ON-LINE COMPUTER PROGRAMS
FOR THE ANALYSIS OF
BORDER-CONTROL PROBLEMS

G. F. Schilling and M. Turner

A Report prepared for
ADVANCED RESEARCH PROJECTS AGENCY
MISSING PAGE NUMBERS ARE BLANK AND WERE NOT FILMED
This research is supported by the Advanced Research Projects Agency under Contract No. DAHC15-67-C-0142. Views or conclusions contained in this study should not be interpreted as representing the official opinion or policy of Rand or of ARPA.
Complex interactions among military, technical, geopolitical, and socioeconomic factors constitute major problems for counterinfiltration programs intended to inhibit the movement of hostile forces across defined boundaries. This report describes two versions of an on-line computer program that incorporates the methodology of a model of border control developed in RM-6250; it enables the user to analyze insurgency situations without mathematical manipulations. The computerized versions of the model permit the ready investigation of specific situations and the rapid testing of new concepts with regard to their probable utility under different contingencies. It also permits testing of quantitative sensitivity analyses of candidate border security systems and programs. Outputs include a detailed account and projected time sequence of the number of guerrillas in the area of interest as a result of infiltration, interdiction, recruitment, and attrition. For any future date, these numerical data are given in terms of actual numbers, area densities, and rates of change.
ON-LINE COMPUTER PROGRAMS
FOR THE ANALYSIS OF
BORDER-CONTROL PROBLEMS

G. F. Schilling and M. Turner

A Report prepared for
ADVANCED RESEARCH PROJECTS AGENCY

Rand
SANTA MONICA, CA 90406

THIS DOCUMENT HAS BEEN APPROVED FOR PUBLIC RELEASE AND SALE, ITS DISTRIBUTION IS UNLIMITED
Rand maintains a number of special, subject bibliographies containing abstracts of Rand publications in fields of wide current interest. The following bibliographies are available upon request:

- Africa
- Arms Control
- Civil Defense
- Combinatorics
- Communication Satellites
- Communication Systems
- Communist China
- Computing Technology
- Decisionmaking
- East-West Trade
- Education
- Foreign Aid
- Health-related Research
- Latin America
- Linguistics
- Long-range Forecasting
- Maintenance
- Mathematical Modeling of Physiological Processes
- Middle East
- Policy Sciences
- Pollution
- Procurement and R&D Strategy
- Program Budgeting
- SIMSCRIPT and Its Applications
- Southeast Asia
- Systems Analysis
- Television
- Urban Problems
- USSR
- Water Resources
- Weather Forecasting and Control

To obtain copies of these bibliographies, and to receive information on how to obtain copies of individual publications, write to: Communications Department, Rand, 1700 Main Street, Santa Monica, California 90406.
An analytic model of border control has recently been developed by The Rand Corporation as part of a study of infiltration and invasion control for the Advanced Research Projects Agency. It has been published as RM-6250-ARPA, Analytic Model of Border Control.

The present Report describes computerized versions of the model for on-line use. Two of the on-line programs are available in Rand's JOSS* library file, and can be recalled from remote consoles and teletypes with access to JOSS. These programs employ everyday language rather than mathematical symbolism. They are, essentially, tools to assist in the analysis of infiltration problems and in comparative evaluations of candidate border security systems.

This Report should be of interest also to other agencies concerned with counterinsurgency research, or with the development of contingency plans for various areas of the world.

*JOSS is the trademark and service mark of The Rand Corporation for its computer program and services using that program. For access to programs, use library 51, and recall item 1 (BRD1) or item 3 (BRD2), respectively.
SUMMARY

The complex interactions among military, technical, geopolitical, and socio-economic factors constitute major problems for counter-infiltration programs intended to inhibit the movement of hostile forces across defined boundaries. We have developed an analytic model of border control (RM-6250-ARPA) that simulates certain quantifiable aspects of these problems. It specifically treats not only guerrilla and counter-guerrilla activity in a country or a geographical area, but also infiltration or exfiltration along stretches of national border or other lines of defense.

In this Report, we describe two versions of an on-line computer program that incorporates the methodology of the model but enables the user to analyze insurgency situations without needing to follow the mathematical manipulations. In view of the complexity of insurgency problems, no simple theoretical model will illuminate them. We have therefore devised several computerized versions of the basic model to permit the ready investigation of specific situations, the rapid testing of new concepts and ideas with regard to their probable utility under different contingencies, and the conduct of quantitative sensitivity analyses of candidate border security systems and programs. Both JOSS versions of this model employ language rather than mathematical symbolism, and are therefore readily usable without instructions; both are available in Rand's JOSS library file, and can be recalled from any of the JOSS consoles within Rand or from remote consoles and teletypes.

