.0) is defined to be 20 dB above these threshold values.

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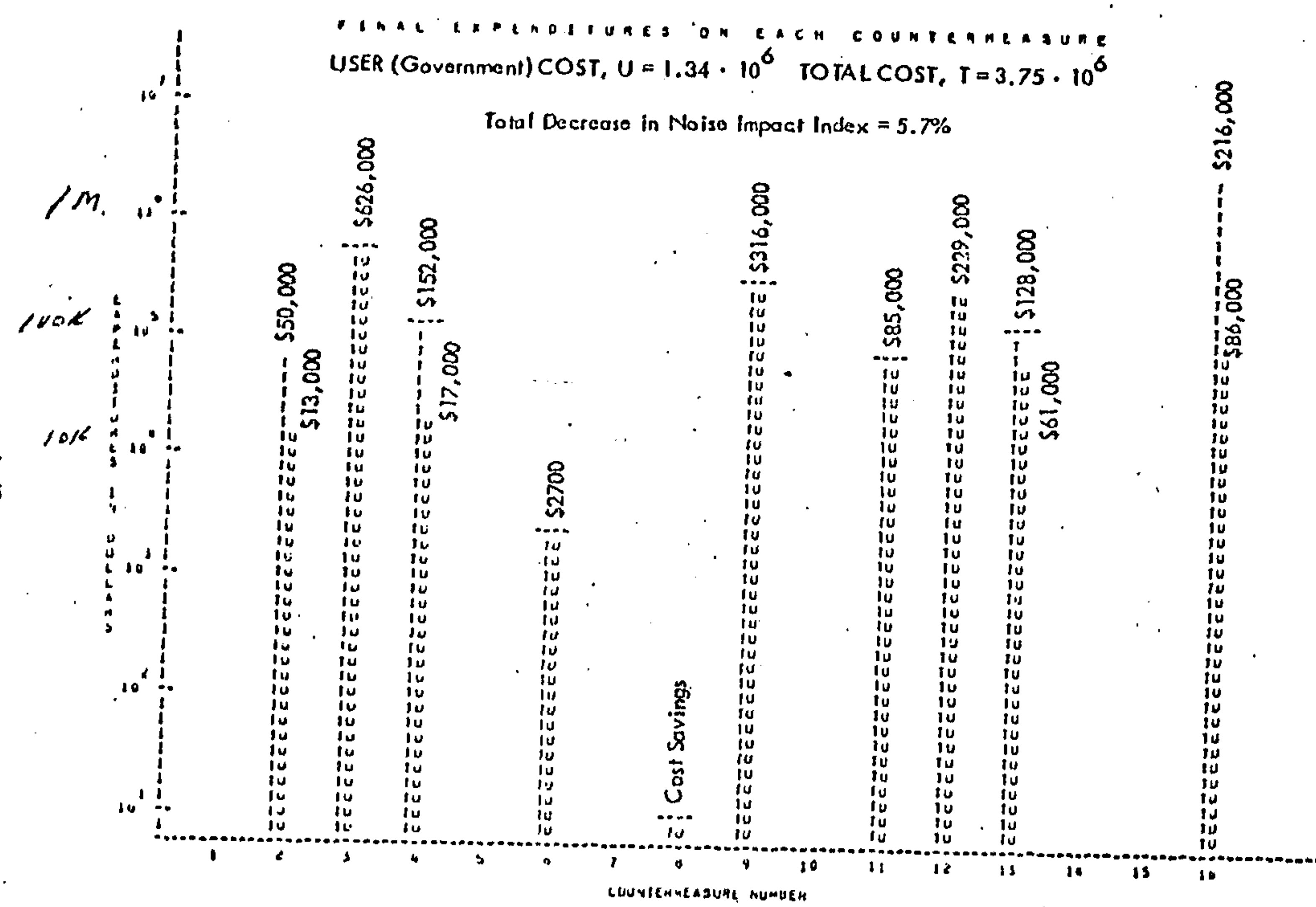

