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USERS' MANUAL
FOR THE
MULTIPLE-BID EVALUATION MODEL

FOR
PROCUREMENT PLANNING & PLACEMENT

AUGUST 1977

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JOINT CONVENTIONAL
AMMUNITION PROGRAM COORDINATING GROUP

DECISION MODELS DIRECTORATE

ROCK ISLAND, ILLINOIS 61201

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

    This report provides useful information to ammunition managers on the Multiple-Bid Evaluation Model. The purpose of the Multiple-Bid Evaluation Model is to enable management to evaluate the economic and base protection impacts of available alternative solutions for complex procurement actions involving large numbers of multiple bidders, multiple bid levels, and multiple buy periods. The model can be used for single or multiple item buys. The sequence of steps by which the model achieves this objective is as follows:

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Input data for the model includes the procurement objectives (items, quantities, and time periods), bidder information (all costs associated with selecting a specific bidder), and base protection costs. These base protection costs are total costs of layaway and maintenance of Government-furnished equipment at those facilities which are not selected for a portion of the contract. The data conversion module accepts the verified input data and converts it into usable form for the main processing module.

The main processing module uses dynamic programming techniques to identify least-cost and alternative solutions. Dynamic programming is an efficient solution technique for multi-stage problems. In the model, the method used employs an approach in which any two bidders are considered. Then, only those bids made which can enter into the final solution are carried forward as a combination to compete against the next bidder. This procedure is repeated until a final combination is obtained. This final combination represents the least-cost solution. During the process, additional information is obtained which enables the model to identify the cost of all feasible solutions, to then rank order them by cost, and to supply additional breakout of information for management review and analysis.

The report generator module converts this information into the management-oriented output. This report provides management with complete cost-ranked sets of alternatives for meeting total or incremental procurement objectives. The latter is particularly useful if requirements are reduced after the bids have been submitted. The report also presents the least-cost solution for each possible total number of suppliers and the options available for various levels of base protection.

USERS' MANUAL
FOR THE
MULTIPLE-BID EVALUATION MODEL
FOR
PROCUREMENT PLANNING AND PLACEMENT

PREPARED BY
JOINT CONVENTIONAL AMMUNITION PROGRAM
DECISION MODELS DIRECTORATE
PRODUCTION AND MOBILIZATION PLANNING DIVISION

AUGUST 1977

JOINT CONVENTIONAL AMMUNITION PROGRAM
COORDINATING GROUP

REPLY TO
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USERS' MANUAL
FOR THE
MULTIPLE-BID EVALUATION MODEL
FOR
PROCUREMENT PLANNING AND PLACEMENT

FOREWORD

In the Department of Defense environment, there is a need for the capability
of evaluating the cost of making one or more procurement awards for an item
or component. The reasons range from distributing awards to maintain planned-
producer capabilities as a part of assuring industrial preparedness to meet
mobilization requirements to distributing procurement awards consistent with
the capability limitations of competing planned-producers.

To meet these requirements specifications of the Military Services, a
Multiple-Bid Evaluation Model was designed under the auspices of the Joint
Conventional Ammunition Program Coordinating Group. The model has been
successfully demonstrated and has been accepted by the Military Services.

This Users' Manual and a companion document, "The Analysts' Manual," comprise
an export package which will permit the Military Services to install and use
this Multiple-Bid Evaluation Model.

The Users' Manual consists of an explanation of the Multiple-Bid Evaluation
Model concept, along with appropriate uses of the model. It also describes
in detail the input variables and how they are entered and arranged.
Included also are descriptions of the model output and a sample problem with
descriptions of input and output related to an actual case.

Configuration management of the model is retained by the Joint Conventional
Ammunition Program Decision Models Directorate. Proposals for modification
of the model and inquiries with respect to the model application and opera-
tion should be addressed to the Director, Joint Conventional Ammunition
Program Decision Models Directorate, Rock Island Arsenal, IL 61201. Telephone
inquiries should be addressed to the Chief, Production and Mobilization
Planning Division of that Directorate, AUTOVON 793-5666.

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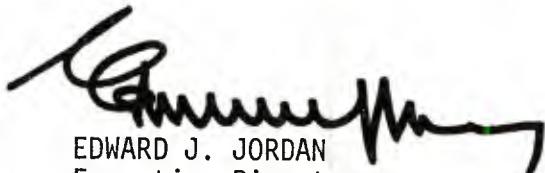## COORDINATING GROUP

REPLY TO ATTENTION OF: Rock Island Arsenal, IL 61201

USERS' MANUAL

FOR THE

MULTIPLE-BID EVALUATION MODEL

FOR

PROCUREMENT PLANNING AND PLACEMENT

This Users' Manual for the Multiple-Bid Evaluation Model, designed, developed, and demonstrated by the Joint Conventional Ammunition Program Decision Models Directorate, is in response to requirements established by the Military Services, which have accepted the model for their uses as described herein.

Although the Multiple-Bid Evaluation Model was designed for procurement planning and placement of ammunition, it is capable of handling any commodity when the effects of multiple-buys and multiple-awards are evaluated by procurement directors.

EDWARD J. JORDAN
Executive Director
Joint Conventional Ammunition
Program Coordinating Group

ABSTRACT

The JCAP Multiple-Bid Evaluation Model is a computerized decision model written in FORTRAN computer language. The model is designed to provide information for selection of the least cost combination of suppliers to provide a total production requirement over a specified single or multiple buy period. The model will provide the least cost solution for each possible explicit number of suppliers. The model uses the principles of dynamic programming to provide the least cost solution as well as other possible solutions for final production of fractions of the original production requirement. It provides "second best" solutions as additional information to assist Management in the decision process in the case that a decision cannot be made based on least costs.

This volume contains:

(1) A detailed description of the input variables required to run the programs, how the variables are entered on the input cards, and how the cards are arranged in the deck.

(2) A sample of input and output for each of the four versions of the program. Included are listings of the input decks and descriptions of the computer printouts including results for the sample problems.

(3) An appendix describing an application of the Multiple-Bid Evaluation Model to the procurement of an artillery fuze by the Army.

ACKNOWLEDGEMENTS

SUMMARY

This report documents the JCAP Multiple-Bid Evaluation Model (MBEM) as adapted and utilized by the JCAP Production and Mobilization Planning Division. The model is a digital mathematical program using the principles of Dynamic Programming to conduct bid analyses for selection of a combination of suppliers to be awarded portions of a total contract.

The model identifies the least cost combination of suppliers to provide the total production requirement over a specified buy period. Program 1 is designed for a single buy period and a single type item. Program 2 can handle up to 2 buy periods or 2 type items for a single buy period. Program 3 can handle up to 3 buy periods or up to 3 type items. Program 4 is a version of Program 1 in which least cost solutions are automatically generated for each explicit possible number of bidders to be selected. In other words, it supplies least cost solutions if one bidder is to be selected for the total production requirement, or if 2 bidders are to be selected, or if 3 bidders are to be selected, and so on.

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INTRODUCTION

1. BACKGROUND.

The JCAP Multiple-Bid Evaluation Model (MBEM) is a computer program which analyzes bids submitted by potential suppliers for portions of a total contract requirement. The model identifies least cost solutions for selection of a combination of suppliers to provide the total production requirement over single or multiple buy periods.

The model can be used to analyze procurement of items when there is a mix of competition from privately-owned and Government-owned facilities.

The techniques and computer programs used in this application were developed initially in support of ORG Report 47 (reference 1). The model has since been modified and adopted as an integral member of the JCAP system of decision models.

2. APPROACH.

The principles of dynamic programming are utilized to provide the least cost solutions for each possible combination of production requirements and number of bidders, as well as "second best" solutions. Secondary solutions are provided as additional information to assist management in the decision process in the event that a decision cannot be made based on least cost solutions. The dynamic programming method employs an approach in which any two bidders are considered and only those bids which can be entered into the final solution are carried forward as a combination to compete against the next bidder. The final combination contains the least cost solution.

3. MODEL OPTIONS.

There are four different program versions of the model. Each program has unique capabilities and options available for the user.

Program one is designed for analyzing a contract procurement for one buy period and one type item. Production base protection, the cost of not selecting a particular bidder, can be assigned to any or all of the bidders prior to the analysis. The number of suppliers allowed in the solution is not included in the analysis. If an analysis for a specified number of suppliers to be selected is desired, then program four should be used. Program one has an option to determine least cost solutions for fractions of the total procurement contract. It is also capable of determining "second best" and other alternative solutions.

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1. DeArmon, Ira A., Jr., and Fermaglich, David M., The Cost of Procuring Ammunition from Industry or from Government-Owned Plants, USAMUCOM ORG Report 47, USAMUCOM Operations Research Group, July 1972, UNCL.

Program two is designed for analyzing a contract procurement for two buy periods for one item or two items for one buy period. The other major difference between program two and program one is that program two can be used to analyze the problem in which there is competition among the bidders for assignment of production base protection responsibility.

Program three is all of the capabilities of the previously-described programs with the additional capability of analyzing a problem with up to three buy periods or up to three items for a single buy period.

Program four is similar to program one in that it is designed for one buy period and one type item. It has the additional capability, however, to identify the least cost solution for each possible number of suppliers which can be selected.

4. MODEL APPLICATION.

The Government issues Invitations for Bid (IFB's) to private industry as well as to its own plants. Each potential supplier submits several bids, each for a specified fraction of the procurement contract. These bids, along with other relevant cost factors, i.e., Government standby costs, transportation costs, equipment rental factors, and production-related costs are analyzed to determine the least cost and several near least cost solutions.

When developing the model for munitions procurement, each Government-owned contractor-operated (GOCO) source is considered as a separate supplier to allow for competition between GOCO facilities. In addition, the contract requirement for the period (or periods) in question must be known. Recognizing that the model derives the solutions for fractions of the total requirement, the decision maker can designate the maximum potential demand as his item requirement in his bid solicitations. Following this procedure, the analyst then defines the discrete bid levels that would be acceptable.

The bid levels selected do not have to be in percentage form, e.g., 0%, 25%, 50%, 75%, 100%. They can also be in actual production units form. For example, if the total requirement for the item to be procured were 100,000 items and the total number of bid levels were five, the bid levels could be entered as 0%, 25%, 50%, 75%, and 100% or as 0 units, 25,000 units, 50,000 units, 75,000 units, and 100,000 units.