The computer programs essentially evaluate the performance of actual or planned border security systems in the framework of a given military or geopolitical situation. The results are presented in terms of situation assessments and projected outcomes. The principal input quantities are the size of the area of interest, the length of its border, initial numbers of guerrillas and defenders, estimates or empirical values of the approximate efficiencies of internal-area security measures and local guerrilla recruitment, the design efficiency of a border security system, and characteristics of the enemy
threat in terms of either attempted or successful rates of infiltration or border penetration. Not all of these data are necessary, however, and the programs automatically select an appropriate mode of operation that depends on the amount and type of input information.

The outputs consist of three parts. The first is a brief interpretation of the implications of the input data. The second is a detailed account and projected time sequence of the variation of the number of guerrillas in the area of interest as a result of the combined effects of infiltration, interdiction, recruitment, and attrition. For any desired future calendar date, these numerical data are given in terms of actual numbers, area densities, and rates of change. The final part of the program is a brief analysis of the eventual outcome.

The presumed efficiency of border security and area security operations, and the degree of overt or covert enemy threats, can be changed at any time to compare and evaluate the probable consequences. The immediacy of the results facilitates the investigation of past as well as probable future situations, the testing of new concepts and ideas with regard to their effects in different circumstances, and the conduct of quantitative sensitivity analyses of candidate border security systems and programs.
FIGURES

1. Simplified Flow Diagram of Basic Program .................... 7
2. Flow Diagram of Version I of Border-control Program ...... 8
3. Flow Diagram of Simplified Version II of Border-control Program ................................. 9
# TABLES

1. Program Symbols for Version I ........................................ 10
2. Program Symbols for Version II ....................................... 13
3. General Input Quantities ................................................. 15
4. Combat Data Input Quantities ........................................... 15
5. Mode Selection Input Quantities ........................................ 16
6. Output Quantities—Recapitulation of Input Data and Implications ........................................ 17
7. Output Quantities—Situation Assessment ............................... 18
8. Output Quantities—Projected Outcome .................................. 19
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFACE</td>
<td>iii</td>
</tr>
<tr>
<td>SUMMARY</td>
<td>v</td>
</tr>
<tr>
<td>FIGURES</td>
<td>ix</td>
</tr>
<tr>
<td>TABLES</td>
<td>xi</td>
</tr>
<tr>
<td><strong>Section</strong></td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>II. PROGRAM OPERATION</td>
<td>3</td>
</tr>
<tr>
<td>External</td>
<td>3</td>
</tr>
<tr>
<td>Internal</td>
<td>4</td>
</tr>
<tr>
<td>III. DESCRIPTION OF JOSS PROGRAMS</td>
<td>5</td>
</tr>
<tr>
<td>IV. PROGRAM DOCUMENTATION</td>
<td>20</td>
</tr>
<tr>
<td>V. SAMPLE PROGRAM RUNS</td>
<td>35</td>
</tr>
<tr>
<td>VI. CONCLUDING REMARKS</td>
<td>50</td>
</tr>
</tbody>
</table>
I. INTRODUCTION

ANALYTICAL MODEL

The analytical model of border control described in RM-6250-ARPA* is essentially a tool to assist in the analysis of actual or potential insurgent conflicts. It enables one to investigate the specific problems of counterguerrilla activities in a country, or an area, subject to infiltration along stretches of national border or other lines of demarcation. The basic analytic formulation of the model allows investigations wide latitude, ranging from critical studies and evaluations of past or current conflict situations to contingency plans for various areas of the world.

But the problems of guerrilla warfare are numerous and complex, and one cannot expect one simple model to illuminate them all. Several computerized versions of the basic model were therefore devised to permit the ready investigation of specific situations, the rapid testing of new concepts and ideas with regard to their probable utility under different contingencies, and the conduct of quantitative sensitivity analyses of candidate border security systems and programs.

The principal uses of numerical solutions of the model are as follows:

a. Through the use of historical data such as enemy orders of battle and casualty figures, the model can reproduce the actual course of events and determine the relative importance of different factors as they influenced past activities.

b. Through the use of conditional input data, one can investigate the applicability and probable usefulness of candidate border security systems and programs for different contingencies and scenarios.

c. Through the use of different model solutions that correspond to various enemy strategies, it is possible to assess the probable consequences of system implementation in terms of likely enemy response and resulting requirements for system changes.