Figure A-12. Expenditures Optimized in 1980

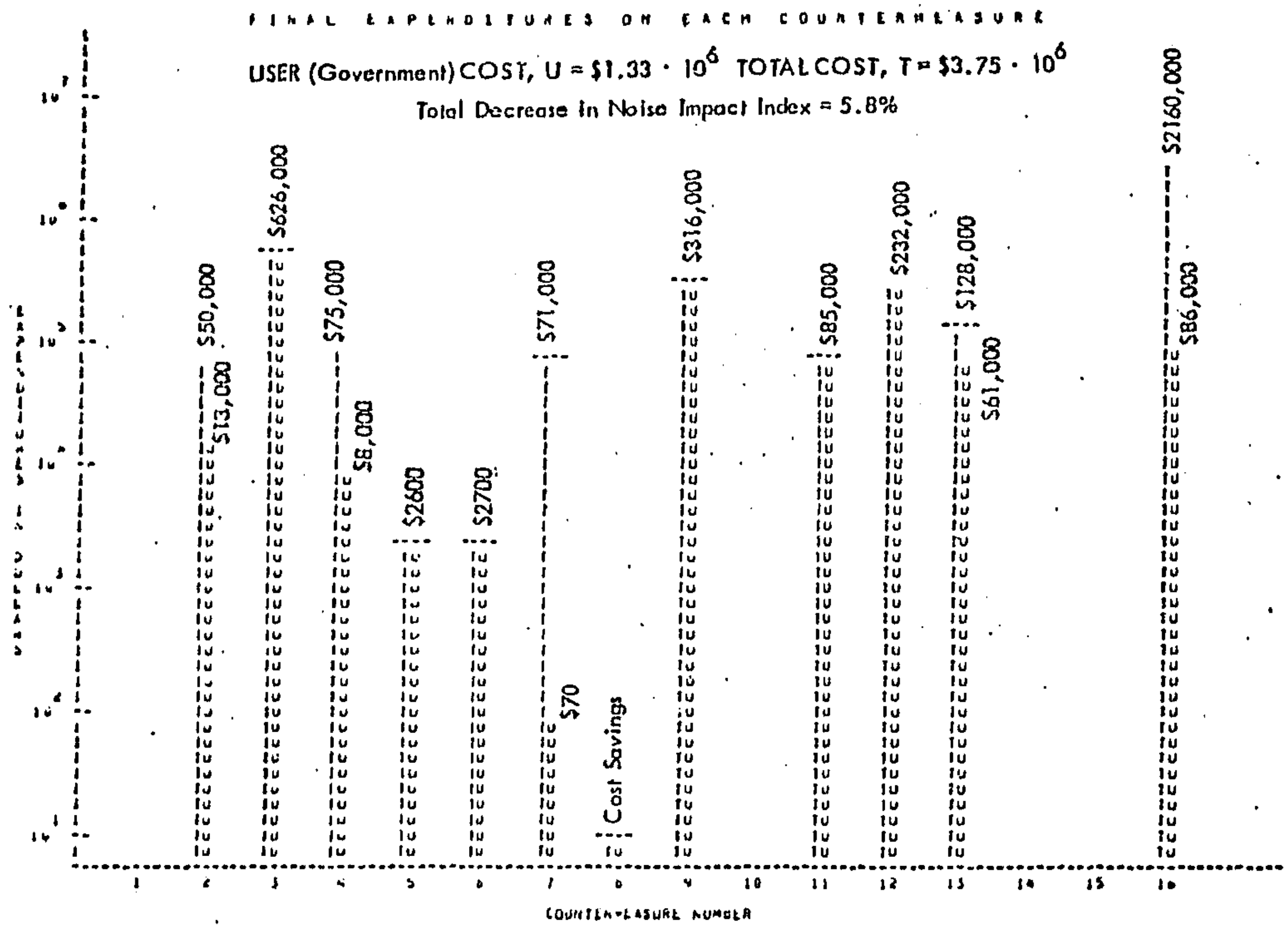

Figure A-13. Expenditures Optimized in 1988

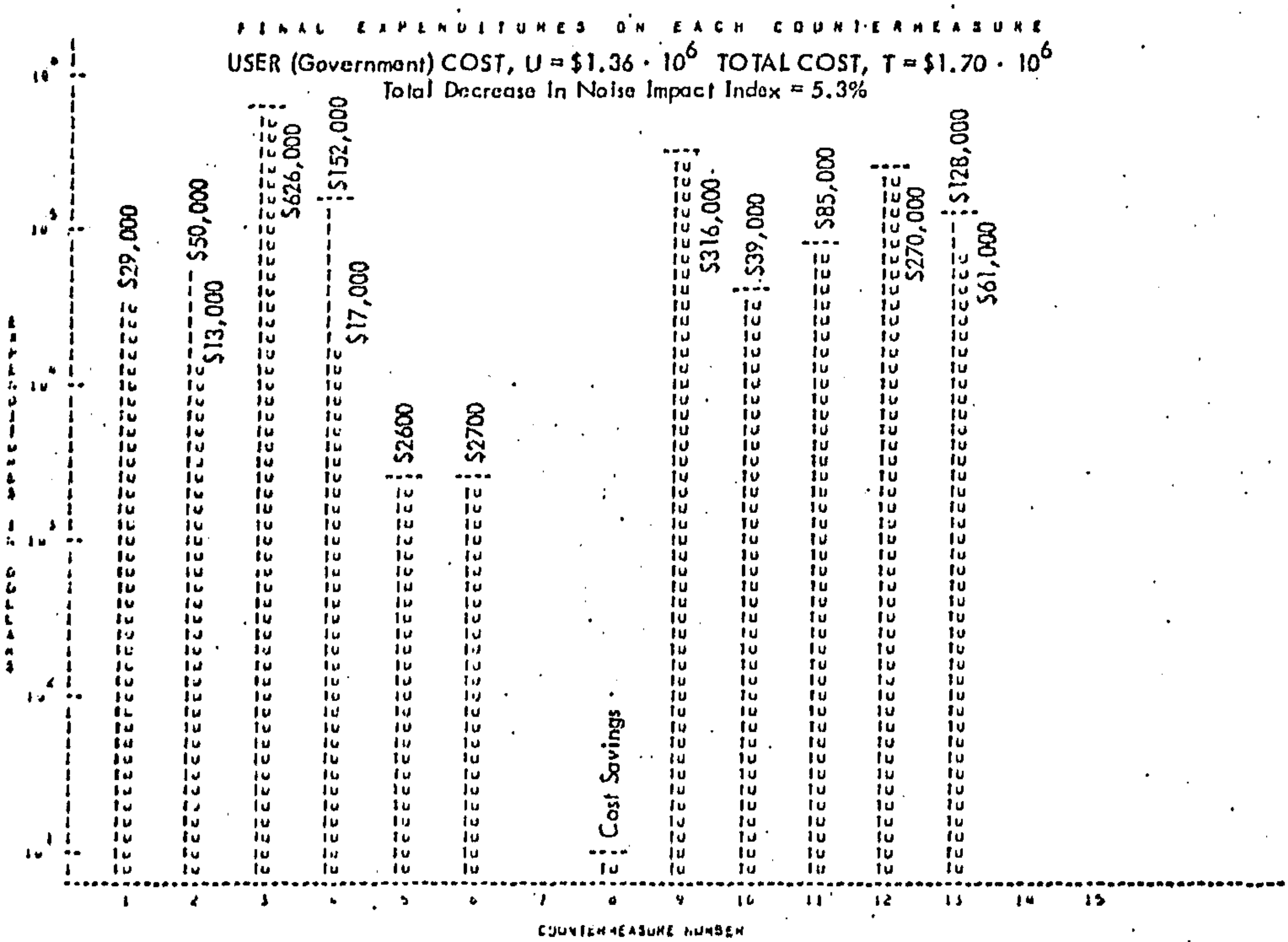

Figure A-14. No Building Insulation, Optimized in 1980

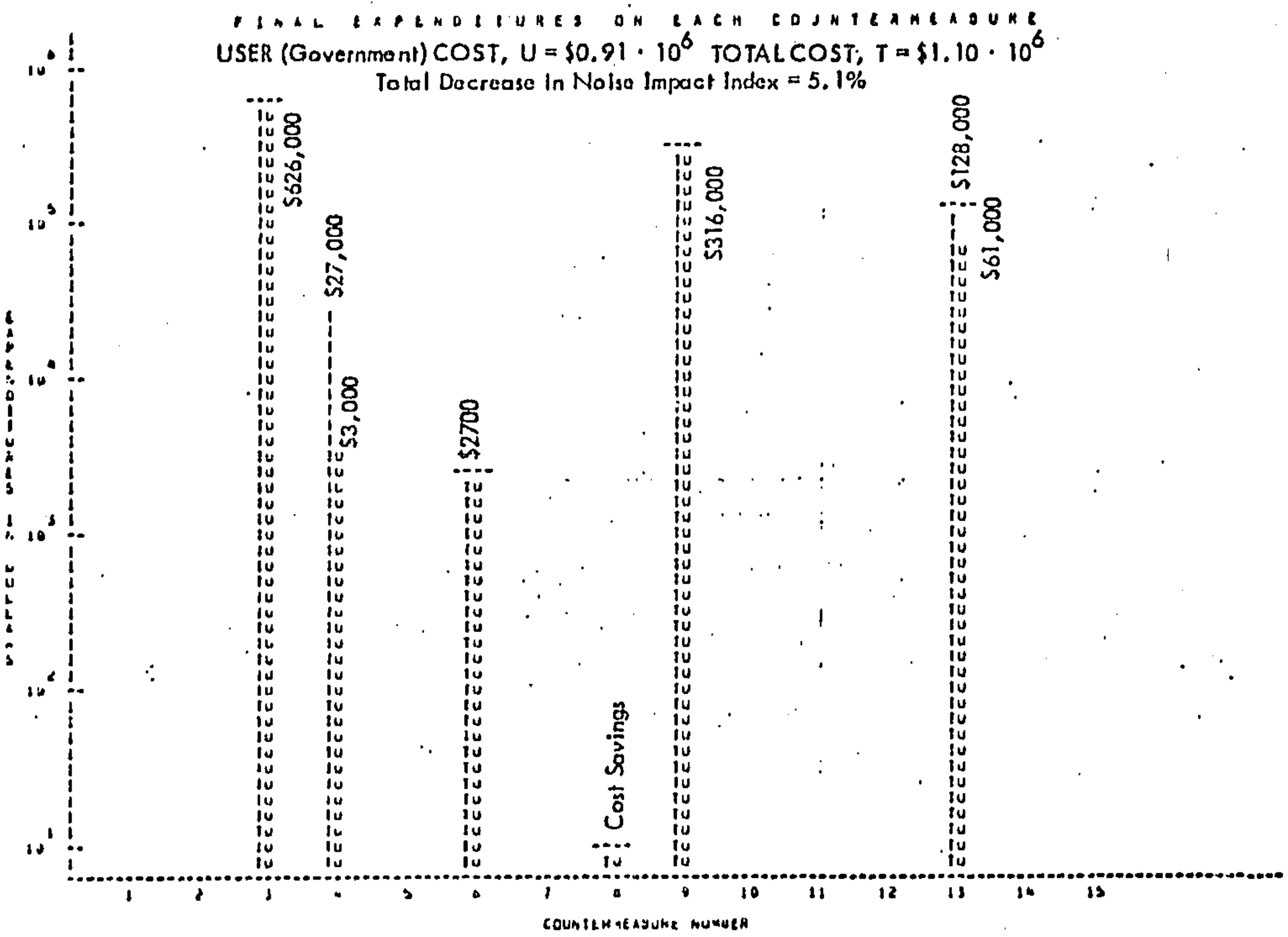

Figure A-15. Lower Budget, Optimized in 1980

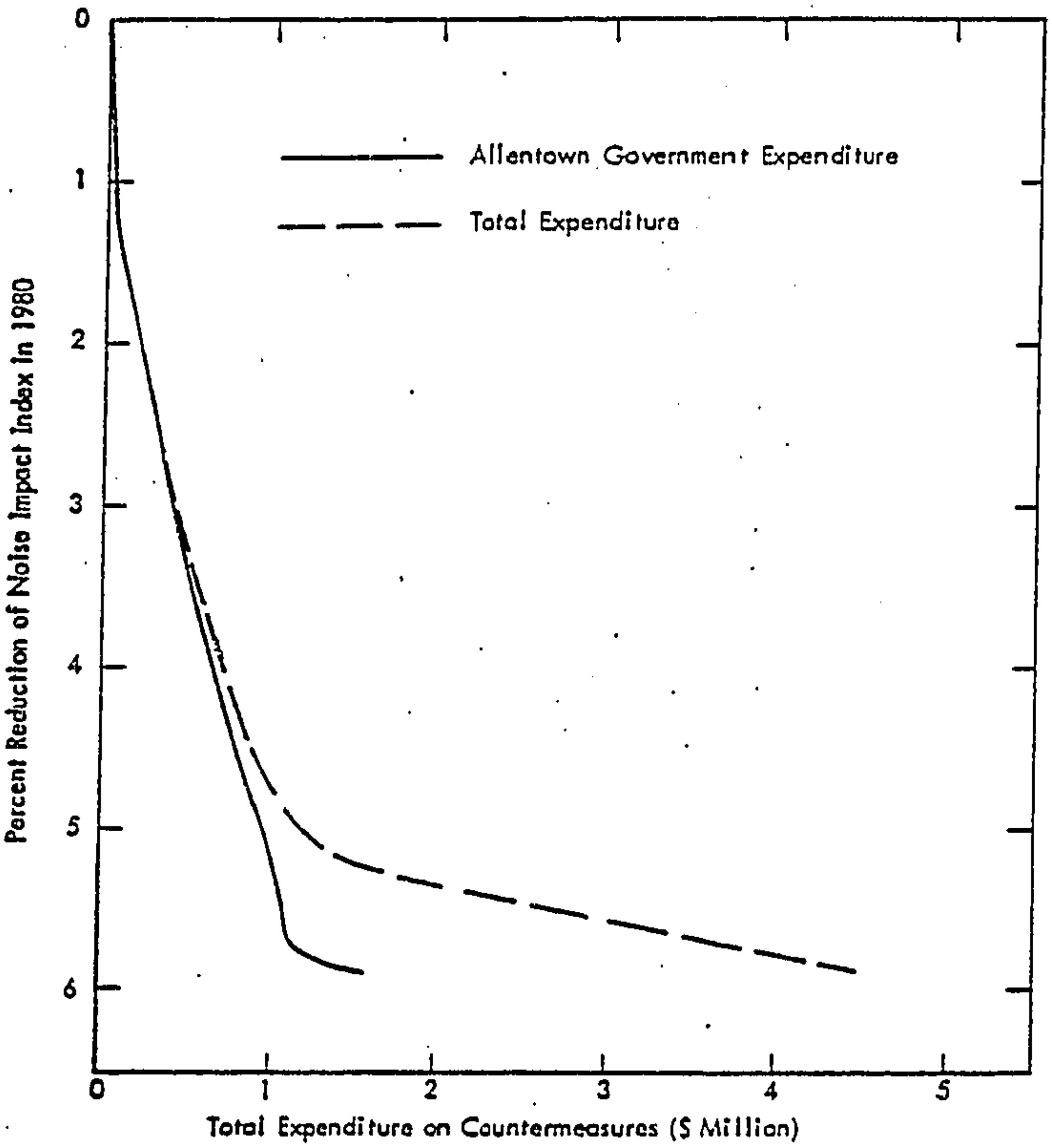

Figure A-16. Relationship Between Total Expenditures on Countermeasures and Reduction of Noise Impact Index in 1980

LIST OF TABLES

LIST OF FIGURES

APPENDIX B

Program Operation and Data Flow Process

B-1 General Overview of Program Flow

It is assumed that the reader is familiar with the terms and concepts presented in Volume I – the NOIZOP User's Guide.

The initial functions of the program are to accept input data and to establish the necessary parameters for proper data processing. Figure B-1 illustrates the subprogram linkage associated with each of the program codewords. The reader may refer to Volume II – Program Listings – for a description of each subroutine. Figure B-2 shows the subroutine linkages of the actual optimization process. The remainder of this section will describe the general data flow during that optimization process. The succeeding sections in this appendix will describe in more detail the individual processes that occur. The variables in the equations presented in this appendix do not necessarily relate to actual variable names used in the program.

The optimization process is controlled by a supervisory subroutine (OPTIM) which examines the components of the NII (Noise Impact Index) gradient vector* in determining the path of optimum expenditure allocation among the countermeasures. Starting with the user-defined initial expenditure scenario, the program will compute the current NII and the current gradient vector. The largest component of the gradient vector indicates the countermeasure which is currently the most cost-effective. The program will allocate additional funds to that countermeasure and calculate the resultant NII and the new gradient vector. This process is repeated, increasing the expenditures among the countermeasures one at a time, until the total budget has been expended.

Generally, subroutine OPTIM controls the evaluation of independent expenditure scenarios. The remainder of the program simply calculates the Noise Impact Index and the gradient values according to the expenditures on each of the countermeasures. After OPTIM has decided on a new set of expenditures, the remainder of the program is entered again to evaluate the new scenario, unaware of any information regarding the previous set of expenditures. Figure B-3 illustrates the main features of the optimization decision process.

*Mathematically, the gradient vector may be thought of as the vector whose components consist of the partial derivatives of NII with respect to the countermeasure expenditures, of which there may be up to 20.