In theory, the model can accommodate a large number of discrete bidding levels. In practice, the problem of expected item demand levels and the practicality of developing suitable cost data will be the limiting factors for choosing the number of bid levels for the analysis. Once the procurement requirement, the suppliers, and the feasible bid levels have been defined, the last ingredient to the analysis, i.e., the input cost data, must be developed for each bid level. This data set should include all relevant cost information for the procurement decision.

It is not necessary for model operation that each bidder submit a bid for each level. This facet of the model allows a smaller company, with an insufficient capacity for meeting the entire requirement, to compete for part of the contract. It also gives a supplier the option of not bidding for a lower bid level when he feels it is not in his self-interest.

Figure 1-1 shows the basic data deck setup to run any of the four program versions.

The program source decks are written in FORTRAN computer language. The formats shown on the card and parameter descriptions for each program version are standard FORTRAN formats.

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LAST BIDDER DATA SET

BIDDER 2 DATA SET

BIDDER 1 DATA SET

— LAST BID LEVEL BY 1ST BIDDER AND ASSOCIATED BID COST

— 1ST BID LEVEL BY 1ST BIDDER AND ASSOCIATED BID COST

— NUMBER OF BID LEVELS BID ON BY BIDDER 1

— MAXIMUM BID LEVEL FOR LAST PERIOD

BID LEVEL DATA SET

— LOWEST PERMITTED BID LEVEL (ALWAYS ZERO) FOR FIRST PERIOD

— BASIC PARAMETERS

— TITLE CARD
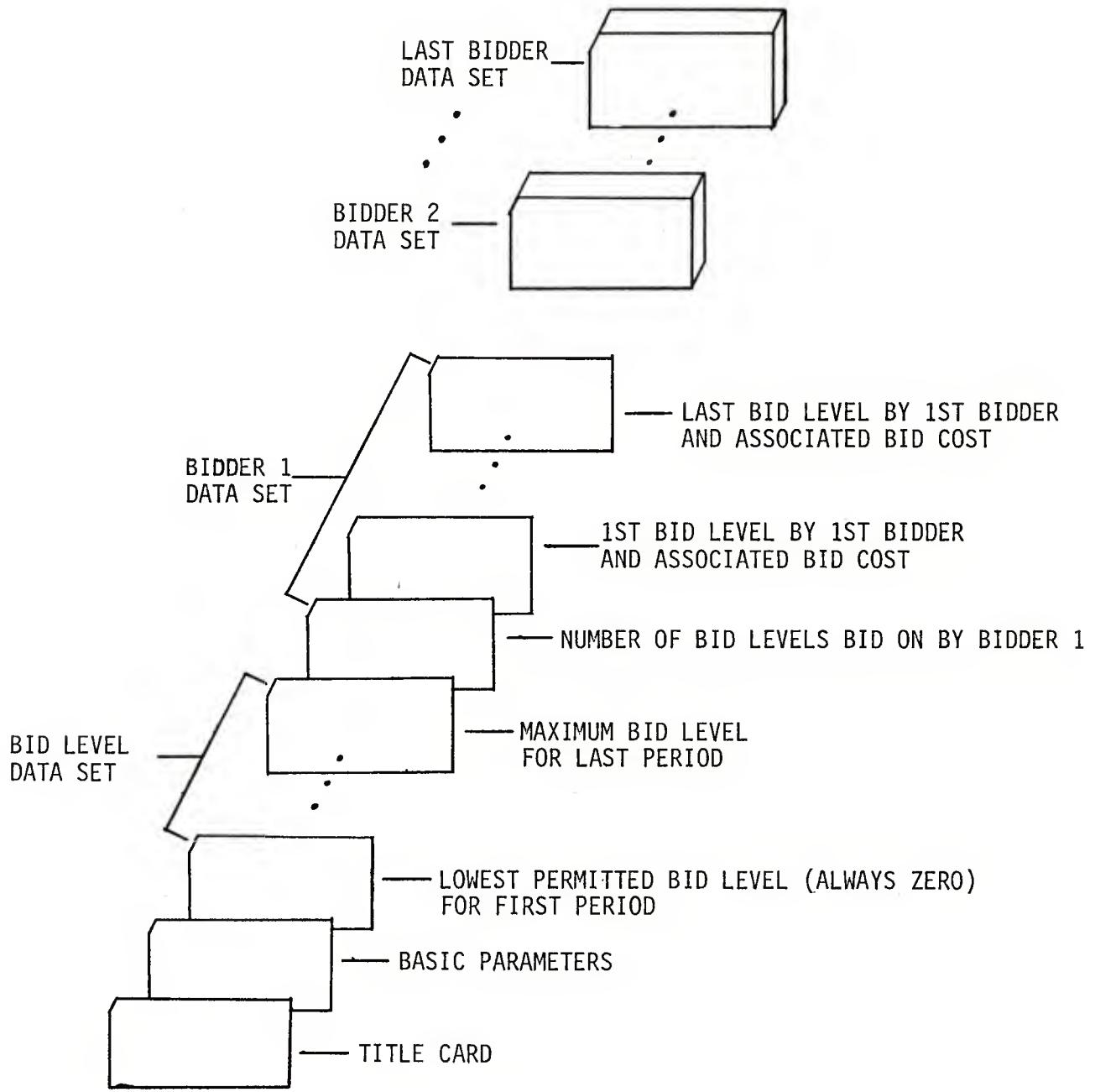
DATA DECK SETUP FOR MULTIPLE-BID EVALUATION MODEL
(REFER TO CARD INPUT DESCRIPTIONS FOR SPECIFIC PARAMETER DEFINITIONS)

FIGURE 1-1

4

SECTION II

PROGRAM ONE

ONE BUY PERIOD/ONE ITEM

1. INPUT.

The following input data are required to run program one:

a. Title (used for printout heading).

b. Total number of bidders.

c. Total number of bid levels (including the zero bid level).

d. Option Indicator. If zero, least cost solution for maximum require-
ment level will be printed. If not zero, least cost solutions will be
printed for each feasible fraction of the maximum requirement level.

e. Possible bid levels (in equal increments) from zero to maximum
level (100%).

f. Number of bid levels actually bid on by each bidder.

g. Bid levels actually bid on by each bidder and associated bid costs.

NOTE: If a potential supplier does not choose to bid at a specific level, do
not include the level/cost card for that level in this set of cards.

Completely detailed card and parameter descriptions for program one are
given on pages 7 through 10.

A typical input data set for program one is shown in Figure 2-1. Each
line represents an 80-column punched card for input.

SAMPLE PROBLEM INPUT DATA

    The sample input below is explained in the card and parameter descriptions on the following pages.

```
SAMPLE MULT BID #1
  3   5   1
              0
             25
             50
             75
            100
      5
              0          100
             25          550
             50          900
             75         1150
            100         1350
      5
              0            0
             25          400
             50          900
             75         1300
            100         1700
  3
              0            0
             25          300
             50          600
```

FIGURE 2-1

STUDY TITLE

CARD 1

	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
A	

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	Title	20	5A4	1-20	Title for output heading.

BASIC PARAMETERS

CARD 2

A	B	C	
			1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	NSUP	3	I3	1-3	Total number of bidders.
B	NLEV	3	I3	4-6	Total number of bid levels (including the zero bid level).
C	ITEST	3	I3	7-9	Option Indicator; if zero, optimal solution for max requirement level will be printed. If not zero, optimal solutions will be printed for all feasible fractions of max requirement level.

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BID LEVELS TO BE CONSIDERED

CARD 3

A

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP(1)	10	F10.0	1-10	Bid level 1 (always = zero)

CARD 4

A

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP(2)	10	F10.0	1-10	Bid level 2.

...

CARD NLEV+2

A

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP(NLEV)	10	F10.0	1-10	Maximum bid level (always = 100%)

8

BIDS FOR FIRST BIDDER

CARD NLEV+3

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	LEV(1)	3	I3	1-3	Number of bid levels actually considered by Bidder 1 (including the zero bid level).

CARD NLEV+4

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV(1,1)	10	F10.0	1-10	1st bid level for 1st Bidder.
B	COST(1,1)	10	F10.0	11-20	Total bid cost for 1st Bidder for 1st bid level.

CARD NLEV+5

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV(1,2)	10	F10.0	1-10	2nd bid level for 1st Bidder.
B	COST(1,2)	10	F10.0	11-20	Total bid cost for 1st Bidder on 2nd bid level.

. . .

CARD NLEV+LEV(1)+4

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV(1,LEV(1))	10	F10.0	1-10	Last bid level for 1st Bidder.
B	COST(1,LEV(1))	10	F10.0	11-20	Total bid cost for 1st Bidder for last bid level.

BIDS FOR SECOND THROUGH LAST BIDDERS

CARD NLEV+LEV(1)+5

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	LEV(2)	3	I3	1-3	Number of bid levels actually considered by Supplier 2 (including the zero bid level).

CARD NLEV+LEV(1)+6

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV(2,1)	10	F10.0	1-10	1st bid level for 2nd Bidder.
B	COST(2,1)	10	F10.0	11-20	Total bid cost for 2nd Bidder for 1st bid level.

CARD NLEV+LEV(1)+LEV(2)+4

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV(2,LEV(2))	10	F10.0	1-10	Last bid level for 2nd Bidder.
B	COST(2,LEV(2))	10	F10.0	11-20	Total bid cost for 2nd Bidder for last bid level.

· · ·

CARD NLEV+LEV(1)+LEV(2)+...+LEV(NSUP)+4

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV(NSUP,LEV(NSUP))	10	F10.0	1-10	Last bid level for last Bidder.
B	COST(NSUP,LEV(NSUP))	10	F10.0	11-20	Total bid cost for last Bidder for last bid level.

2. OUTPUT.

The printed output for program one of the MBEM consists of one or more pages of results. The number of pages depends on the total number of bidders and bid levels, as well as the value of the option indicator which specifies whether the least cost solution for the maximum requirement only is to be printed or if least cost solutions are to be printed for all feasible fractions of the maximum requirement. The actual output consists of a printout of the data that were entered, the least cost solution(s) and three next best solutions for comparison purposes.

A typical printout for program one is shown in Figures 2-2 and 2-3. This is the printout associated with the input data shown in Figure 2-1. The printout is broken down into sections which are annotated with numbers in hexagons. An explanation of each section follows:

SECTION
NUMBER   EXPLANATION

⟨1⟩   Recapitulation of input data. For explanation please
           refer back to the description of input data.

⟨2⟩   These are the solutions for less than the total require-
           ment level. A least cost solution is printed for each
           feasible fraction of the total requirement, which is
           the maximal bid level.

⟨3⟩   This is the least cost solution for the total require-
           ment. In the example, at the 100 percent level the
           least cost solution is bidder 1 at 100 percent, bidder
           2 at 0 percent, and bidder 3 at 0 percent.

⟨4⟩   Next best solutions are presented for use in the event
           that the least cost solution cannot be used.

⟨1⟩ SAMPLE MULT BID #1

3 BIDDERS, 5 BID LEVELS

BID LEVELS
         0.
        25.
        50.
        75.
       100.

BIDS

BIDDER 1

BID LEVEL TOTAL COST
         0.   100.
        25.   550.
        50.   900.
        75.   1150.
       100.   1350.

BIDDER 2

BID LEVEL TOTAL COST
         0.   0.
        25.   400.
        50.   900.
        75.   1300.
       100.   1700.

BIDDER 3

BID LEVEL TOTAL COST
         0.   0.
        25.   300.
        50.   600.

⟨2⟩ SOLUTIONS

REQUIREMENT LEVEL   0. MINIMUM COST   100.
BIDDER 1   0.
BIDDER 2   0.
BIDDER 3   0.

REQUIREMENT LEVEL   25. MINIMUM COST   400.
BIDDER 1   0.
BIDDER 2   0.
BIDDER 3   25.

REQUIREMENT LEVEL   50. MINIMUM COST   700.
BIDDER 1   0.
BIDDER 2   0.
BIDDER 3   50.

REQUIREMENT LEVEL   75. MINIMUM COST   1100.
BIDDER 1   0.
BIDDER 2   25.
BIDDER 3   50.

FIGURE 2-2

⬡ ③   REQUIREMENT LEVEL   100. MINIMUM CCST   1350.
           BIDDER   1   100.
           BIDDER   2   0.
           BIDDER   3   0.

⬡ ④   SUBOPT SOLN   1

SOLUTIONS

REQUIREMENT LEVEL   100. MINIMUM CCST   1450.
BIDDER   1   75.
BIDDER   2   0.
BIDDER   3   25.

                      SUBOPT SOLN   2

SOLUTIONS

REQUIREMENT LEVEL   100. MINIMUM CCST   1550.
BIDDER   1   75.
BIDDER   2   25.
BIDDER   3   0.

                      SUBOPT SOLN   3

SOLUTIONS

REQUIREMENT LEVEL   100. MINIMUM CCST   1450.
BIDDER   1   75.
BIDDER   2   0.
BIDDER   3   25.

FIGURE 2-3

SECTION III

PROGRAM TWO

TWO BUY PERIODS OR TWO ITEMS

1. <u>INPUT</u>.

The following input data are required to run program two:

a. Title (used for printout heading).

b. Total number of bidders.

c(1) Total number of bid levels for period one or for item one (including the zero bid level).

(2) Total number of bid levels for period two or for item two or for base protection competition (including the zero bid level).

d. Option Indicator. If zero, least cost solution for maximum requirement level will be printed. If not zero, least cost solutions will be printed for each feasible combination of fractions of the maximum bid levels.

e(1) Possible bid levels (in equal increments) from zero to maximum level (100%) for period one or item one.

(2) Possible bid levels (in equal increments) from zero to maximum level (100%) for period two, item two or for base protection levels.

f. Number of bid levels actually bid on by each bidder for each period, item or base protection.

g. Bid level combinations actually bid on by each bidder and associated bid costs.

NOTE: If a potential supplier does not choose to bid at a specific level, do not include the level/cost card for that level in this set of cards.

Completely detailed card and parameter descriptions for program two are given on pages 16 through 23.

A typical input data set is shown in Figure 3-1. Each line represents an 80-column punched card for input.

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SAMPLE PROBLEM INPUT DATA

The sample input below is explained in the card and parameter descriptions on the pages which follow.

```
SAMPLE MULT BID #2
  3   5   5   0   0   1
                0
               25
               50
               75
              100
                0
               25
               50
               75
              100
  3   4
                0           0        200
                0          25        650
                0          50       1000
                0          75       1250
               25           0        650
               25          25       1100
               25          50       1450
               25          75       1700
               50           0       1000
               50          25       1450
               50          50       1800
               50          75       2050
  2   3
                0           0          0
                0          25        400
                0          50        900
               25           0        400
               25          25        800
               25          50       1300
  3   3
                0           0          0
                0          25        300
                0          50        600
               25           0        300
               25          25        600
               25          50        900
               50           0        600
               50          25        900
               50          50       1200
```

FIGURE 3-1

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STUDY TITLE

CARD 1

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	Title	20	5A4	1-20	Title for output heading.

BASIC PARAMETERS

CARD 2

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	NSUP	3	I3	1-3	Total number of bidders.
B	NLEV1	3	I3	4-6	Total number of bid levels for period or item 1 (including the zero bid level).
C	NLEV2	3	I3	7-9	Total number of bid levels for period or item 2 (including the zero bid level).
D	ITYPE	3	I3	10-12	Option Indicator; if zero, multiple periods. If one, multiple items.
E	NTEST	3	I3	13-15	Test printout option; if zero, no special test output will be printed.
F	ITEST	3	I3	16-18	Option Indicator. If zero, optimal solution for maximum requirement level will be printed. If not zero, optimal solutions will be printed for each feasible combination of fractions of the maximum bid levels.

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BID LEVELS TO BE CONSIDERED IN PERIOD ONE

CARD 3

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP1(1)	10	F10.0	1-10	Bid level 1 for period 1 (always = zero).

CARD 4

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP1(2)	10	F10.0	1-10	Bid level 2 for period 1.

. . .

CARD NLEV1+2

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP1(NLEV1)	10	F10.0	1-10	Maximum bid level for period 1 (always = 100%)

BID LEVELS TO BE CONSIDERED IN PERIOD TWO

CARD NLEV1+3

	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 ... 80
	A

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP2(1)	10	F10.0	1-10	Bid level 1 for period 2 (always = zero).

CARD NLEV1+4

	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 ... 80
	A

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP2(2)	10	F10.0	1-10	Bid level 2 for period 2.

. . .

CARD NLEV1+NLEV2+2

	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 ... 80
	A

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP2(NLEV2)	10	F10.0	1-10	Maximum bid level for period 2 (always = 100%).

BIDS FOR FIRST BIDDER

CARD NLEV1+NLEV2+3

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	LEV1(1)	3	I3	1-3	Number of bid levels actually considered by Bidder 1 in period 1 (including the zero bid level).
B	LEV2(1)	3	I3	4-6	Number of bid levels actually considered by Bidder 1 in period 2 (including the zero bid level).

CARD NLEV1+NLEV2+4

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(1,1)	10	E10.3	1-10	1st bid level for 1st period for 1st Bidder.
B	PLEV2(1,1)	10	E10.3	11-20	1st bid level for 2nd period for 1st Bidder.
C	COST(1,1,1)	10	E10.3	21-30	Total bid cost for 1st Bidder at 1st bid level in period 1 and 1st bid level in period 2.

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BIDS FOR FIRST BIDDER (Cont)

CARD NLEV1+NLEV2+5

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(1,1)	10	E10.3	1-10	1st bid level for 1st period for 1st Bidder.
B	PLEV2(1,2)	10	E10.3	11-20	2nd bid level for 2nd period for 1st Bidder.
C	COST(1,1,2)	10	E10.3	21-30	Total bid cost for 1st Bidder at 1st bid level in period 1 and 2nd bid level in period 2.

. . .

CARD NLEV1+NLEV2+(LEV1(1)*LEV2(1))+2

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(1,LEV1(1))	10	E10.3	1-10	Last bid level for 1st period for 1st Bidder.
B	PLEV2(1,LEV2(1))	10	E10.3	11-20	Last bid level for 2nd period for 1st Bidder.
C	COST(1,LEV1(1),LEV2(1))	10	E10.3	21-30	Total bid cost for 1st Bidder at last bid level in period 1 and last bid level in period 2.

BIDS FOR SECOND BIDDER

CARD NLEV1+NLEV2+(LEV1(1)*LEV2(1))+3

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	LEV1(2)	3	I3	1-3	Number of bid levels actually considered by Bidder 2 in period 1 (including the zero bid level).
B.	LEV2(2)	3	I3	4-6	Number of bid levels actually considered by Bidder 2 in period 2 (including the zero bid level).

CARD NLEV1+NLEV2+(LEV1(1)*LEV2(1))+4

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(2,1)	10	E10.3	1-10	1st bid level for 1st period for 2nd Bidder.
B	PLEV2(2,1)	10	E10.3	11-20	1st bid level for 2nd period for 2nd Bidder.
C	COST(2,1,1)	10	E10.3	21-30	Total bid cost for 2nd Bidder at 1st bid level in period 1 and 1st bid level in period 2.

BIDS FOR SECOND BIDDER (Cont)

CARD NLEV1+NLEV2+(LEV1(1)*LEV2(1))+5

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(2,1)	10	E10.3	1-10	1st bid level for 1st period for 2nd Bidder.
B	PLEV2(2,2)	10	E10.3	11-20	2nd bid level for 2nd period for 2nd Bidder.
C	COST(2,1,2)	10	E10.3	21-30	Total bid cost for 2nd Bidder at 1st bid level in period 1 and 2nd bid level in period 2.

CARD NLEV1+NLEV2+(LEV1(1)*LEV2(1))+(LEV1(2)*LEV2(2))+2

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(2,LEV1(2))	10	E10.3	1-10	Last bid level for 1st period for 2nd Bidder.
B	PLEV2(2,LEV2(2))	10	E10.3	11-20	Last bid level for 2nd period for 2nd Bidder.
C	COST(2,LEV1(2),LEV2(2))	10	E10.3	21-30	Total bid cost for 2nd Bidder at last bid level in period 1 and last bid level in period 2.

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LAST BID FOR LAST BIDDER

CARD   NLEV1+NLEV2+(LEV1(1)*LEV2(1))+(LEV1(2)+LEV2(2))+...+(LEV1(NSUP)*LEV2(NSUP))+2

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(NSUP,LEV1(NSUP))	10	E10.3	1-10	Last bid level for 1st period for last Bidder.
B	PLEV2(NSUP,LEV2(NSUP))	10	E10.3	11-20	Last bid level for 2nd period for last Bidder.
C	COST (NSUP,LEV1(NSUP), LEV2(NSUP))	10	E10.3	21-30	Total bid cost for last Bidder at last bid level in period 1 and last bid level in period 2.