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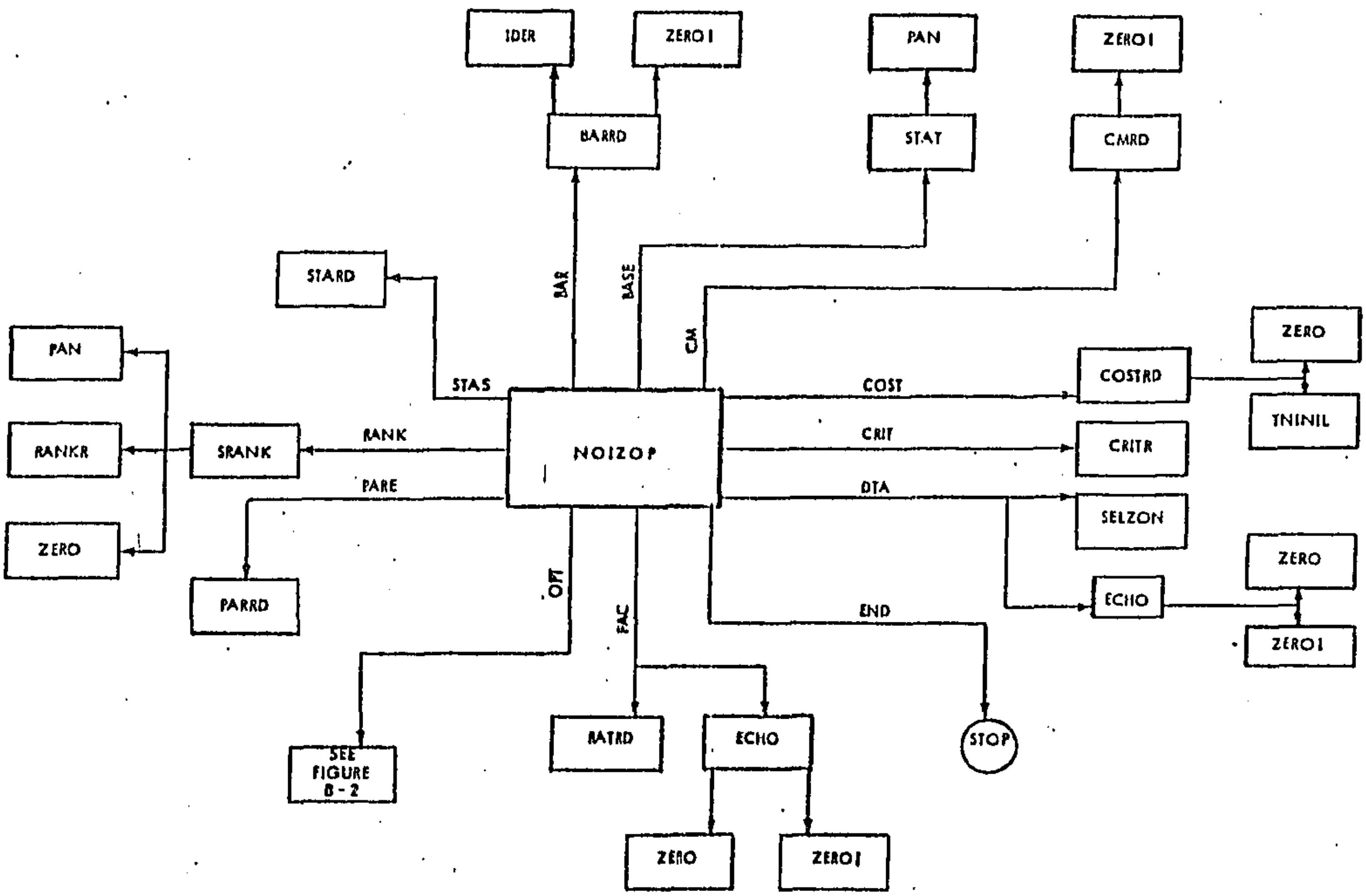

Figure B-1. Subroutine Linkage Diagram Indicating Program Flow By Codeword

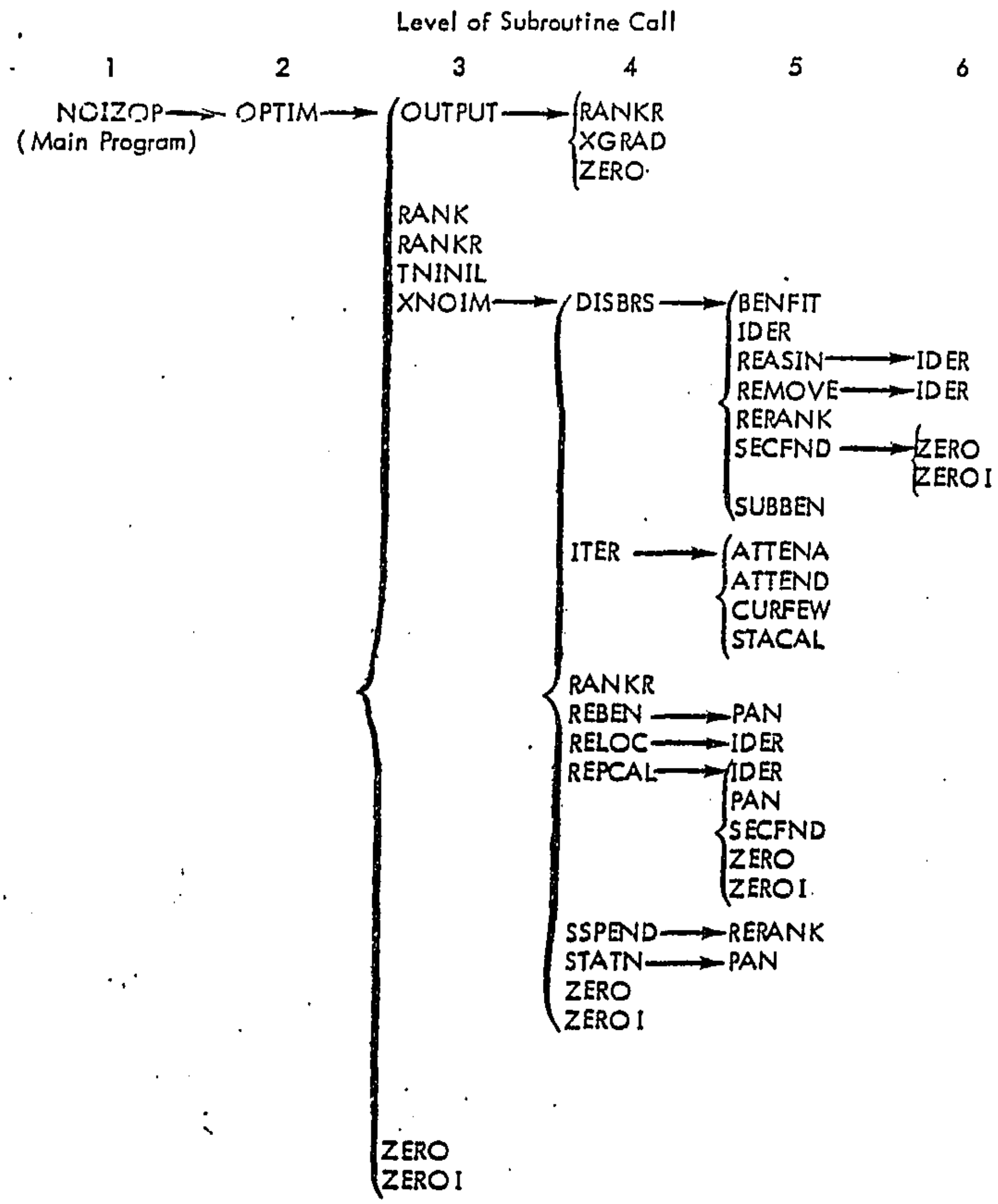

Figure B-2. Subroutine Linkages (Alphabetical Order) For the Main Optimization Process, Codeword OPT.

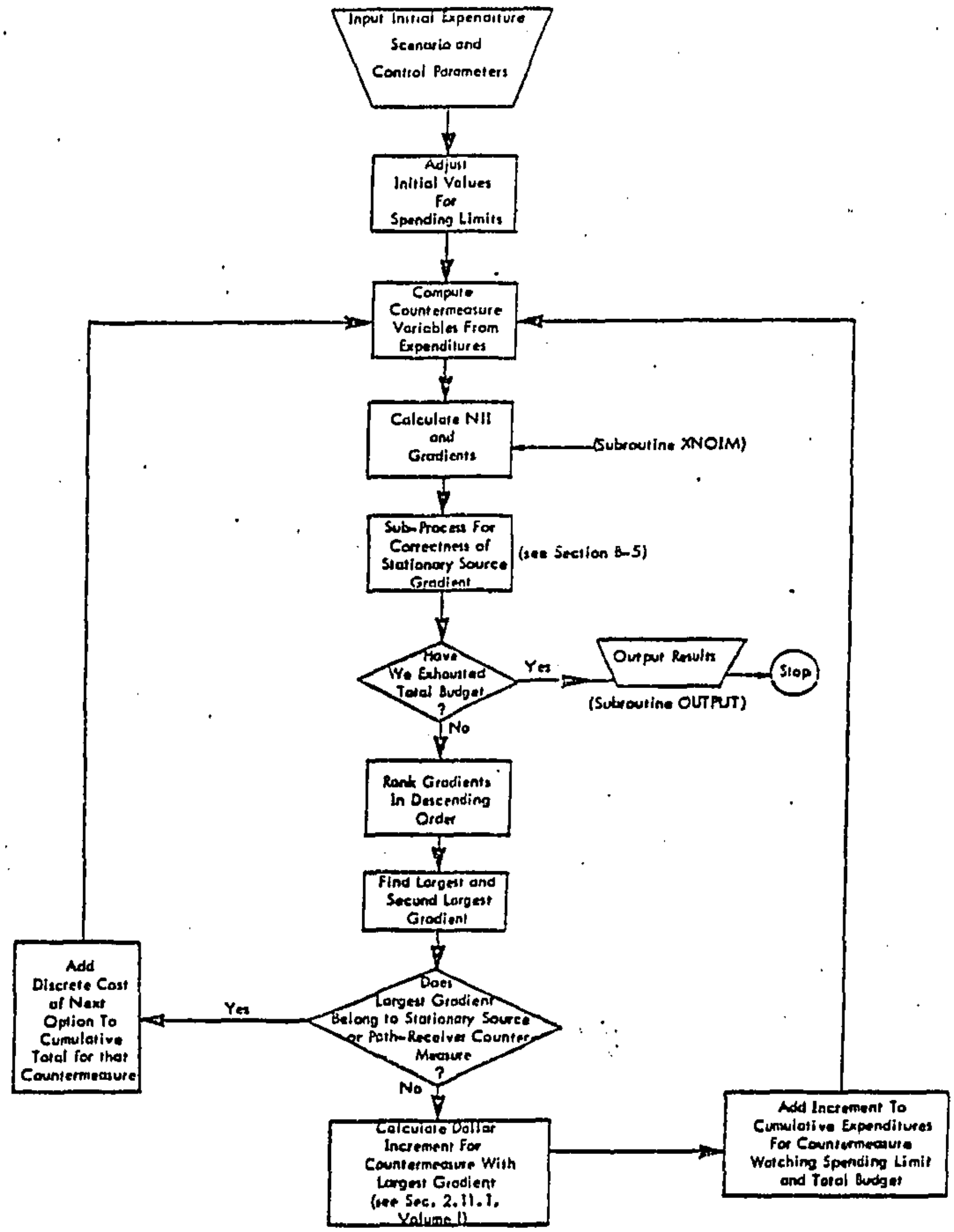

Figure B-3. Operational Flow of Optimization Decision Process, Subroutine OPTIM.