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2. OUTPUT.

The printed output for program two of the model consists of several pages of results. The number of pages depends on the total number of bidders and bid levels as well as the value of the option indicator which specifies whether the least cost solution for the maximum requirement in both periods is to be printed or if least cost solutions are to be printed for all feasible combinations of fractions of the maximum requirements. The actual output consists of a printout of the permissible bid levels for each period, the data that were entered, and the least cost solution(s).

A typical printout for program two is shown in Figures 3-2 through 3-5. This is the printout associated with the input data shown in Figure 3-1. The printout is broken down into sections which are annotated with numbers in hexagons. An explanation of each section follows:

SECTION NUMBER	EXPLANATION
⟨1⟩	Recapitulation of input data. For explanation please refer back to the description of input data.
⟨2⟩	These are the solutions for less than the total requirement level. A least cost solution is printed for each feasible fraction of the total requirement, which is the maximal bid level.
⟨3⟩	This is the least cost solution for the total requirement. In the example, at the 100 percent level for each period, the least cost solution is bidder 1 at 50 percent for period 1 and 75 percent for period 2, bidder 2 at 0 percent for each period, and bidder 3 at 50 percent for period 1 and 25 percent for period 2.

SAMPLE MULT BID #2

3 BIDDERS
5 BID LEVELS FOR FIRST PERIOD
5 BID LEVELS FOR SECOND PERIOD

BID LEVELS FOR FIRST PERIOD
         0.
        25.
        50.
        75.
       100.

BID LEVELS FOR SECOND PERIOD
         0.
        25.
        50.
        75.
       100.

BIDS

		PERIOD 1	PERIOD 2	TOTAL COST
BIDDER	1	0.	0.	200.
BIDDER	1	0.	25.	650.
BIDDER	1	0.	50.	1000.
BIDDER	1	0.	75.	1250.
BIDDER	1	25.	0.	650.
BIDDER	1	25.	25.	1100.
BIDDER	1	25.	50.	1450.
BIDDER	1	25.	75.	1700.
BIDDER	1	50.	0.	1000.
BIDDER	1	50.	25.	1450.
BIDDER	1	50.	50.	1800.
BIDDER	1	50.	75.	2050.

		PERIOD 1	PERIOD 2	TOTAL COST
BIDDER	2	0.	0.	0.
BIDDER	2	0.	25.	400.
BIDDER	2	0.	50.	900.
BIDDER	2	25.	0.	400.
BIDDER	2	25.	25.	800.
BIDDER	2	25.	50.	1300.

FIGURE 3-2

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```
                    PERIOD 1 PERIOD 2 TOTAL COST

       BIDDER  3         0.         0.         C.

       BIDDER  3         0.        25.       300.

       BIDDER  3         0.        50.       600.

       BIDDER  3        25.         0.       300.

       BIDDER  3        25.        25.       600.

       BIDDER  3        25.        50.       900.

       BIDDER  3        50.         0.       600.

       BIDDER  3        50.        25.       900.

       BIDDER  3        50.        50.      1200.
```


OPTIMAL SOLUTIONS

```
   REQUIREMENT LEVEL1       0. REQUIREMENT LEVEL2        0. MINIMUM COST      200.
              PERIOD 1                      PERIOD 2
 BIDDER  1         0.                          0.
 BIDDER  2         0.                          0.
 BIDDER  3         0.                          0.

   REQUIREMENT LEVEL1       0. REQUIREMENT LEVEL2       25. MINIMUM COST      500.
              PERIOD 1                      PERIOD 2
 BIDDER  1         0.                          0.
 BIDDER  2         0.                          0.
 BIDDER  3         0.                         25.

   REQUIREMENT LEVEL1       0. REQUIREMENT LEVEL2       50. MINIMUM COST      800.
              PERIOD 1                      PERIOD 2
 BIDDER  1         0.                          0.
 BIDDER  2         0.                          0.
 BIDDER  3         0.                         50.

   REQUIREMENT LEVEL1       0. REQUIREMENT LEVEL2       75. MINIMUM COST     1200.
              PERIOD 1                      PERIOD 2
 BIDDER  1         0.                          0.
 BIDDER  2         0.                         25.
 BIDDER  3         0.                         50.

   REQUIREMENT LEVEL1       0. REQUIREMENT LEVEL2      100. MINIMUM COST     1550.
              PERIOD 1                      PERIOD 2
 BIDDER  1         0.                         75.
 BIDDER  2         0.                          0.
 BIDDER  3         0.                         25.

   REQUIREMENT LEVEL1      25. REQUIREMENT LEVEL2        0. MINIMUM COST      500.
              PERIOD 1                      PERIOD 2
 BIDDER  1         0.                          0.
 BIDDER  2         0.                          0.
 BIDDER  3        25.                          0.

   REQUIREMENT LEVEL1      25. REQUIREMENT LEVEL2       25. MINIMUM COST      800.
              PERIOD 1                      PERIOD 2
 BIDDER  1         0.                          C.
 BIDDER  2         0.                          0.
 BIDDER  3        25.                         25.

   REQUIREMENT LEVEL1      25. REQUIREMENT LEVEL2       50. MINIMUM COST     1100.
              PERIOD 1                      PERIOD 2
 BIDDER  1         0.                          C.
 BIDDER  2         0.                          0.
 BIDDER  3        25.                         50.
```

FIGURE 3-3

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```
REQUIREMENT LEVEL1      25. REQUIREMENT LEVEL2      75. MINIMUM COST    1500.
              PERIOD 1                 PERIOD 2
BIDDER   1        0.                        0.
BIDDER   2        0.                       25.
BIDDER   3       25.                       50.

REQUIREMENT LEVEL1      25. REQUIREMENT LEVEL2     100. MINIMUM COST    1850.
              PERIOD 1                 PERIOD 2
BIDDER   1        0.                       75.
BIDDER   2        0.                        0.
BIDDER   3       25.                       25.

REQUIREMENT LEVEL1      50. REQUIREMENT LEVEL2       0. MINIMUM COST     800.
              PERIOD 1                 PERIOD 2
BIDDER   1        0.                        0.
BIDDER   2        0.                        0.
BIDDER   3       50.                        0.

REQUIREMENT LEVEL1      50. REQUIREMENT LEVEL2      25. MINIMUM COST    1100.
              PERIOD 1                 PERIOD 2
BIDDER   1        0.                        0.
BIDDER   2        0.                        0.
BIDDER   3       50.                       25.

REQUIREMENT LEVEL1      50. REQUIREMENT LEVEL2      50. MINIMUM COST    1400.
              PERIOD 1                 PERIOD 2
BIDDER   1        0.                        0.
BIDDER   2        0.                        0.
BIDDER   3       50.                       50.

REQUIREMENT LEVEL1      50. REQUIREMENT LEVEL2      75. MINIMUM COST    1800.
              PERIOD 1                 PERIOD 2
BIDDER   1        0.                        0.
BIDDER   2        0.                       25.
BIDDER   3       50.                       50.

REQUIREMENT LEVEL1      50. REQUIREMENT LEVEL2     100. MINIMUM COST    2150.
              PERIOD 1                 PERIOD 2
BIDDER   1        0.                       75.
BIDDER   2        0.                        0.
BIDDER   3       50.                       25.

REQUIREMENT LEVEL1      75. REQUIREMENT LEVEL2       0. MINIMUM COST    1200.
              PERIOD 1                 PERIOD 2
BIDDER   1        0.                        0.
BIDDER   2       25.                        0.
BIDDER   3       50.                        0.

REQUIREMENT LEVEL1      75. REQUIREMENT LEVEL2      25. MINIMUM COST    1500.
              PERIOD 1                 PERIOD 2
BIDDER   1        0.                        0.
BIDDER   2       25.                        0.
BIDDER   3       50.                       25.
```

FIGURE 3-4

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```
REQUIREMENT LEVEL1        75. REQUIREMENT LEVEL2     50. MINIMUM COST     1800.
               PERIOD 1                  PERIOD 2
BIDDER   1        0.                        0.
BIDDER   2       25.                        0.
BIDDER   3       50.                       50.

REQUIREMENT LEVEL1        75. REQUIREMENT LEVEL2     75. MINIMUM COST     2200.
               PERIOD 1                  PERIOD 2
BIDDER   1        0.                        0.
BIDDER   2       25.                       25.
BIDDER   3       50.                       5C.

REQUIREMENT LEVEL1        75. REQUIREMENT LEVEL2    100. MINIMUM COST     2550.
               PERIOD 1                  PERIOD 2
BIDDER   1        0.                       75.
BIDDER   2       25.                        0.
BIDDER   3       50                        25.

REQUIREMENT LEVEL1       100. REQUIREMENT LEVEL2      0. MINIMUM COST     1600.
               PERIOD 1                  PERIOD 2
BIDDER   1       50.                        0.
BIDDER   2        0.                        0.
BIDDER   3       50.                        0.

REQUIREMENT LEVEL1       100. REQUIREMENT LEVEL2     25. MINIMUM COST     1900.
               PERIOD 1                  PERIOD 2
BIDDER   1       50.                        0.
BIDDER   2        0.                        0.
BIDDER   3       50.                       25.

REQUIREMENT LEVEL1       100. REQUIREMENT LEVEL2     50. MINIMUM COST     2200.
               PERIOD 1                  PERIOD 2
BIDDER   1       50.                        0.
BIDDER   2        0.                        0..
BIDDER   3       50.                       50.

REQUIREMENT LEVEL1       100. REQUIREMENT LEVEL2     75. MINIMUM COST     2600.
               PERIOD 1                  PERIOD 2
BIDDER   1       50.                        0.
BIDDER   2        0.                       25.
BIDDER   3       50.                       50.