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The index and gradient calculation process is controlled by a secondary level subroutine – XNOIM. This routine controls the logic of all subsequent functions including the suboptimization of stationary source and path-receiver countermeasures (see Sections B-2, B-3).

XNOIM initiates three independent passes of countermeasure application through all the cells. The first pass through the cells is used in the suboptimization of the stationary source countermeasure. Countermeasure Types 1-15 are applied on a cell-by-cell basis and the remaining noise exposure is used in the evaluation of the potential benefits of each of the stationary source countermeasure options utilizing an approximation of path-receiver benefits (see Section B-3).

The second pass through the cells is used in the suboptimization of the path-receiver countermeasure. The other countermeasures are again applied and, together with the results from the first pass (stationary source suboptimization), the potential benefits of each path-receiver option are calculated.

The third pass again applies countermeasure Types 1-15 along with the optimized results for stationary source and path-receiver countermeasures obtained in the first two passes. This pass through the cells calculates the components of the gradient vector and the Noise Impact Index. Figure B-4 shows the logical operation of subroutine XNOIM.

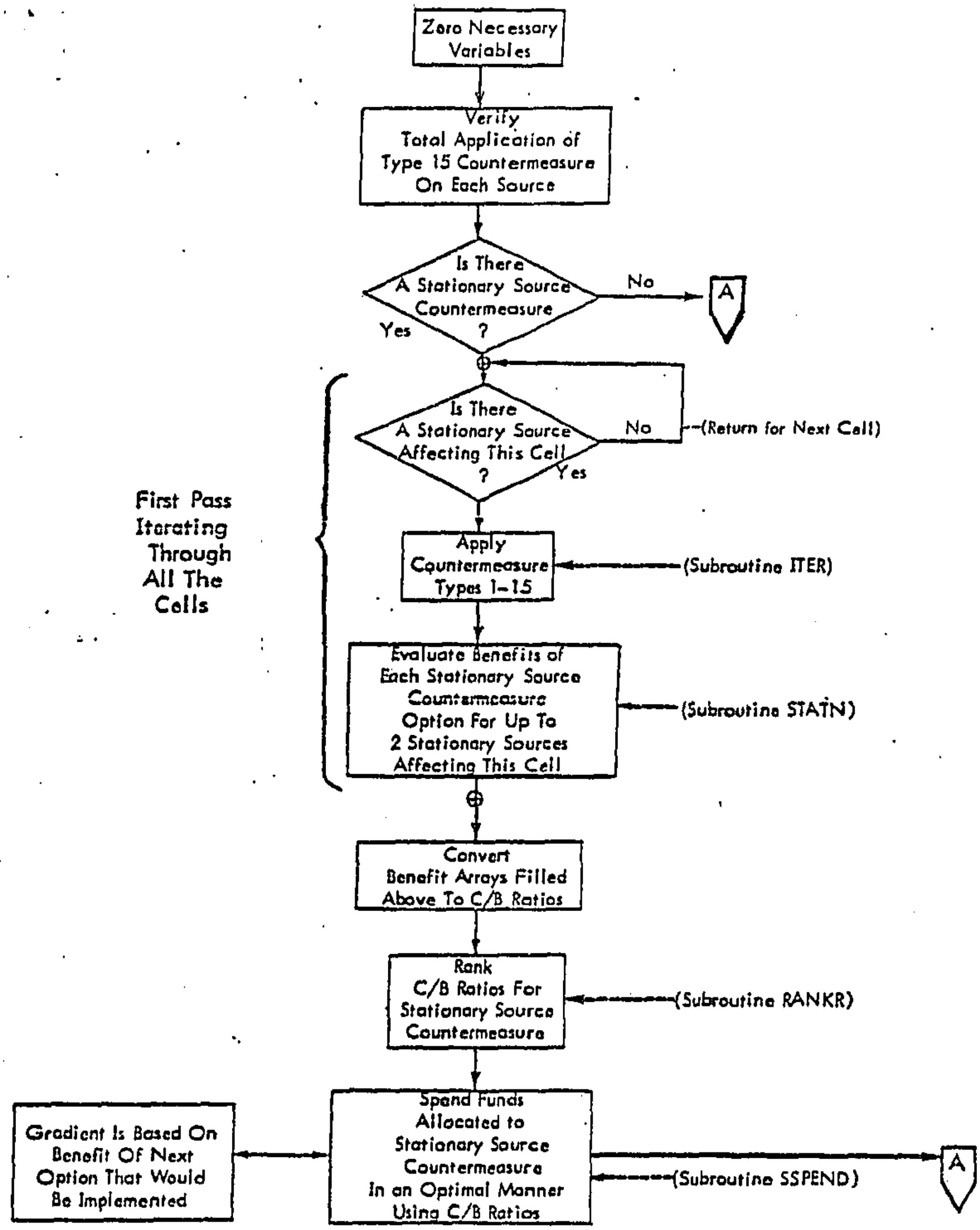

Figure B-4. Logical Operation of Subroutine XNOIM, Evaluation of Expenditure Scenarios. (C/B = Cost/Benefit)

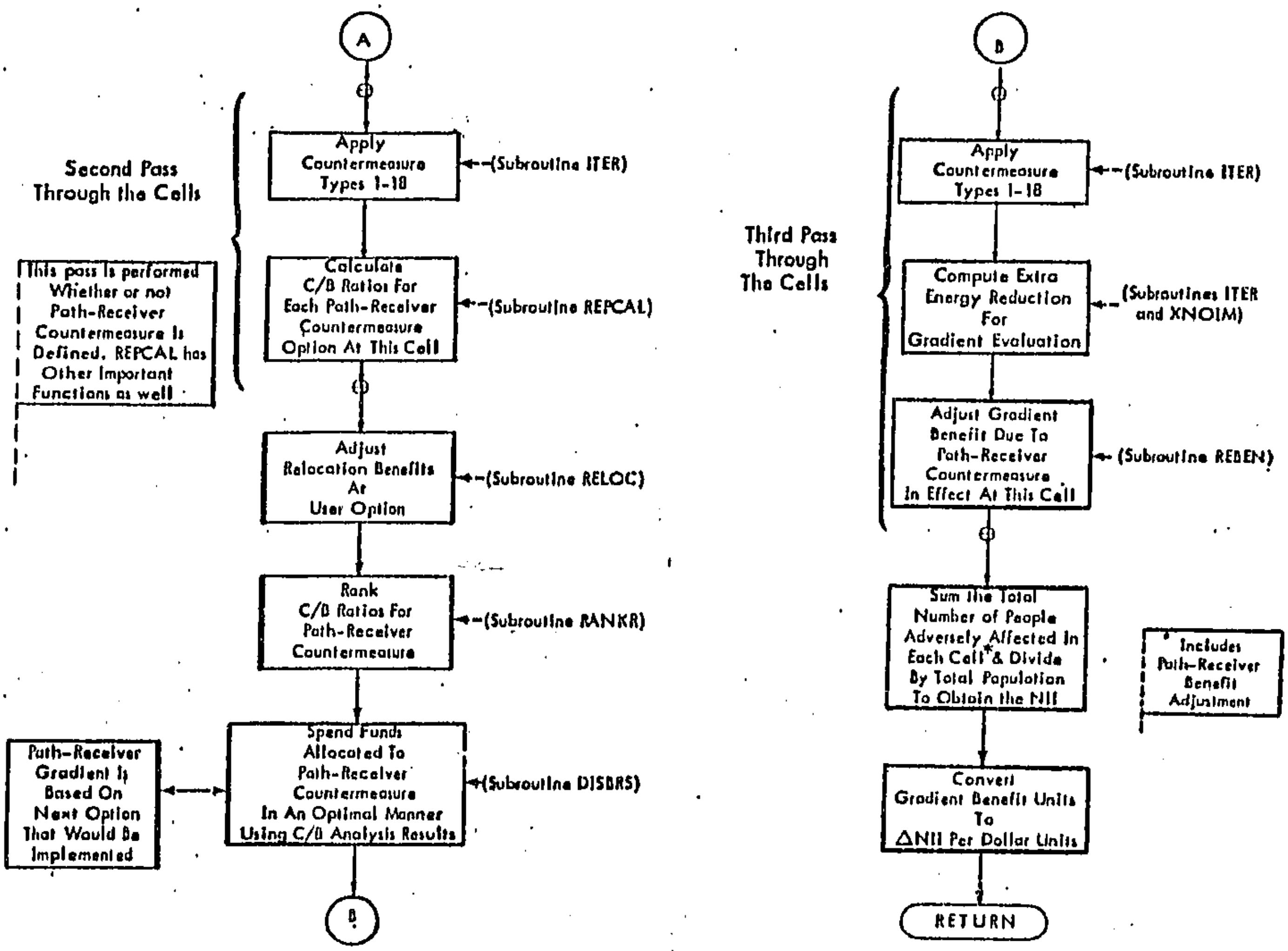

Figure B-4 (Continued)

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B-2 Suboptimization of Stationary Source Countermeasures

The stationary source countermeasure lists six alternative options (see Table 2-3, Volume I) which may be implemented at each stationary source. The program will decide which option, if any, to apply to each stationary source. The actual procedure involved in this decision is described in this section.

The basis of the suboptimization process is a cost/benefit analysis which consists of computing the potential benefit of each alternative option at each source together with the associated costs. The end product of this analysis is an ordered list of cost/benefit ratios, the most cost-effective options being at the top of the list. The program will proceed to implement the countermeasure alternatives, starting at the top of the list, until the funds allocated to the stationary source countermeasure are exhausted. Note that the allocated funds may be zero, in which case no alternatives are implemented and the generated list is used only for gradient evaluation.(Section B-5). Note also that after this suboptimization some stationary sources may have countermeasures applied to them and some may not.

One segment of the cost/benefit analysis calculates the potential benefit of each countermeasure alternative at each stationary source. The benefit parameter is the number of people no longer adversely affected by noise with the implementation of that option. Note that this parameter is summed over all cells that are affected by the stationary source in question. Before the benefit parameters can be accurately evaluated, the effects of the other countermeasure types (Types 1 through 15) must be known. These other countermeasures have been applied by the time the program considers the stationary source countermeasure. The path-receiver alternative which was selected for each cell for the expenditure scenario calculated during the previous step in the optimization analysis is also assumed to apply again. This is equivalent to performing the first two steps of the iterative process which is required to simultaneously optimize the two interrelated subjects. This procedure is necessary because the transfer function may not be linear in all defined regions and the potential benefit must be limited by the actual number of people that are still adversely affected after the implementation of the other countermeasure types.