REQUIREMENT LEVEL1       100. REQUIREMENT LEVEL2    100. MINIMUM COST     2950.
               PERIOD 1                  PERIOD 2
BIDDER   1       50.                       75.
BIDDER   2        0.                        0.
BIDDER   3       50.                       25.
```

〈3〉

FIGURE 3-5

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SECTION IV

PROGRAM THREE

THREE BUY PERIODS OR THREE ITEMS

1. **INPUT**.

   The following input data are required to run program three:

   a. Title (used for printout heading).

   b. Total number of bidders.

   c(1) Total number of bid levels for period one or for item one (including the zero bid level).

   (2) Total number of bid levels for period two or for item two (including the zero bid level).

   (3) Total number of bid levels for period three or for item three (including the zero bid level).

   d. Option Indicator. If zero, least cost solution for maximum requirement level will be printed. If not zero, least cost solutions will be printed for each feasible combination of fractions of the maximum bid levels.

   e(1) Possible bid levels (in equal increments) from zero to maximum level (100%) for period one or item one.

   (2) Possible bid levels (in equal increments) from zero to maximum level (100%) for period three or item three.

   f. Number of bid levels actually bid on by each bidder for each period, item or base protection.

   g. Bid level combinations actually bid on by each bidder and associated bid costs.

NOTE: If a potential supplier does not choose to bid at a specific level, do not include the level/cost card for that level in this set of cards.

   Completely detailed card and parameter descriptions for program three are given on pages 31 through 38.

   A typical input data set is shown in Figure 4-1. Each line represents an 80-column punched card for input.

SAMPLE PROBLEM INPUT DATA

The sample input below is explained in the card and parameter descriptions
on the following pages.

```
SAMPLE MULT BID #3
 4   3   3   3   1   0   1   0
             0
            50
           100
             0
            50
           100
             0
            50
           100
 2   2   2
             0          0          0        200
             0          0         50       1100
             0         50          0       1100
             0         50         50       1900
            50          0          0       1100
            50          0         50       2000
            50         50          0       2000
            50         50         50       2700
 2   2   2
             0          0          0          0
             0          0         50        400
             0         50          0        450
             0         50         50        850
            50          0          0        500
            50          0         50        900
            50         50          0        950
            50         50         50       1350
 2   2   2
             0          0          0          0
             0          0         50        900
             0         50          0        900
             0         50         50       1800
            50          0          0        900
            50          0         50       1800
            50         50          0       1800
            50         50         50       2700
 2   2   2
             0          0          0          0
             0          0         50       1000
             0         50          0       1000
             0         50         50       2000
            50          0          0       1000
            50          0         50       2000
            50         50          0       2000
            50         50         50       3000
```

FIGURE 4-1

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STUDY TITLE

CARD 1

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	Title	20	5A4	1-20	Title for output heading.

BASIC PARAMETERS

CARD 2

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	NSUP	3	I3	1-3	Total number of bidders.
B	NLEV1	3	I3	4-6	Total number of bid levels for period or item 1 (including the zero bid level).
C	NLEV2	3	I3	7-9	Total number of bid levels for period or item 2 (including the zero bid level).
D	NNLEV3	3	I3	10-12	Total number of bid levels for period or item 3 (including the zero bid level).
E	ITYPE	3	I3	13-15	Option Indicator; if zero, multiple-periods. If one, multiple items.
F	NTEST	3	I3	16-18	Test printout option; if zero, no special test output will be printed.
G	ITES1	3	I3	19-21	Option Indicator. If zero, optimal solution for maximum requirement level will be printed. If not zero, optimal solutions will be printed for each feasible combination of fractions of the maximum bid levels.
H	ITES2	3	I3	22-24	Always set this variable to zero.

BID LEVELS TO BE CONSIDERED IN PERIOD ONE

CARD 3

ID		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
A		

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP1(1)	10	F10.0	1-10	Bid level 1 for period 1 (always = zero).

CARD 4

ID		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
A		

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP1(2)	10	F10.0	1-10	Bid level 2 for period 1.

. . .

CARD NLEV1+2

ID		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
A		

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP1(NLEV1)	10	F10.0	1-10	Maximum bid level for period 1 (always - 100%)

BID LEVELS TO BE CONSIDERED IN PERIODS TWO THROUGH THREE

CARD NLEV1+3

| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 |
| A |

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP2(1)	10	F10.0	1-10	Bid level 1 for period 2 (always = zero)

CARD NLEV1+4

| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 |
| A |

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP2(2)	10	F10.0	1-10	Bid level 2 for period 2.

. . .

CARD NLEV1+NLEV2+NLEV3+2

| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 |
| A |

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	SURP3(NLEV3)	10	F10.0	1-10	Maximum bid level for period 3 (always = 100%).

BIDS FOR SECOND BIDDER

CARD   NLEV1+NLEV2+NLEV3+(LEV1(1)*LEV2(1)*LEV3(1))+3

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	LEV1(2)	3	I3	1-3	Number of bid levels actually considered by Bidder 2 in period 1 (including the zero bid level).
B	LEV2(2)	3	I3	4-6	Number of bid levels actually considered by Bidder 2 in period 2 (including the zero bid level).
C	LEV3(2)	3	I3	7-9	Number of bid levels actually considered by Bidder 2 in period 3 (including the zero bid level).

CARD   NLEV1+NLEV2+NLEV3+(LEV1(1)*LEV2(1)*LEV3(1))+4

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(2,1)	10	E10.3	1-10	1st bid level for 1st period for 2nd Bidder.
B	PLEV2(2,1)	10	E10.3	11-20	1st bid level for 2nd period for 2nd Bidder.
C	PLEV3(2,1)	10	E10.3	21-30	1st bid level for 3rd period for 2nd Bidder.
D	COST(2,1,1,1)	10	E10.3	31-40	Total bid cost for 2nd Bidder at 1st bid level in period 1, 1st bid level in period 2, and 1st bid level in period 3.

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BIDS FOR SECOND BIDDER (Cont)

CARD NLEV1+NLEV2+NLEV3+(LEV1(1)*LEV2(1)*LEV3(1))+5

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(2,1)	10	E10.3	1-10	1st bid level for 1st period for 2nd Bidder.
B	PLEV2(2,1)	10	E10.3	11-20	1st bid level for 2nd period for 2nd Bidder.
C	PLEV3(2,2)	10	E10.3	21-30	2nd bid level for 3rd period for 2nd Bidder.
D	COST(2,1,1,2)	10	E10.3	31-40	Total bid cost for 2nd Bidder at 1st bid level in period 1, 1st bid level in period 2, and 2nd bid level in period 3.

· · ·

CARD NLEV1+NLEV2+NLEV3+(LEV1(1)*LEV2(1)*LEV3(1))+(LEV1(2)*LEV2(2)*LEV3(2))+2

ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(2,LEV1(2))	10	E10.3	1-10	Last bid level for 1st period for 2nd Bidder.
B	PLEV2(2,LEV2(2))	10	E10.3	11-20	Last bid level for 2nd period for 2nd Bidder.
C	PLEV3(2,LEV3(2))	10	E10.3	21-30	Last bid level for 3rd period for 2nd Bidder.
D	COST(2,LEV1(2), LEV2(2),LEV3(2))	10	E10.3	31-40	Total bid cost for 2nd Bidder at last bid level in period 1, last bid level in period 2, and last bid level in period 3.

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LAST BID FOR LAST BIDDER

CARD NLEV1+NLEV2+NLEV3+(LEV1(1)*LEV2(1)*LEV3(1))+(LEV1(2)*LEV2(2)*LEV3(2))+(LEV1(3)*LEV2(3)*LEV3(3))+2

	A	B	C	D	
ID	PARAMETER NAME	LENGTH	FORMAT	COLUMNS	DESCRIPTION
A	PLEV1(NSUP,LEV1(NSUP))	10	E10.3	1-10	Last bid level for 1st period for last Bidder.
B	PLEV2(NSUP,LEV2(NSUP))	10	E10.3	11-20	Last bid level for 2nd period for last Bidder.
C	PLEV3(NSUP,LEV3(NSUP))	10	E10.3	21-30	Last bid level for 3rd period for last Bidder.
D	COST(NSUP,LEV1(NSUP), LEV2(NSUP),LEV3(NSUP))	10	E10.3	31-40	Total bid cost for last Bidder at last bid level in period 1, last bid level in period 2, and last bid level in period 3.

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2. OUTPUT.

The printed output for program three of the model consists of several pages of results. The number of pages depends on the total number of bidders and bid levels as well as the value of the option indicator which specifies whether the least cost solution for the maximum requirement in all periods is to be printed or if optimal solutions are to be printed for all feasible combinations of fractions of the maximum requirements. The actual output consists of a printout of the permissible bid levels for each period, the data that were entered, the least cost solution(s), and next best solution(s).

A typical printout for program three is shown in Figures 4-2 through 4-8. This is the printout associated with the input data shown in Figure 4-1. The printout is broken down into sections which are annotated with numbers in hexagons. An explanation of each section follows:

SECTION NUMBER	EXPLANATION
⟨1⟩	Recapitulation of input data. For explanation please refer back to the description of input data.
⟨2⟩	These are the solutions for less than the total requirement level. A least cost solution is printed for each feasible fraction of the total requirement.
⟨3⟩	This is the least cost solution for the total requirement. In the example, at the 100 percent level for each period, the least cost solution is bidder 1 and bidder 2 each at 50 percent for each item, and bidders 3 and 4 at 0 percent for each item.
⟨4⟩	Next best solutions are presented for use in the event that the least cost solution cannot be used.

⟨1⟩   SAMPLE MULT BID #3

4 BIDDERS

3 BID LEVELS FOR FIRST ITEM
3 BID LEVELS FOR SECOND ITEM
3 BID LEVELS FOR THIRD ITEM

BIDS

		ITEM 1	ITEM 2	ITEM 3	TOTAL COST
BIDDER	1	0.	0.	0.	200.
BIDDER	1	0.	0.	5C.	1100.
BIDDER	1	0.	50.	C.	1100.
BIDDER	1	0.	50.	50.	1900.
BIDDER	1	50.	0.	0.	1100.
BIDDER	1	50.	0.	5C.	2000.
BIDDER	1	50.	50.	C.	2000.
BIDDER	1	50.	50.	5C.	2700.
		ITEM 1	ITEM 2	ITEM 3	TOTAL COST
BIDDER	2	0.	0.	0.	0.
BIDDER	2	0.	0.	5C.	400.
BIDDER	2	0.	50.	C.	450.
BIDDER	2	0.	50.	50.	850.
BIDDER	2	50.	0.	0.	500.
BIDDER	2	50.	0.	5C.	900.
BIDDER	2	50.	50.	C.	950.
BIDDER	2	50.	50.	50.	1350.

FIGURE 4-2

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		ITEM 1	ITEM 2	ITEM 3	TOTAL COST
BIDDER	3	0.	0.	0.	0.
BIDDER	3	0.	0.	50.	900.
BIDDER	3	0.	50.	0.	900.
BIDDER	3	0.	50.	50.	1800.
BIDDER	3	50.	0.	0.	900.
BIDDER	3	50.	0.	50.	1800.
BIDDER	3	50.	50.	0.	1800.
BIDDER	3	50.	50.	50.	2700.
		ITEM 1	ITEM 2	ITEM 3	TOTAL COST
BIDDER	4	0.	0.	C.	0.
BIDDER	4	0.	0.	50.	1000.
BIDDER	4	0.	50.	0.	1000.
BIDDER	4	0.	50.	50.	2000.
BIDDER	4	50.	0.	C.	1000.
BIDDER	4	50.	0.	50.	2000.
BIDDER	4	50.	50.	0.	2000.
BIDDER	4	50.	50.	50.	3000.

FIGURE 4-3

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OPTIMAL SOLUTIONS

REQUIREMENT LEVEL1 0. REQUIREMENT LEVEL2 0. REQUIREMENT LEVEL3 0. MINIMUM COST 200.
       ITEM 1   ITEM 2   ITEM 3
BIDDER 1 0.   0.   0.
BIDDER 2 0.   0.   0.
BIDDER 3 0.   0.   0.
BIDDER 4 0.   0.   0.

REQUIREMENT LEVEL1 0. REQUIREMENT LEVEL2 0. REQUIREMENT LEVEL3 0. MINIMUM COST 600.
       ITEM 1   ITEM 2   ITEM 3
BIDDER 1 0.   0.   0.
BIDDER 2 0.   0.   50.
BIDDER 3 0.   0.   0.
BIDDER 4 0.   0.   0.

REQUIREMENT LEVEL1 0. REQUIREMENT LEVEL2 0. REQUIREMENT LEVEL3 0. MINIMUM COST 1500.
       ITEM 1   ITEM 2   ITEM 3
BIDDER 1 0.   0.   50.
BIDDER 2 0.   0.   50.
BIDDER 3 0.   0.   0.
BIDDER 4 0.   0.   0.

REQUIREMENT LEVEL1 0. REQUIREMENT LEVEL2 0. REQUIREMENT LEVEL3 50. MINIMUM COST 650.
       ITEM 1   ITEM 2   ITEM 3
BIDDER 1 0.   0.   0.
BIDDER 2 0.   50.   0.
BIDDER 3 0.   0.   0.
BIDDER 4 0.   0.   0.

REQUIREMENT LEVEL1 0. REQUIREMENT LEVEL2 0. REQUIREMENT LEVEL3 50. MINIMUM COST 1050.
       ITEM 1   ITEM 2   ITEM 3
BIDDER 1 0.   0.   0.
BIDDER 2 0.   50.   50.
BIDDER 3 0.   0.   0.
BIDDER 4 0.   0.   0.

REQUIREMENT LEVEL1 0. REQUIREMENT LEVEL2 0. REQUIREMENT LEVEL3 50. MINIMUM COST 1950.
       ITEM 1   ITEM 2   ITEM 3
BIDDER 1 0.   0.   50.
BIDDER 2 0.   50.   50.
BIDDER 3 0.   0.   0.
BIDDER 4 0.   0.   0.

REQUIREMENT LEVEL1 0. REQUIREMENT LEVEL2 0. REQUIREMENT LEVEL3 100. MINIMUM COST 1550.
       ITEM 1   ITEM 2   ITEM 3
BIDDER 1 0.   50.   0.
BIDDER 2 0.   50.   0.
BIDDER 3 0.   0.   0.
BIDDER 4 0.   0.   0.

⬡ 2

FIGURE 4-4

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REQUIREMENT LEVEL1 = 0.   REQUIREMENT LEVEL2 = 100.   REQUIREMENT LEVEL3 = 50.   MINIMUM COST 1950.

	ITEM 1	ITEM 2	ITEM 3
BIDDER 1	0.	50.	0.
BIDDER 2	0.	50.	50.
BIDDER 3	0.	0.	0.
BIDDER 4	0.	0.	0.

REQUIREMENT LEVEL1 = 0.   REQUIREMENT LEVEL2 = 100.   REQUIREMENT LEVEL3 = 100.   MINIMUM COST 2750.

	ITEM 1	ITEM 2	ITEM 3
BIDDER 1	0.	50.	50.
BIDDER 2	50.	50.	50.
BIDDER 3	0.	0.	0.
BIDDER 4	0.	0.	0.

REQUIREMENT LEVEL1 = 50.   REQUIREMENT LEVEL2 = 0.   REQUIREMENT LEVEL3 = 0.   MINIMUM COST 700.

	ITEM 1	ITEM 2	ITEM 3
BIDDER 1	0.	0.	0.
BIDDER 2	50.	0.	0.
BIDDER 3	0.	0.	0.
BIDDER 4	0.	0.	0.

REQUIREMENT LEVEL1 = 50.   REQUIREMENT LEVEL2 = 0.   REQUIREMENT LEVEL3 = 50.   MINIMUM COST 1100.

	ITEM 1	ITEM 2	ITEM 3
BIDDER 1	0.	0.	0.
BIDDER 2	50.	0.	50.
BIDDER 3	0.	0.	0.
BIDDER 4	0.	0.	0.

REQUIREMENT LEVEL1 = 50.   REQUIREMENT LEVEL2 = 0.   REQUIREMENT LEVEL3 = 100.   MINIMUM COST 2000.

	ITEM 1	ITEM 2	ITEM 3
BIDDER 1	0.	0.	50.
BIDDER 2	50.	0.	50.
BIDDER 3	0.	0.	0.
BIDDER 4	0.	0.	0.

REQUIREMENT LEVEL1 = 50.   REQUIREMENT LEVEL2 = 50.   REQUIREMENT LEVEL3 = 0.   MINIMUM COST 1150.

	ITEM 1	ITEM 2	ITEM 3
BIDDER 1	0.	0.	0.
BIDDER 2	50.	50.	0.
BIDDER 3	0.	0.	0.
BIDDER 4	0.	0.	0.

REQUIREMENT LEVEL1 = 50.   REQUIREMENT LEVEL2 = 50.   REQUIREMENT LEVEL3 = 50.   MINIMUM COST 1550.

	ITEM 1	ITEM 2	ITEM 3
BIDDER 1	0.	0.	0.
BIDDER 2	50.	50.	50.
BIDDER 3	0.	0.	0.
BIDDER 4	0.	0.	0.

FIGURE 4-5