In actuality, cost/benefit ratios for eight countermeasure alternatives are calculated as shown in Table B-1 below. Note that the first four coincide with the first four options in Table 2-3, Volume I.

Table B-1

Cost/Benefit Ratios Calculated During the Stationary Source Suboptimization Process

Benefit Parameter	Countermeasure Alternative
1	A minimum source reduction.
2	A maximum source reduction.
3	Elimination of night operations.
4	Elimination of the source.
5	Elimination of night operations if a minimum reduction was in effect.
6	Elimination of night operations if a maximum reduction was in effect.
7	A minimum reduction if night operations were eliminated.
8	A maximum reduction if night operations were eliminated.

Benefit parameters 1 and 2 are calculated by using the simple energy reduction formula

$$NL = OL \cdot 10^{\frac{-RED}{10}}$$

where

NL = Noise energy remaining after treatment,

OL = Noise energy before treatment,

RED = Decibel reduction from the treatment.

The transfer function is entered using OL and NL, and, together with the impacted population, the difference in adverse effect is computed. This procedure is cumulative over all cells — both day and night — affected by the particular stationary source.

Benefit parameter 3 is calculated by simply summing the remaining number of adversely affected people in each night cell affected by the source.

Item 4 is like 3, except that both day and night cells are considered.

The benefits of items 5 and 6 are computed by subtracting the benefits of items 1 and 2, respectively, from item 3. This procedure is performed only for night cells. Thus, the incremental effect of eliminating the night operations is obtained.

Parameters 7 and 8 are calculated by summing the benefits of items 1 and 2, respectively, over the day cells alone. In this manner, the incremental benefits are computed.

The benefit values are then converted to cost/benefit ratios by considering the costs associated with these measures. Costs for items 1 through 4 are input directly; costs for items 5 and 6 are the same as for item 3; and items 7 and 8 are the same as for items 1 and 2, respectively.

The cost/benefit ratios for items 1-4 are then placed in a separate list and sorted in ascending order. The most cost-effective options (those with the greatest benefit for the least cost) appear at the top of the list. Given the total expenditure allocated to the stationary source countermeasure, the next step is to spend that money in the most cost-effective manner. This is accomplished by proceeding through the list of cost/benefit ratios, beginning at the top, noting the costs of each, and noting which options, if any, have previously been applied to each source. The necessity for the latter will become apparent in the following paragraph.

Many complications can arise. For example: Suppose the next option to apply is a minimum reduction to stationary source number six, but a more cost-effective option was to eliminate the night operations of source number six. Hence, since we have already decided to eliminate the night operations of that source, the cost/benefit ratio previously calculated for a minimum reduction is not correct. The program method is to replace the ratio for the minimum reduction alone with the cost/benefit ratio for a minimum reduction with night operations eliminated — alternative number seven in Table B-1. This ratio can now be used since it is known that the night operations have been eliminated. The correct ratio is inserted and the remainder of the ordered list of cost/benefit ratios (including the inserted ratio) is reranked to verify that the inserted ratio is still the next most cost-effective option to implement (i.e., has not moved down the list). If it is, then the option applied to stationary source number six would be identified as number five in Table 2-3, Volume I — a combination of two independent countermeasures, elimination of night operations and minimum reduction. These complications are the reason for the calculation of cost/benefit ratios numbers 5 through 8 listed in Table B-1.

Not all complications are as easily handled as just described. Table B-2 summarizes the methods for resolving all complications that can arise. Note that these complications are due to the implementation of multiple options on one stationary source. Before any option is implemented, the program will check which options, if any, have previously been applied to the source.

The final result of the suboptimization process is a list of option numbers as shown in Table 2-3, Volume I, each of which correspond to a defined stationary source. The actual application of the selected countermeasure option for each source, where the decibel reduction is finally registered, takes place after this list has been compiled (Section B-4).

Table B-2

Methods of Solution For All Meaningful Cases Which Can Arise During the Optional Expenditure of Funds On Stationary Source Countermeasures

(underscored numbers correspond to option numbers described in Table 2-3, Vol. I)

Previous Option Applied To This Source	Allowed Additional Options and Method For Evaluating Potential Benefit
0 (nothing)	1-4 No modification to straightforward procedure.
1	2 Recompute cost/benefit (\$/B) ratio according to $C/B = \frac{\$_{max.\ red.} - \$_{min.\ red.}}{B_{max.\ red.} - B_{min.\ red.}}$ where the individual costs and benefits are extracted from the individual cost/benefit ratios.
	3 Use cost/benefit ratio number 5 in Table B-1
	4 Recompute cost/benefit ratio according to $C/B = \frac{\$_{elim.\ source} - \$_{min.\ red.}}{B_{elim.\ source} - B_{min.\ red.}}$
2	3 Use cost/benefit ratio number 6 in Table B-1
	4 $C/B = \frac{\$_{elim.\ source} - \$_{max.\ red.}}{B_{elim.\ source} - B_{max.\ red.}}$
3	1 Use cost/benefit ratio number 7 in Table B-1
	2 Use cost/benefit ratio number 8 in Table B-1
	4 $C/B = \frac{\$_{elim.\ source} - \$_{elim.\ night}}{B_{elim.\ source} - B_{elim.\ night}}$
4	NOTHING
5	2 Subscript numbers refer to C/B ratios in Table B-1 $C/B = \frac{\$_{max.\ red.} - \$_{min.\ red.}}{B_8 - B_7}$
	4 $C/B = \frac{\$_{elim.\ source} - (\$_{elim.\ night} + \$_{min.\ red.})}{B_4 - (B_5 + B_1)}$
6	4 $C/B = \frac{\$_{elim.\ source} - (\$_{elim.\ night} + \$_{max.\ red.})}{B_4 - (B_6 + B_2)}$

B-3 Suboptimization of Path-Receiver Countermeasures

The suboptimization of the path-receiver countermeasure options (see Table 2-4, Volume I) proceeds much in the same manner as for the stationary source countermeasure. However, since there are more alternatives, and there exists the concept of secondary cells for barriers, the procedure is much more complicated.

The initial step is the calculation of benefit parameters and cost/benefit (C/B) ratios for each alternative at each cell. Unlike stationary sources, the benefit parameters are saved in addition to the resulting C/B ratios. The benefits are in units of people no longer adversely affected. In addition, the benefits are evaluated with the other countermeasure types in effect, including the result of the optimized stationary source countermeasure.

Eighteen benefit parameters are calculated for each cell. In addition, the first six are used in the calculation of C/B ratios for rank ordering before the actual selection process begins.

1. Minimum soundproofing is applied in a straightforward manner to all cells using the following energy reduction formula:

$$NL = OL \cdot \left[T + (1 - T) \cdot 10^{\frac{-RED}{10}} \right]$$

where

NL = Resulting energy level,

OL = Energy level before soundproofing,

T = Fraction of time spent outdoors (i.e., when soundproofing is effective, this value is dependent on land use type and on day and night),

RED = Decibel reduction from the soundproofing; this value is also dependent on land use type.

The resulting energy level is then entered into the transfer function and compared to the transfer function result using the unattenuated level. The difference is the benefit of the soundproofing in terms of people no longer adversely affected. The cost of soundproofing a cell is obtained by multiplying the area for soundproofing in square feet (input in the master data set) by the cost per square foot for this grade of soundproofing at this type of cell (residential or commercial). The benefit parameter is summed over the day and the night version of this cell.

2. Medium soundproofing is similar to minimum soundproofing.

3. Maximum soundproofing is also similar to minimum soundproofing.

4. Low barriers require more complex handling due to the fact that one primary cell and up to three secondary cells may be affected. Barrier attenuation is computed using the following formula:

$$RE = SL \cdot \left(10^{\frac{-ATT \cdot ER}{10}} \right)$$

where

RE = Remainder of the noise energy after erection of the barrier,

SL = Noise energy from the noise source being attenuated,

ATT = Decibel attenuation of the barrier on a standard source (see Section 2.4, Vol. I),

ER = Effectiveness ratio for the current noise source.

The above formula is applied to each source level individually; the results are then summed to obtain the total remaining noise energy.

For the purposes of preparing C/B ratios, all benefits of a barrier at the secondary cell location are combined with the benefits at the primary cell location. A barrier location is always identified by the primary cell associated with that barrier. The individual barrier benefits at every cell location affected by a barrier are, in addition, stored separately for later use. As always, benefits are in terms of people no longer adversely affected.

5. High barriers are handled in the same way as are low barriers. Note that the secondary cells for a high barrier may be different from the secondary cells for the associated low barrier. Since the program can allow only one barrier to affect

a cell, and since a secondary cell may be affected by more than one barrier location, the program will select the barrier location which is the most effective at each cell. This selection is repeated independently for each barrier height. Consequently, the program may select a different barrier location for the low barrier as for the high barrier as far as one particular cell is concerned.

6. Relocation can be treated two ways at the user's option (see Section 2.5, Vol. I). The benefits are either corrected for the region into which people would be moved, or uncorrected. In the latter case, the benefit is all the people in the cell who are adversely affected. All cell locations may be subject to relocation.

The parameters listed in Table B-3 are not used in the calculation of cost/benefit ratios but are used in the event that more than one of the above countermeasure alternatives are to be applied to the same cell location.

Table B-3

Incremental Benefit Parameters Used In Path-Receiver Countermeasure Suboptimization

Incremental Benefit Parameter Number	Incremental Benefit Parameter
7	Minimum soundproofing if low barrier in place.
8	Medium soundproofing if low barrier in place.
9	Maximum soundproofing if low barrier in place.
10	Minimum soundproofing if high barrier in place.
11	Medium soundproofing if high barrier in place.
12	Maximum soundproofing if high barrier in place.
13	Low barrier if minimum soundproofing in place.
14	Low barrier if medium soundproofing in place.
15	Low Barrier if maximum soundproofing in place.
16	High barrier if minimum soundproofing in place.
17	High barrier if medium soundproofing in place.
18	High barrier if maximum soundproofing in place.

Table B-4 summarizes the situations that can arise when combinatorial or replacement countermeasure alternatives are applied to the same cell. An example of a replacement is the application of a higher grade of soundproofing at a cell where a lower grade was implemented previously.