```
REQUIREMENT LEVEL1   50.  REQUIREMENT LEVEL2   50.  REQUIREMENT LEVEL3   50.  100. MINIMUM COST   2450.
              ITEM 1                ITEM 2                ITEM 3
BIDDER  1       0.                   0.                   50.
BIDDER  2      50.                  50.                   50.
BIDDER  3       0.                   0.                    0.
BIDDER  4       0.                   0.                    0.

REQUIREMENT LEVEL1   50.  REQUIREMENT LEVEL2   50.  REQUIREMENT LEVEL3  100.    0. MINIMUM COST   2050.
              ITEM 1                ITEM 2                ITEM 3
BIDDER  1       0.                  50.                    0.
BIDDER  2      50.                  50.                    0.
BIDDER  3       0.                   0.                    0.
BIDDER  4       0.                   0.                    0.

REQUIREMENT LEVEL1   50.  REQUIREMENT LEVEL2   50.  REQUIREMENT LEVEL3  100.   50. MINIMUM COST   2450.
              ITEM 1                ITEM 2                ITEM 3
BIDDER  1       0.                  50.                    0.
BIDDER  2      50.                  50.                   50.
BIDDER  3       0.                   0.                    0.
BIDDER  4       0.                   0.                    0.

REQUIREMENT LEVEL1   50.  REQUIREMENT LEVEL2  100.  REQUIREMENT LEVEL3  100.  100. MINIMUM COST   3250.
              ITEM 1                ITEM 2                ITEM 3
BIDDER  1       0.                  50.                   50.
BIDDER  2      50.                  50.                   50.
BIDDER  3       0.                   0.                    0.
BIDDER  4       0.                   0.                    0.

REQUIREMENT LEVEL1  100.  REQUIREMENT LEVEL2  100.  REQUIREMENT LEVEL3    0.    0. MINIMUM COST   1600.
              ITEM 1                ITEM 2                ITEM 3
BIDDER  1      50.                   0.                    0.
BIDDER  2      50.                   0.                    0.
BIDDER  3       0.                   0.                    0.
BIDDER  4       0.                   0.                    0.

REQUIREMENT LEVEL1  100.  REQUIREMENT LEVEL2  100.  REQUIREMENT LEVEL3    0.   50. MINIMUM COST   2000.
              ITEM 1                ITEM 2                ITEM 3
BIDDER  1      50.                   0.                    0.
BIDDER  2      50.                   0.                   50.
BIDDER  3       0.                   0.                    0.
BIDDER  4       0.                   0.                    0.

REQUIREMENT LEVEL1  100.  REQUIREMENT LEVEL2  100.  REQUIREMENT LEVEL3    0.  100. MINIMUM COST   2900.
              ITEM 1                ITEM 2                ITEM 3
BIDDER  1      50.                   0.                   50.
BIDDER  2      50.                   0.                   50.
BIDDER  3       0.                   0.                    0.
BIDDER  4       0.                   0.                    0.
```

FIGURE 4-6

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```
REQUIREMENT LEVEL1      100. REQUIREMENT LEVEL2      50. REQUIREMENT LEVEL3       0. MINIMUM COST     2050.
            ITEM 1                      ITEM 2                     ITEM 3
BIDDER  1    50.                         0.                         0.
BIDDER  2    50.                        50.                         0.
BIDDER  3     0.                         0.                         0.
BIDDER  4     0.                         0.                         0.

REQUIREMENT LEVEL1      100. REQUIREMENT LEVEL2      50. REQUIREMENT LEVEL3      50. MINIMUM COST     2450.
            ITEM 1                      ITEM 2                     ITEM 3
BIDDER  1    50.                         0.                         0.
BIDDER  2    50.                        50.                        50.
BIDDER  3     0.                         0.                         0.
BIDDER  4     0.                         0.                         0.

REQUIREMENT LEVEL1      100. REQUIREMENT LEVEL2      50. REQUIREMENT LEVEL3     100. MINIMUM COST     3350.
            ITEM 1                      ITEM 2                     ITEM 3
BIDDER  1    50.                         0.                        50.
BIDDER  2    50.                        50.                        50.
BIDDER  3     0.                         0.                         0.
BIDDER  4     0.                         0.                         0.

REQUIREMENT LEVEL1      100. REQUIREMENT LEVEL2     100. REQUIREMENT LEVEL3       0. MINIMUM COST     2950.
            ITEM 1                      ITEM 2                     ITEM 3
BIDDER  1    50.                        50.                         0.
BIDDER  2    50.                        50.                         0.
BIDDER  3     0.                         0.                         0.
BIDDER  4     0.                         0.                         0.

REQUIREMENT LEVEL1      100. REQUIREMENT LEVEL2     100. REQUIREMENT LEVEL3      50. MINIMUM COST     3350.
            ITEM 1                      ITEM 2                     ITEM 3
BIDDER  1    50.                        50.                         0.
BIDDER  2    50.                        50.                        50.
BIDDER  3     0.                         0.                         0.
BIDDER  4     0.                         0.                         0.

REQUIREMENT LEVEL1      100. REQUIREMENT LEVEL2     100. REQUIREMENT LEVEL3     100. MINIMUM COST     4050.
            ITEM 1                      ITEM 2                     ITEM 3
BIDDER  1    50.                        50.                        50.
BIDDER  2    50.                        50.                        50.
BIDDER  3     0.                         0.                         0.
BIDDER  4     0.                         0.                         0.
```

FIGURE 4-7

SUBOPT SOLN   1

	REQUIREMENT LEVEL1 100. ITEM 1	REQUIREMENT LEVEL2 100. ITEM 2	REQUIREMENT LEVEL3 100. ITEM 3	MINIMUM COST 4150.
BIDDER 1	0.	50.	50.	
BIDDER 2	50.	50.	50.	
BIDDER 3	50.	0.	0.	
BIDDER 4	0.	0.	0.	

SUBOPT SOLN   2

	REQUIREMENT LEVEL1 100. ITEM 1	REQUIREMENT LEVEL2 100. ITEM 2	REQUIREMENT LEVEL3 100. ITEM 3	MINIMUM COST 4450.
BIDDER 1	50.	50.	50.	
BIDDER 2	0.	50.	50.	
BIDDER 3	50.	0.	0.	
BIDDER 4	0.	0.	0.	

SUBOPT SOLN   3

	REQUIREMENT LEVEL1 100. ITEM 1	REQUIREMENT LEVEL2 100. ITEM 2	REQUIREMENT LEVEL3 100. ITEM 3	MINIMUM COST 4150.
BIDDER 1	0.	50.	50.	
BIDDER 2	50.	50.	50.	
BIDDER 3	50.	0.	0.	
BIDDER 4	0.	0.	0.	

SUBOPT SOLN   4

	REQUIREMENT LEVEL1 100. ITEM 1	REQUIREMENT LEVEL2 100. ITEM 2	REQUIREMENT LEVEL3 100. ITEM 3	MINIMUM COST 4250.
BIDDER 1	0.	50.	50.	
BIDDER 2	50.	50.	50.	
BIDDER 3	0.	0.	0.	
BIDDER 4	50.	0.	0.	

⬡ 4

FIGURE 4-8

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SECTION V

PROGRAM FOUR

ONE BUY PERIOD/ONE ITEM

LEAST COST SOLUTION FOR EACH POSSIBLE NUMBER OF SUPPLIERS

1. INPUT.

    The following input data are required to run program four:

    a. Title (used for printout heading).

    b. Total number of bidders.

    c. Total number of bid levels (including the zero bid level).

    d. Option Indicator. If zero, least cost solution for maximum require-
ment level will be printed. If not zero, least cost solutions will be
printed for each feasible fraction of the maximum requirement level.

    e. Possible bid levels (in equal increments) from zero to maximum
level (100%).

    f. Number of bid levels actually bid on by each bidder.

    g. Bid levels actually bid on by each bidder and associated bid costs.

NOTE: If a potential supplier does not choose to bid at a specific level, do
not include the level/cost card for that level in this set of cards.

    Completely detailed card and parameter descriptions for program four are
the same as for program one and are given on pages 7 through 10.

    A typical input data set for program four is shown in Figure 5-1. Each
line represents an 80-column punched card for input.

SAMPLE PROBLEM INPUT DATA

The sample input below is described in the card and parameter descriptions for program one. Please see pages 7 through 10.

```
SAMPLE MULT BID #4
  3   5   1
            0
           25
           50
           75
          100
  5
            0          100
           25          550
           50          900
           75         1150
          100         1350
  5
            0            0
           25         . 400
           50          900
           75         1300
          100         1700
  3
            0            0
           25          300
           50          600
```

FIGURE 5-1

2. OUTPUT.

   The printed output for program four of the model consists of one or more
pages of results. The number of pages depends on the total number of bidders
and bid levels, as well as the value of the option indicator which specifies
whether the least cost solution for the maximum requirement is to be printed
or if least cost solutions are to be printed for all feasible fractions of
the maximum requirement. The actual output consists of a printout of the
data that were entered, the least cost solution(s) and second best solution(s)
for each explicit possible number of bidders to be selected.

   A typical printout for program four is shown in Figures 5-2 through 5-5.
This is the printout associated with the input data shown in Figure 5-1. The
printout is broken down into sections which are annotated with numbers in
hexagons. An explanation of each section follows:

SECTION
NUMBER   EXPLANATION

⟨1⟩   Recapitulation of input data. For explanation please
           refer back to the description of input data.

⟨2⟩   These are the solutions for less than the total require-
           ment level. A least cost solution is printed for each
           feasible fraction of the total requirement, which is
           the maximal bid level.

⟨3⟩   This is the least cost solution for the total require-
           ment. In the example, at the 100 percent level, the
           least cost solution is bidder 1 at 25 percent, bidder
           2 at 25 percent, and bidder 3 at 50 percent.

⟨4⟩   Next best solutions are presented in the event that the
           least cost solution cannot be used.

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⟨1⟩

SAMPLE MULT BID #4

3 BIDDERS & 5 BID LEVELS

BIDS

BIDDER 1
BID LEVEL TOTAL COST
        0.   100.
       25.   550.
       50.   900.
       75.   1150.
      100.   1350.

BIDDER 2
BID LEVEL TOTAL COST
        0.   0.
       25.   400.
       50.   900.
       75.   1300.
      100.   1700.

BIDDER 3
BID LEVEL TOTAL COST
        0.   0.
       25.   300.
       50.   600.

⟨2⟩   OPTIMAL SOLUTICNS

        REQUIREMENT LEVEL   0. NO. BIDCERS   C
        OPTIMAL COST   100.
        BIDDER 1   0.
        BIDDER 2   0.
        BIDDER 3   0.

        REQUIREMENT LEVEL   0. NO. BIDCERS   1
        NO FEASIBLE SOLUTIONS

        REQUIREMENT LEVEL   0. NO. BIDCERS   2
        NO FEASIBLE SOLUTIONS

        REQUIREMENT LEVEL   0. NO. BIDCERS   3
        NO FEASIBLE SOLUTIONS

        REQUIREMENT LEVEL   25. NO. BIDCERS   0
        NO FEASIBLE SOLUTIONS

        REQUIREMENT LEVEL   25. NO. BIDCERS   1
        OPTIMAL COST   400.
        BIDDER 1   0.
        BIDDER 2   0.
        BIDDER 3   25.

        REQUIREMENT LEVEL   25. NO. BIDCERS   2
        NO FEASIBLE SOLUTICNS

        REQUIREMENT LEVEL   25. NO. BIDCERS   3
        NO FEASIBLE SOLUTIONS

FIGURE 5-2

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```
 REQUIREMENT LEVEL        50. NO. BIDDERS    0
 NO FEASIBLE SOLUTIONS

 REQUIREMENT LEVEL        50. NO. BIDDERS    1
 OPTIMAL COST      700.
 BIDDER  1          0.
 BIDDER  2          0.
 BIDDER  3         50.

 REQUIREMENT LEVEL        50. NO. BIDDERS    2
 OPTIMAL COST      800.
 BIDDER  1          0.
 BIDDER  2         25.
 BIDDER  3         25.

 REQUIREMENT LEVEL        50. NO. BIDDERS    3
 NO FEASIBLE SOLUTIONS

 REQUIREMENT LEVEL        75. NO. BIDDERS    C
 NO FEASIBLE SOLUTIONS

 REQUIREMENT LEVEL        75. NO. BIDDERS    1
 OPTIMAL COST     1150.
 BIDDER  1         75.
 BIDDER  2          0.
 BIDDER  3          0.

 REQUIREMENT LEVEL        75. NO. BIDDERS    2
 OPTIMAL COST     1100.
 BIDDER  1          0.
 BIDDER  2         25.
 BIDDER  3         50.

 REQUIREMENT LEVEL        75. NO. BIDDERS    3
 OPTIMAL COST     1250.
 BIDDER  1         25.
 BIDDER  2         25.
 BIDDER  3         25.

 REQUIREMENT LEVEL       100. NO. BIDDERS    C
 NO FEASIBLE SOLUTIONS

 REQUIREMENT LEVEL       100. NO. BIDDERS    1
 OPTIMAL COST     1350.
 BIDDER  1        100.
 BIDDER  2          0.
 BIDDER  3          0.

 REQUIREMENT LEVEL       100. NO. BIDDERS    2
 OPTIMAL COST     1450.
 BIDDER  1         75.
 BIDDER  2          0.
 BIDDER  3         25.