Table B-4

Program Techniques For Path-Receiver Countermeasures
(underscored numbers refer to countermeasure options as listed in Table 2-4, Vol. I)

Previous Option Applied To This Cell	Allowed Additional Options and Method For Evaluating Potential Benefit
0 (nothing)	1-6 Straightforward Procedure (note that 4 and 5 will only occur for the primary cell of a barrier, in which case we must check those options already implemented at the secondary cell locations and adjust the cost/benefit ratio accordingly before performing the reranking operation which verifies that the adjusted cost/benefit ratio is still the most cost-effective). 1. Indicate that the option is implemented at the cell(s) in question. 2. Register the cost of the option. 3. Save benefit achieved for each affected cell. The following cases all require the above as a minimum. The descriptions will refer to the procedure that must be followed before the above three steps are implemented.
1	2 Recompute the cost/benefit ($/B) according to $C/B = \frac{\$_{med.sprf.} - \$_{min.sprf.}}{B_{med.sprf.} - B_{min.sprf.}}$
	3 $C/B = \frac{\$_{max.sprf.} - \$_{min.sprf.}}{B_{max.sprf.} - B_{min.sprf.}}$
	4 This will occur for primary cells only. Determine what has been done to each secondary cell (must be soundproofing, relocation, or nothing in this specific case). Use the appropriate incremental benefit parameters (7-18) in Table B-3 (zero benefit if relocation) to determine the total benefit at the secondary cell (sc) locations of building this barrier at the primary cell. Add that total to parameter no. 13 for the primary cell to obtain total benefit. $C/B = \frac{\$_{low\ bar.}}{B_{13} + \sum_{sc} \Delta B_{low\ bar.}}$ where ΔB is used to signify appropriate incremental benefit parameter, determined by entering this table independently for each secondary cell.
	5 $C/B = \frac{\$_{high\ bar.}}{B_{16} + \sum_{sc} \Delta B_{high\ bar.}}$
	6 $C/B = \frac{\$_{reloc.} - \$_{min.sprf.}}{B_{reloc.} - B_{min.sprf.}}$ If this option is implemented, the cost of soundproofing is added back to the available total.

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Table B-4 - Continued

(underscored numbers refer to countermeasure options as listed in Table 2-4, Vol. I)

Previous Option Applied To This Cell	Allowed Additional Options and Method For Evaluating Potential Benefit
2	3 $C/B = \frac{\$_{max.sprf.} - \$_{med.sprf.}}{B_{max.sprf.} - B_{med.sprf.}}$
	4 $C/B = \frac{\$_{low\ bar.}}{B_{14} + \sum_{sc} \Delta B_{low\ bar.}}$
	5 $C/B = \frac{\$_{high\ bar.}}{B_{17} + \sum_{sc} \Delta B_{high\ bar.}}$
	6 $C/B = \frac{\$_{reloc.} - \$_{med.sprf.}}{B_{reloc.} - B_{med.sprf.}}$
3	4 $C/B = \frac{\$_{low\ bar.}}{B_{15} + \sum_{sc} \Delta B_{low\ bar.}}$
	5 $C/B = \frac{\$_{high\ bar.}}{B_{18} + \sum_{sc} \Delta B_{high\ bar.}}$
	6 $C/B = \frac{\$_{reloc.} - \$_{max.sprf.}}{B_{reloc.} - B_{max.sprf.}}$
4	1 Subscript numbers refer to incremental benefit parameters in Table B-3 $C/B = \frac{\$_{min.\ sprf.}}{B_7}$
	2 $C/B = \frac{\$_{med.\ sprf.}}{B_8}$
	3 $C/B = \frac{\$_{max.\ sprf.}}{B_9}$
	5 $C/B = \frac{\$_{high\ bar.} - \$_{low\ bar.}}{B_{high\ bar.} - B_{low\ bar.} + \sum_{sc} \Delta B_{high\ bar.}}$ The incremental benefit at the secondary cells is dependent on options previously implemented there.
	6 Relocation of a primary cell removes the barrier and, thus, the benefit of the barrier on every affected cell. If the current cell is itself secondary, the summation term is not used and cost of the barrier is zero. $C/B = \frac{\$_{reloc.} - \$_{low\ bar.}}{B_{reloc.} - B_{low\ bar.} - \sum_{sc} \Delta B_{low\ bar.}}$

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Table B-4 – Continued

(underscored numbers refer to countermeasure options as listed in Table 2-4, Vol. I)

Previous Option Applied To This Cell	Allowed Additional Options and Method For Evaluating Potential Benefit	
5	1	$C/B = \frac{\$_{min.\ sprf.}}{B_{10}}$
	2	$C/B = \frac{\$_{med.\ sprf.}}{B_{11}}$
	3	$C/B = \frac{\$_{max.\ sprf.}}{B_{12}}$
	6	$C/B = \frac{\$_{reloc.} - \$_{high\ bar.}}{B_{reloc.} - B_{high\ bar.} - \sum_{sc} \Delta B_{high\ bar.}}$
6	NOTHING	
7	2	$C/B = \frac{\$_{med.\ sprf.} - \$_{min.\ sprf.}}{B_8 - B_7}$
	3	$C/B = \frac{\$_{max.\ sprf.} - \$_{min.\ sprf.}}{B_9 - B_7}$
	5	$C/B = \frac{\$_{high\ bar.} - \$_{low\ bar.}}{B_{16} - B_{13} + \sum_{sc} \Delta B_{high\ bar.}}$
	6	$C/B = \frac{\$_{reloc.} - (\$_{low\ bar.} + \$_{min.\ sprf.})}{B_{reloc.} - B_7 - B_{low\ bar.} - \sum_{sc} \Delta B_{reloc.}}$ The incremental benefit of relocation at the secondary cells is dependent upon any soundproofing that may be there (we know the low barrier exists).
8	3	$C/B = \frac{\$_{max.\ sprf.} - \$_{med.\ sprf.}}{B_9 - B_8}$
	5	$C/B = \frac{\$_{high\ bar.} - \$_{low\ bar.}}{B_{17} - B_{14} + \sum_{sc} \Delta B_{high\ bar.}}$
	6	$C/B = \frac{\$_{reloc.} - (\$_{low\ bar.} + \$_{med.\ sprf.})}{B_{reloc.} - B_8 - B_{low\ bar.} - \sum_{sc} \Delta B_{reloc.}}$
9	5	$C/B = \frac{\$_{high\ bar.} - \$_{low\ bar.}}{B_{18} - B_{15} + \sum_{sc} \Delta B_{high\ bar.}}$
	6	$C/B = \frac{\$_{reloc.} - (\$_{low\ bar.} + \$_{max.\ sprf.})}{B_{reloc.} - B_9 - B_{low\ bar.} - \sum_{sc} \Delta B_{reloc.}}$

Table B-4 - Continued

(underscored numbers refer to countermeasure options as listed in Table 2-4, Vol. 1)

Previous Option Applied To This Cell	Allowed Additional Options and Method For Evaluating Potential Benefit	
10	2	$C/B = \frac{\$_{med.\ sprf.} - \$_{min.\ sprf.}}{B_{11} - B_{10}}$
	3	$C/B = \frac{\$_{max.\ sprf.} - \$_{min.\ sprf.}}{B_{12} - B_{10}}$
	6	$C/B = \frac{\$_{reloc.} - (\$_{min.\ sprf.} + \$_{high\ sprf.})}{B_{reloc.} - B_{10} - B_{high\ bar.} - \sum_{sc} \Delta B_{reloc.}}$
11	3	$C/B = \frac{\$_{max.\ sprf.} - \$_{med.\ sprf.}}{B_{12} - B_{11}}$
	6	$C/B = \frac{\$_{reloc.} - (\$_{med.\ sprf.} + \$_{high\ bar.})}{B_{reloc.} - B_{11} - B_{high\ bar.} - \sum_{sc} \Delta B_{reloc.}}$
12	6	$C/B = \frac{\$_{reloc.} - (\$_{max.\ sprf.} + \$_{high\ bar.})}{B_{reloc.} - B_{12} - B_{high\ bar.} - \sum_{sc} \Delta B_{reloc.}}$

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B-4 Application of Countermeasures

Countermeasure Types 1 through 15 apply to moving noise sources, usually emitted from surface or air transportation vehicles. A Type 18 countermeasure is applied to stationary sources. A variety of countermeasure types were developed to deal with these noise sources. The algorithms used to implement these countermeasures are presented in this section. The reader is referred to Section 2.2 of Volume I for a more qualitative description of each countermeasure. Countermeasure Type 20 refers to path-receiver treatments.

Type 1 Frequency Reduction or Rerouting

$$NL_1 = OL_1 \cdot (1 - F)$$

$$NL_2 = OL_2 \cdot F$$

where

NL_1 = Resulting energy level from unrerouted position,

NL_2 = Resulting energy level from rerouted position,

OL_1 = Energy level from source to be rerouted,

OL_2 = Energy level from source if all operations were rerouted,

F = Fraction of operations to be rerouted (this is the countermeasure variable).

If the countermeasure is a simple frequency reduction, the NL_2 equation is not applicable.

Type 3 Reduction of Nighttime Operations

$$NL = OL \cdot (1 - F)$$

where

NL = Remaining energy after frequency reduction,

OL = Energy before any reduction,

F = Fraction of night operation to be curtailed (this is the countermeasure variable).

The above equation is used only on source levels affecting cells defined over the nighttime period.

Type 5   Shifting of Nighttime Activity to Day, or Daytime to Night

If the countermeasure variable specifies a shifting of nighttime activity to day, then the following expressions are used:

For daytime cells,

$$NL = OL \cdot (1 + \frac{R}{1-R} \cdot PT) \quad \text{for } R \neq 1$$

$$NL = OL \cdot PT \qquad \text{for } R=1$$

For nighttime cells,

$$NL = OL \cdot (1 - PT)$$

If the countermeasure variable specifies a shifting of daytime activity to night, then the following expressions are used:

For daytime cells,

$$NL = OL \cdot (1 - PT)$$

For nighttime cells,

$$NL = OL \cdot (1 + \frac{1-R}{R} \cdot PT) \quad \text{for } R \neq 0$$

$$NL = OL \cdot PT \qquad \text{for } R=0$$

where, for all equations

- NL = Resulting energy after transfer,
- OL = Energy before transfer,
- R = Fraction of noise energy during nighttime period, before countermeasure application,
- PT = Fraction of noise energy to be transferred (this is the countermeasure variable).

Type 10 Fixed L_{eq} Reduction to a Portion of the Source Population

$$NL = OL \cdot \left[1 - PCNT \cdot \left(1 - 10^{\frac{-DB}{10}}\right)\right].$$

where

NL = Resulting energy level after treatment,

OL = Energy level before treatment,

PCNT = Fraction of source population to be treated (this is the countermeasure variable),

DB = Decibel reduction from the treatment.

Type 12 Overall L_{eq} Reduction

$$NL = OL \cdot 10^{\frac{-DB}{10}}$$

where

NL = Resulting energy level,

OL = Energy level before reduction,

DB = Decibel reduction (this is the countermeasure variable).

Type 15 Fixed L_{eq} Reduction to an Exclusive Portion of the Source Population

Successive countermeasures of this type applying to the same source affect only that portion left untreated by any previous countermeasures of this type.

$$NL = CL - OL \cdot PCNT \cdot \left(1 + 10^{\frac{-DB}{10}}\right)$$

where

NL = Resulting energy level,

CL = Current energy level (NL after previous Type 15 countermeasure),

OL = Original energy level (before any Type 15 countermeasures),

PCNT = Fraction of sources to be treated (this is the countermeasure variable),

DB = Decibel reduction from the treatment.

Note the following constraint:

$$\sum_{\substack{\text{Over all Type 15} \\ \text{Countermeasures} \\ \text{On This Source}}} PCNT_i \leq 1$$

Type 18 Stationary Source Countermeasures

Once the optimized list of individual source-option combinations has been determined (see Section B-2), the actual reduction in the source levels may be accomplished.

Options 1 and 2: Minimum and Maximum Noise Level Reduction

The reduction is applied equally among day and night cells according to:

$$NL = OL \cdot 10^{\frac{-RED}{10}}$$

where

NL = Resulting energy level,

OL = Original energy level,

RED = Decibel reduction.

Option 3: Elimination of Night Operations

This is accomplished by eliminating all the noise energy from the source at each affected night cell location. Those cells defined over the daytime period remain unaffected.

Option 4: Elimination of the Source

This is achieved by eliminating all the noise energy from the source at each affected cell, both day and night.

Options 5 and 6: Elimination of Night Operations and Minimum or Maximum Reduction

Realized by applying Option 3 to the affected night cells in conjunction with Options 1 or 2 at each corresponding day cell.

The countermeasures are applied in order of increasing countermeasure type. It is important that the rerouting countermeasure be performed first so that any other countermeasure which applies to the rerouted source has those results available. Note that the stationary source countermeasures were optimized previously using a preliminary application of the other countermeasures. This preliminary application was for the specific purpose of stationary source suboptimization and constituted the first pass through the cells as described in Section B-1.

Type 20 Path-Receiver Countermeasures

When the program is compiling an optimized list of path-receiver countermeasures among the cells, it is also saving the benefits of those options on a cell-by-cell basis. These benefits are expressed in terms of the number of people no longer adversely affected by noise and are obtained from the cost/benefit ratios and benefit parameters associated with the particular option.

The actual application of the countermeasure occurs when the NII is being evaluated. The NII is calculated by summing – on a cell-by-cell basis – the number of people who remain adversely affected after the application of countermeasure Types 1 through 18. For each cell, the benefit of the path-receiver countermeasure option implemented, if any, is subtracted from the remainder figure just mentioned to obtain the net number of people who are still adversely affected by the noise climate. The grand sum of this net figure over all the cells is then divided by the total population to obtain the NII.

$$NII = \frac{\sum_{cells} (PR_i - BFT_i)}{TPOP}$$

where

NII = Noise Impact Index,

PR_i = Number of people who remain adversely affected in this cell after the application of countermeasure Types 1 through 18,

BFT_i = Benefit of the path-receiver countermeasure chosen for this cell,

$TPOP$ = Total population of the community.

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B-5 Gradient Evaluation

The gradient is calculated to indicate, at the current point, the slope of the Noise Impact Index (NII) hypersurface formed by the countermeasures (see Figure 2-9, Volume I, for a three-dimensional illustration resulting from two countermeasures). The program uses the steepest-descent technique to find the minimum point with the given constraints. The gradient for a countermeasure is an indication of the change in the NII that will result if an additional dollar is spent on that countermeasure alone. In actuality, the gradient is based on a fixed increment (not one dollar) and then normalized to one dollar.

For countermeasure Types 1 through 15, the gradient is indeed calculated by comparing the effectiveness of the countermeasure at the current expenditure level and the effectiveness of that same countermeasure at the current expenditure level plus the gradient stepsize amount. For the stationary source and path-receiver countermeasures — Types 18 and 20, respectively — the gradient is based on the next-most-cost-effective countermeasure option that would be implemented if sufficient funds were allocated to that countermeasure. In that case, the gradient expression takes on the following form:

$$GRAD_i = \frac{1}{CBR \cdot TPOP}$$

where

$GRAD_i$ = Gradient magnitude of the i^{th} countermeasure,

CBR = Cost/benefit ratio associated with the countermeasure alternative that would next be implemented (cost of alternative is in dollars and the benefit in terms of people),

TPOP = Total population of all the cells.

There is a complication that arises with the stationary source gradient value. Since the suboptimization of the stationary source countermeasures uses the effectiveness of the path-receiver measures of the previous expenditure scenario,* the stationary source gradient value as calculated using the above expression is only an approximation. Should this

*See Section B-2, third paragraph, page B-8.

approximation be the largest of all countermeasure types, the program will automatically initiate a pseudo-expenditure evaluation which includes the next stationary source countermeasure option as well, and will use the actual difference in the Noise Impact Indices (with and without the extra stationary source measure) to calculate the gradient value. This value is assured to be correct since the path-receiver measures which are used as an approximation are the actual measures that were calculated during the evaluation of the previous expenditure scenario. Note that the approximate gradient value will always have a larger magnitude than the actual value — i.e., the approximation is calculated using a larger potential benefit of people adversely affected.

In the event that the application of the extra stationary source measure causes a change in the path-receiver benefits, the actual NII difference technique used with the pseudo-evaluation will ensure the accuracy of the gradient value.

If the stationary source countermeasure using the corrected gradient is found to be less effective than another countermeasure, the program will search the other gradients that were calculated before pseudo-evaluation. The pseudo-evaluation does not calculate gradients for the other countermeasure types.

If it is found that the next-most-cost-effective countermeasure option (either for the stationary source or path-receiver countermeasure) costs more than the total budget balance for all countermeasures, the gradient value will then be based on the next item in the list that allows us to remain within the budget. It is conceivable that even an option further down the list may be more cost-effective than the application of any of the other countermeasure types (1 through 15). If no option is within the budget, the returned gradient will be zero.

For countermeasure Types 1–15 the gradient value is computed using an energy reduction ratio, defined as follows:

$$RR = \frac{E_g}{E_r}$$

where

RR = Energy reduction ratio,

E_g = Source noise energy remaining after countermeasure application including gradient stepsize expenditures (this is called 'extra' application below),

E_r = Noise energy remaining after countermeasure application excluding gradient stepsize expenditures; i.e., that energy calculated in the last step.

Since each countermeasure may apply to two sources, a reduction ratio is computed for each countermeasure on each affected source. A reduction ratio of 1.0 indicates no reduction and hence no benefit.

The reduction ratio concept is important because it maintains the same decibel value independent of the magnitude of the energy level. Therefore, we need not be concerned with the order in which the countermeasures are applied. Since the application of the countermeasures is cumulative, that is — more than one countermeasure may affect the same source — the ratio concept will result in the calculation of the same correct decibel reduction value independent of the current magnitude of the energy from the affected source.

After all the reduction ratios have been obtained, the program must convert the information to benefits in terms of people. The following expression indicates how the energy reduction ratio is used to compute the energy value for entry into the transfer function.

$$RLVL_j = EXP - \sum_{i=1}^{2} \left[XN_{ij} - \left(RR_{ij} \cdot XN_{ij} \right) \right]$$

where

$RLVL_j$ = Total energy remaining at the cell with extra application of the j^{th} countermeasure (the other countermeasures are in effect at their regular expenditure levels),

EXP = Total energy remaining at the cell due to application of all the countermeasures at regular expenditure level,

XN_{ij} = Energy from the i^{th} source affected by the j^{th} countermeasure,

RR_{ij} = Energy reduction ratio for the j^{th} countermeasure on the i^{th} source.

The $RLVL_j$ value is used to compute the number of people adversely affected in each cell location with the extra application of the j^{th} countermeasure. This value is summed over all cells with the results separated for each countermeasure.

The benefit parameter must also include the actual benefit that would be obtained from the path-receiver measure (if any) in effect at the cell in question with the extra amount spent on the countermeasure in question. The absolute benefit of the path-receiver measure, in terms of people, at a cell location would be different if additional funds were spent on any countermeasure. The difference is computed and considered in the calculation of the gradient benefits.

The expression used to calculate the gradient values is:

$$GRAD_i = \frac{PEO - DPEO - PADV_i - DPPR_i}{GS \cdot TPOP}$$

where

$GRAD_i$ = Gradient value for the i^{th} countermeasure.

PEO = Total number of people adversely affected by noise in the community after the application of countermeasure Types 1-18 at their allocated expenditure levels.

DPEO = Total number of people in the community that would no longer be adversely affected by noise if the selected path-receiver countermeasure options were implemented.

$PADV_i$ = Total number of people adversely affected with an extra amount spent on the i^{th} countermeasure. The extra amount is given by GS.

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$DPPR_i$ = Total number of people who would no longer be adversely affected due to path-receiver countermeasures with an extra amount spent on the i^{th} countermeasure.

GS = The gradient stepsize in dollars. This is the extra amount that is spent on each countermeasure, one at a time, in evaluating the potential benefits.

TPOP = Total population of the community.

Note that the calculation of the Noise Impact Index uses three of the above variables:

$$NII = \frac{PEO - DPEO}{TPOP}$$

APPENDIX C

Variable Descriptions For Common Blocks

This section consists of a list of the common blocks in NOIZOP. In the succeeding discussion each block is briefly described followed by the variables, which are listed and defined – with their dimensions – in the order in which they appear in the block.

/ AUXOUT / — Contains information regarding the optional auxiliary print file.

LAUX — A logical variable that is True if the secondary short form output (also called "auxiliary file") is to be created; False if this file is not desired.

LAUXUN — The Fortran logical unit number of the device to which the auxiliary file is to be output. This variable has no meaning if LAUX is False.

/ BARDEF / — The common block that contains parameters used for barrier calculations.

BAT(2,21) — An array of barrier effectiveness ratios for the 20 possible sources and two barrier heights. The extra two locations are not presently used.

NPZ(100) — Cell identification for the primary cell associated with each of 100 possible barrier locations. Given zone number, NZ, and cell number, NC, for the primary cell of the I th barrier, then

$$NPZ(I) = NZ \cdot 1000 + NC$$

NSEC(6, 100) — Relates primary internal cell location number for a barrier to each of the internal cell location numbers for each of three possible secondary cells. Indices 1–3 refer to the cell location numbers for the secondary cells for a low barrier height; indices 4–6 refer to cell locations for a high barrier height. While the secondary cells are usually the same for both barrier heights, there may be instances when they are not.

/CELDAT/ — Contains most of the elements of the master cell data set. There is an allowed maximum of 200 cells.

ID(200) Contains the cell identification number for internal use. If NZ is the zone number and NC is the cell number, then the ID of the Ith cell is given by

$$ID(I) = NZ \cdot 1000 + NC$$

ICRIT(200) Contains three parameters packed into one variable. If the Ith cell has lower bound criterion level, LC (an integer), land use type, LU, and a day-night indicator, IDN (0 for day, 1 for night), then

$$ICRIT(I) = LC \cdot 1000 + LU \cdot 10 + IDN$$

VPOP(200) This array holds corrected population figures for each of the cells. The population is corrected for the time period over which the cell is defined. Input population is factored by 15/24 for a day cell and by 9/24 for a night cell.