 REQUIREMENT LEVEL       100. NO. BIDDERS    3
 OPTIMAL COST     1550.
 BIDDER  1         25.
 BIDDER  2         25.
 BIDDER  3         50.
```

〈3〉

FIGURE 5-3

SECOND BEST SOLUTIONS

REQUIREMENT LEVEL   0. NO. BIDDERS   0
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL   0. NO. BIDDERS   1
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL   0. NO. BIDDERS   2
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL   0. NO. BIDDERS   3
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL   25. NO. BIDDERS   0
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL   25. NO. BIDDERS   1
SECOND BEST SOL.   500.
BIDDER 1   0.
BIDDER 2   25.
BIDDER 3   0.

REQUIREMENT LEVEL   25. NO. BIDDERS   2
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL   25. NO. BIDDERS   3
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL   50. NO. BIDDERS   0
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL   50. NO. BIDDERS   1
SECOND BEST SOL.   900.
BIDDER 1   50.
BIDDER 2   0.
BIDDER 3   0.

REQUIREMENT LEVEL   50. NO. BIDDERS   2
SECOND BEST SOL.   850.
BIDDER 1   25.
BIDDER 2   0.
BIDDER 3   25.

REQUIREMENT LEVEL   50. NO. BIDDERS   3
NO FEASIBLE SOLUTIONS

FIGURE 5-4

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```
REQUIREMENT LEVEL          75. NO. BIDDERS      C
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL          75. NO. BIDDERS      1
SECOND BEST SOL.        1400.
BIDDER   1               0.
BIDDER   2              75.
BIDDER   3               0.

REQUIREMENT LEVEL     ·    75. NO. BIDDERS      2
SECOND BEST SOL.       1150.
BIDDER   1              25.
BIDDER   2               0.
BIDDER   3              50.

REQUIREMENT LEVEL          75. NO. BIDDERS      3
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL         100. NO. BIDDERS      0
NO FEASIBLE SOLUTIONS

REQUIREMENT LEVEL         100. NO. BIDDERS      1
SECOND BEST SOL..      1800.
BIDDER   1               0.
BIDDER   2             100.
BIDDER   3               0.

REQUIREMENT LEVEL         100. NO. BIDDERS      2
SECOND BEST SOL.       1500.
BIDDER.  1              50.
BIDDER   2               0.
BIDDER   3              50.

REQUIREMENT LEVEL         100. NO. BIDDERS      3
SECOND BEST SOL.       1600.
BIDDER   1              50.
BIDDER   2              25.
BIDDER   3              25.
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FIGURE 5-5

APPENDIX

APPLICATION OF THE JCAP
MULTIPLE-BID EVALUATION
MODEL TO THE PROCUREMENT
OF AN ARTILLERY FUZE

This appendix describes an application by the Decision Models Directorate, JCAP, of the JCAP Multiple-Bid Evaluation Model to the procurement of an artillery fuze by the Army.

The objective of the application was to provide least cost solutions for selection of a combination of suppliers to provide the total production requirement over a specified single buy period. Additionally, Procurement personnel desired to obtain a solution giving the least cost combination production level for each supplier for each possible explicit number of suppliers. This was desired in order to determine the difference in cost of selecting several bidders, instead of one or two, for the purpose of maintaining production capability in the event of mobilization and also to prevent dependence on a single source of supply. Version four of the model provides this additional information and was thus selected for application.

The techniques and computer programs used in this application were developed initially in support of ORG Report 47 (reference 1). The model has since been adopted as an integral member of the JCAP system of economic models. The principles of dynamic programming are utilized to provide the least cost solutions for each possible combination of production requirements and number of bidders, as well as "second best" solutions. Secondary solutions are provided as additional information to assist Management in the decision process in the case that a decision cannot be made based on least cost solutions.

The input requirements for the model are:

1. Total number of bidders.

2. Base protection - total cost of layaway and maintenance of those facilities to include Government-owned, contractor-operated (GOCO) and contractor-owned, contractor-operated (COCO) facilities which have Government-furnished equipment.

3. Total procurement quantity - total production requirement.

4. Bid levels - portions of, and including, the total procurement quantity that a potential supplier is willing to bid for.

5. Bid cost (bid price) - all cost to the Government associated with choosing a specific bidder for a given bid level. This cost includes production costs, transportation costs (motor, rail options), Government-furnished equipment costs, and "First Article Approval" costs.

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1. DeArmon, Ira A., Jr., and Fermaglich, David M., The Cost of Procuring Ammunition from Industry or from Government-Owned Plants, USAMUCOM ORG Report 47, USAMUCOM Operations Research Group, July 1972, UNCL.

FIGURE 1 EXAMPLE OF ADJUSTED BID PRICE CALCULATION FOR

BIDDER TWO AT THE 25% PRODUCTION LEVEL

(531,000 UNITS)

	GOVERNMENT SHIPPING (RAIL)	GOVERNMENT SHIPPING (MOTOR)	SUPPLIER SHIPPING (RAIL)	SUPPLIER SHIPPING (MOTOR)
TRANSPORTED UNIT COST	$4,623	$4,618	$4,654	$4,626

MINIMUM TRANSPORTED UNIT COST $4,618
UNIT COST OF GOVERNMENT-FURNISHED EQUIPMENT   .008
TOTAL TRANSPORTED UNIT COST $4,626

BID PRICE $2,456,406
WAIVER OF FIRST ARTICLE APPROVAL   - 3,000
TOTAL ADJUSTED BID PRICE $2,453,406

Base protection costs are provided to procurement personnel by the bidder and are a percentage of the dollar replacement values of the facilities to be laid away in the event that a particular bidder does not receive a portion of the total contract. Since the base protection costs are actually a cost to the Government for selecting a bidder at the zero production level, the costs are entered into the program at the zero production level.

Production costs and costs of transportation to the destination by the supplier are submitted as bids by the potential supplier. The costs of Government shipping from origin to destination are obtained from Government schedules of rates negotiated with motor and rail carriers. The bidders submit evaluations of per unit costs of Government-furnished equipment in accordance with methods provided by procurement personnel. The evaluations are checked by procurement personnel and validated as to accuracy. First article approval costs may be applicable if a bidder has not supplied the item to the Government within the previous ninety-day period. First article refers to preproduction models, initial production samples, test samples, first lots, pilot models, and pilot lots. Approval involves testing and evaluating the first article for conformance with specified contract requirements before or in the initial stage of production under a contract. In the case where first article approval may be required, the bidder also furnishes a bid for the cost of first article approval procedures.

Bidder two was one of the bidders potentially requiring first article approval. Although the company was already producing the item under a previous contract, first article approval procedures had not been completed. The submitted bid stated that if the requirement for first article approval were waived, the total bid price at any production level should be reduced by $3000.

Figure 1 shows an example of actual data and the process of adjusting the data to be input to the program. For this application, the number of bidders involved in the competition is five. There were nine bid levels ranging from 0 to 100% in increments of 12.5%. The adjustment shown in Figure 1 is for bidder two at the 25% production level. The production quantity at this level is 530,885 units.

The transported unit cost shown in Figure 1 is the cost to the Government of each unit if obtained from supplier two, including transportation. The minimum transported unit cost for this bidder and production level are used in the analysis since all items obtained from a particular bidder will be shipped by the minimum cost mode. The pro-rated unit cost of Government-furnished equipment is added to the minimum transported unit cost to obtain the total transported unit cost. The bid price is the product of the total transported unit cost and the production level quantity, in this case $4.626 x 530,885 = $2,456,405. The requirement for first article approval in this case was waived because the previously initiated first article approval procedures were completed subsequent to the submission of the bids. Therefore, the total adjusted bid price to be entered into the program was $3000 less than the bid price shown above.

Figure 2 shows the total adjusted bid prices for the various bid levels by the various bidders. The total procurement quantity at the 100% bid level was 2,123,540 units. Note that some bid levels were not bid on due to insufficient capacity to meet these levels or, in some cases, bids not being solicited.

Figures 3 and 4 show the results supplied by the model for the least cost solutions at the 50% production level and the 100% production level, respectively. Figure 5 shows results for the second best solutions at the 100% production level.

It is seen from Figure 3 that if the decision is made to reduce the production requirement to half of the original requirement, then the least cost solution is to select bidders two and four, each at the 25% production level, resulting in a total cost of 4.98 million dollars.

If the contracts are to be awarded to obtain 100% of the original requirement, then it is seen from Figure 4 that the least cost solution is to award the whole contract to supplier three at the 100% level at a cost of 10.06 million dollars. If, however, the Government wants to avoid having to depend on a single source for supply of the item, the contracts can be awarded to suppliers two, three, and four at an additional cost of .23 million dollars.

The second best solutions, such as shown in Figure 5, are output as additional information for the manager. If other than least cost solutions are to be used, then these additional solutions can be used in the decision-making process.

The Decision Models Directorate has applied this model to several other applications for the Army and anticipates using the model for Navy and Air Force applications in the near future.

FIGURE 2 BID-SUPPLIER INPUT MATRIX

COST IN THOUSANDS

(ROUNDED TO NEAREST THOUSAND)

BID
LEVELS

Bid Level	Bidder 1	Bidder 2	Bidder 3	Bidder 4	Bidder 5
100					
87.5	*	*			*
75	*	*	10031	*	*
62.5	*	*	*	*	*
50	*	*	*	*	*
37.5	*	*	5322	*	*
25	*	*	*	*	*
12.5	3551	2453	2811	2505	4024
0	1956	1226	1543	1256	2077
	4	3	5	7	8

BIDDER

FIGURE 3 MULTIPLE BID ALTERNATIVE SOLUTIONS AT 50% LEVEL

NUMBER OF BIDDERS SELECTED

SUPPLIER	1	2	3	4	5
1				12.5%	
2		25%	25%	12.5%	NO SOLUTION OBTAINABLE BASED ON SUBMITTED BIDS
3	50%		12.5%	12.5%	
4		25%	12.5%	12.5%	
5					
TOTAL COST (MILLIONS)	5.35	4.98	5.26	5.99	

FIGURE 4 MULTIPLE BID ALTERNATIVE SOLUTIONS AT 100% LEVEL

NUMBER OF BIDDERS SELECTED

SUPPLIER	1	2	3	4	5
1				12.5%	12.5%
2			25%	25%	25%
3	100%	NO SOLUTION OBTAINABLE BASED ON SUBMITTED BIDS	50%	50%	25%
4			25%	12.5%	25%
5					12.5%
TOTAL COST (MILLIONS)	10.06		10.29	10.99	11.80

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FIGURE 5 MULTIPLE BID ALTERNATIVE SOLUTIONS AT 100% LEVEL

(SECOND BEST SOLUTIONS)

NUMBER OF BIDDERS SELECTED

SUPPLIER	1	2	3	4	5
1	NO SECOND BEST SOLUTION	NO SOLUTION OBTAINABLE BECAUSE ONLY ONE CONTRACTOR BID 50%	25%	25%	25%
2			25%	25%	25%
3			50%	25%	25%
4				25%	12.5%
5					12.5%
TOTAL COST (MILLIONS)			11.34	11.33	12.15