VAL(200) Costs for relocation for each cell. The input value is entered in thousands of dollars but is converted to dollars before being placed in this array.

ENERGY(20,200) An array of noise source contribution levels in energy units from each of the 20 possible sources for each cell.

IND(20,200) Countermeasure manipulation indicators for each cell. Up to 20 such indicators are allowed.

ICON(20) An array of elements that determines whether or not the Ith source is to be considered in the computation of the baseline case Noise Impact Index.

RUMZ(200) Total floor area for each cell in square feet. This value is used in the calculation of soundproofing costs.

TPOP Total corrected population for the community.

BI The baseline case Noise Impact Index.

NCELZ The total number of cells defined during input. A daytime cell is counted as different from a nighttime cell.

/CMDEF/ — Contains countermeasure definition data. Up to 20 countermeasures may be defined.

MTYP(20) Countermeasure type codes for each defined countermeasure. See Table 2-5 of the User's Guide (Volume I) for a listing of allowed types.

KR(20) A list of countermeasure numbers sorted in ascending order of countermeasure type codes.

NSORS(2,20) An array of source numbers (up to two) affected by each countermeasure.

ICD(2,20) An array of indicator numbers (up to two) used by each countermeasure.

NCM The actual number of defined countermeasures.

/CRITL/ — The common block that contains parameters used in evaluating the adverse effect transfer function.

UPBND(15,2) This array contains 100 percent adversely affected noise levels for each of the 15 possible land use categories and each of the two time periods over which a cell may be defined, day or night. See Table 2-7 of the User's Guide for a listing of default program values.

ISH The transfer function shape indicator. ISH may range from one to five. See Figures 2-9 through 2-12 in the User's Guide for an illustration of each function type.

BLG The transfer function bulge parameter. This variable corresponds to "r" in Figures 2-9 through 2-12 in the User's Guide.

/ EXPENS / — Contains the variables which define the cost data associated with each of the countermeasures.

COSDTA(8,2,20) An array containing data points of countermeasure variable versus cost. COSDTA(I,1,J) contains up to eight countermeasure variables for the J th countermeasure. COSDTA(I,2,J) contains up to eight corresponding costs in dollars.

COSTB(2,100) Contains barrier costs for each of 100 barrier locations. Costs for two barrier heights are stored — low and high, respectively.

COSS(4,20) Stationary source countermeasure costs for each of 20 stationary sources.

COSS(1,I) — Cost for a minimum noise reduction of the I th stationary source.

COSS(2,I) — Cost for a maximum noise reduction.

COSS(3,I) — Cost to eliminate nighttime operations of the I th source.

COSS(4,I) — Cost to eliminate the I th source.

CMIN(20) The minimum allowable expenditure on each of the countermeasures in dollars.

CMAX(20) The maximum allowable expenditure. This variable defines the upper spending limits.

COSTS(20) The current expenditures on each of the countermeasures.

COSP(3,2) Soundproofing costs in dollars per square foot of floor area. Costs are given for three grades of soundproofing and two general types of building structures — residential and commercial, respectively.

NCD(20) An array containing the number of data points (up to eight) which comprise the countermeasure cost function. Twenty countermeasure cost functions can be defined.

/GRADIE/ — Used to make available data concerning the countermeasure gradient calculation.

GRAD(20) Contains the current countermeasure gradient vector. One gradient component is calculated for each countermeasure.

IFILL(20) This array is used to indicate when the spending limit has been reached on a countermeasure.

DELTA This is the gradient stepsize.

COSNSS The cost of implementing the next-most-cost-effective stationary source countermeasure option.

COSNPR The cost of implementing the next-most-cost-effective path-receiver countermeasure option.

BUDGET This is the total budget for all the countermeasures.

/RATIOS/ — Contains benefit parameters for evaluating the suboptimization of the path-receiver countermeasure options.

PRCB(18,200) An array indicating the benefit, in terms of people no longer adversely affected by noise, for each of 18 path-receiver countermeasure situations (see Section B-3). These benefits are calculated for each cell number.

CNPR(18,200) Like PRCB, but calculated for each cell location; day and night cells have been combined where appropriate. The program has room for 200 cell locations as well as 200 cell numbers in the event the user has defined all day cells or all night cells.

/ RECPAT / — Holds various parameters which are also used in evaluating path-receiver countermeasures.

IDX(200) Contains cell identification for all physical cell locations in the community. The values stored are equivalent to ID in / CELDAT / but day and night cell identifications are not repeated.

IOPT(200) Stores the path-receiver countermeasure option that the program has decided to implement at each of the physical cell locations.

PAND(200) Total number of people adversely affected by noise in each physical cell location before the implementation of any path-receiver countermeasure.

DPAN(200) Serves a dual function (at different points in the program). DPAN stores percent adversely affected data in each physical cell location in the same fashion as PAND stores numbers of people. Subsequently, DPAN is used to hold differences in people adversely affected in each cell location due to the application of a path-receiver countermeasure.

ANOYD(200) Stores differences in people adversely affected by noise in each cell number after the application of a path-receiver countermeasure. DPAN stores this information by cell location.

IDS(1200) Contains information on how data are stored in array DOLPER. If NCL is the physical cell location number of a cell for which a path-receiver cost/benefit ratio is stored in DOLPER, and IX is the corresponding option number for this cost/benefit ratio, then, for arbitrary index I,

$$IDS(I) = NCL \cdot 100 + IX$$

Therefore, IDS(I) indicates which cell location and option corresponds to the I th cost/benefit ratio in DOLPER.

DOLPER(1200) Stores cost/benefit ratios for the application of each of the six basic path-receiver countermeasure options (see Section B-3) at each of the 200 possible cell locations.

IVRR(12) Path-receiver countermeasure option override array. A zero in the Ith location precludes that option from consideration. Note that six of the options (shown in Table 2-4, Volume I) are combinations of basic options.

IRP Actual number of cost/benefit ratios present in DOLPER. The extent to which the DOLPER array has been filled.

NCL The number of physical cell locations in the master cell data set.

/ SCRACH /— A storage saving common block. It contains different arrays and variables at different points in the program. A description by subroutine follows. Most of the variables are local to each subroutine mentioned.

BARRD (Subroutine)

IZ(4) — Variables into which zone numbers are read for barrier definition. Up to four cells per barrier are accepted.

IC(4) — Variables into which corresponding cell numbers are input.

A1(4) — Attenuation from a low barrier height.

A2(4) — Attenuation from a high barrier height.

TI(18) — Array containing titling information.

CMRD (Subroutine)

TI(18) — Title array.

COSTRD (Subroutine)

TI(18) — Title array.

CMN(20) — Array used to contain minimum expenditure on each countermeasure in thousands of dollars. Used for printout purposes only.

CMX(20) — Like CMN, but for maximum expenditures.

DISBRS (Subroutine) (see EQUIVALENCE statement in Subroutine XNOIM)

KRNK(1200) — Ranking index array for array DOLPER. If KRNK(8) = 3, then the eighth most cost-effective path-receiver countermeasure option is represented by the cost/benefit ratio contained in DOLPER (3).

ECHO (Subroutine)

BUF(22)— Used to convert cell data from internal storage to a form suitable for output.

IBUF(20)— Buffer array for printout of countermeasure manipulation indicators.

OPTIM (Subroutine)

KT(20) — Used to replace countermeasure gradients in descending order.

KS(20) — Ranking index array, like KT, for ordering gradients in ascending order.

OUTPUT (Subroutine)

CSTPR(12)—Contains total expenditures over all cells on each of the 12 path-receiver countermeasure options.

KT(20) — Used in ranking final gradients in descending order.

KS(20) — Used to indicate if the spending limit was reached on any of the countermeasures; used for printout purposes only.

PARRD (Subroutine)

TI(18) — Title array.

IRDB(3) — Used to input three grades of residential soundproofing.

ICDB(3) — Used to input three grades of commercial soundproofing.

RATRD (Subroutine)

TI(18) — Title array.

IUS(4) — Used to input four land use codes.

FAC(20)— Used to input 20 noise energy factors.

RELOC and REPCAL (Subroutine)

TVAL(200) — Relocation cost by physical cell location.

RPOP(200) —Cell population by physical cell location.

LNDUS(200)-Land use code by physical cell location.

BENE(18) — (REPCAL only) Working array which stores people-benefits of the 18 path-receiver situations before this data is placed in other arrays. Data here is summed over the day and night versions of a cell.

CC(12) — (REPCAL only) Corresponding costs for the first 12 path-receiver cases (see Section B-3).

SELZON (Subroutine)

BUF(10) — Used to input master cell data cards Type 1-5.

/ SNDPRF / — This is the block that holds the energy reduction ratios associated with the grades of soundproofing that are defined.

DB1(2) Energy reduction ratios for the first grade of soundproofing for residential and commercial land uses, respectively.

DB2(2) Like DB1, but for medium soundproofing.

DB3(2) Like DB1, but for maximum soundproofing.

/ SORST / — Contains the titles for the noise sources input at the beginning of the master cell data set.

STITL(8,21) The actual source titles for the 20 sources with 8 bytes allocated for the characters (A4, for a total of 32 characters). The twenty-first location is used to store 'ALL SOURCES' for output purposes describing the sources affected by path-receiver countermeasure.

/ STASOR / — Used to store stationary source countermeasure data.

SRED(2,20) Holds the decibel reduction levels corresponding to a minimum and a maximum reduction, respectively, for each of 20 possible stationary sources.

INSS(20) An array containing the stationary source countermeasure option number (0-6) that the program has decided to implement at each stationary source. A zero implies no countermeasure in effect.

ISOVR(6) Stationary source countermeasure option override array. A zero in the Ith field precludes that option from consideration.

NUSS Actual number of stationary sources defined.

TI(10) — Used to input countermeasure manipulation indicator titles.

SRANK (Subroutine)

XL(20) — Used to store the contribution to the NII from each of the 20 possible sources for each cell.

KR(20) — Ranking index array for ranking the noise sources by adverse affect.

XTOT(20) — Like XL, but is cumulative over all the cells.

SSPEND and XNOIM (Subroutine)

SSCB(8,20) — Cost/benefit ratios for each of eight stationary source countermeasure cases (see Section B-2) for each of 20 possible stationary sources.

IDSS(80) — Contains information regarding the stationary source cost/benefit ratios stored in CB. If JK is the stationary source countermeasure option number (1-4 only; see Section B-2), and IS is the source number, then, for arbitrary index I,

$$IDSS(I) = JK \cdot 1000 + IS$$

KS(80) — Ranking index array for array CB. If KS(1) = 15, then CB(15) contains the cost/benefit ratio representing the most cost-effective stationary source countermeasure option.

CB(80) — Contains cost/benefit ratios for each of four basic stationary source countermeasure options at each of the 20 possible sources.

STARD (Subroutine)

BUF(18) — Used to input title card. Also used to input stationary source countermeasure costs.