---

d. Through time projections, different mixes of border security systems and internal-area security programs can be tested with respect to optimal resource allocations.

**JOSS PROGRAMS**

In this Report, we describe and document two specific computer versions of the model that have been programmed for on-line use on JOSS. These programs are available in the JOSS library file, and can be recalled from remote consoles. They employ everyday language rather than mathematical symbolism, and the user need neither understand computer processes nor be familiar with the mathematical formulations of the analytical model.

Both programs apply to the situation in which the user has very limited information about the strategy employed by the enemy. The two programs differ principally in their respective complexity of analysis. The more sophisticated one, called here VERSION I, incorporates internal safeguards against user errors and logical fallacies and provides a written analysis of the projected outcome. The simpler VERSION II, on the other hand, will suffice for many investigations in which only historical data are analyzed or where only limited results are needed.

A unique feature of the programs is their ability to provide instant situation assessments. They can thus be used as a means of providing quick-response analyses. They should not be regarded as more than tools, however; although they can augment analysis, they cannot replace it.

To enable this Report to serve as a programmer's manual, the programs have been described and documented in considerable detail. In conjunction with the published model (RM-6250-ARPA), the basic program can be adapted to specific geopolitical situations.

---

*JOSS is an interactive, time-shared computing service developed at The Rand Corporation to provide for the solution of numerical problems.*
II. PROGRAM OPERATION

EXTERNAL

The programs are stored in the JOSS library and are recalled by the following commands:

**VERSION I**
- Use library 51.
- Recall item 1 (BRD1).

**VERSION II**
- Use library 51.
- Recall item 3 (BRD2).

Program operation is initiated by the command:

**Do part 1.**

The subsequent operation of both programs is **fully automatic**. Demands for input data are made sequentially, and logic circuits select appropriate modes of operation, depending on the type and quantity of input data. After briefly recapitulating the input data and their implications, the program provides the principal output for the dates and time intervals specified by the user.

On reaching a previously specified date for re-evaluation, **VERSION I** provides additional output in the form of a **time projection**; i.e., the eventual outcome of the general situation is predicted in the absence of any changes in the original order of battle. At this date, JOSS is also ready to accept modified combat data resulting from the user's assessment of desirable system alterations, and to continue evaluations with these new data or orders of battle.

If a completely new set of basic input data is introduced, however, such as a different area of interest or length of border, the command "Delete all" should be given, and the program recalled from the library.

Both versions are programmed to be operated on JOSS consoles. They will also operate on teletype consoles, but on occasion some nonessential text near the right margin may overprint.

Examples of the operations of both programs are reproduced in Section V.
The internal operation of the program is fully detailed in Sections III and IV. It should be noted that VERSION I actually occupies space for two file items; the second item is automatically recalled at the appropriate time, and excess material is deleted.

The mathematical basis of the programs is described in RM-6250-ARPA, and is not repeated here. Essentially, the programs obtain a set of integral solutions to a nonlinear differential equation and solutions for several auxiliary relations. The solutions consist of numerical values of finite integrals over specified time intervals, and the instantaneous values of a series of differentials at the specified dates. In addition, VERSION I also solves for the limiting values that certain relations would reach after infinite time.

The internal logic circuits decide sequentially what input data to ask for, and then select an appropriate combination of mathematical equations that permits operation with the given input data.
III. DESCRIPTION OF JOSS PROGRAMS

This Section provides a detailed description of both program versions in the form of tables and diagrams. The programs themselves are reproduced in Section IV.

Figure 1 is a simplified schematic of the basic program flow. The part numbers listed identify the segment of the program in which the indicated activity is carried out. In addition, VERSION I contains parts 30, 31, 32, and 33, which provide error messages for incorrect input data.

Figure 2 is a detailed flow diagram of VERSION I. Note that this version has a capability for consecutive re-evaluations to facilitate sensitivity analyses whereby selected individual parameters can be varied while other parameters remain constant. The technique used involves the setting of appropriate limits of integration for each new set of integral evaluations, and the use of derived combat conditions as new starting data.

Figure 3 is a detailed flow diagram for VERSION II. This simplified program cannot perform consecutive re-evaluations. Once the end date is reached, it retains only the general input data, and demands new combat data.

Tables 1 and 2 are alphabetical listings of the program symbols used in VERSION I and II, respectively. The units given are those presently employed, namely miles and months. If necessary, they can be changed to other units without affecting the basic operation of the program. The mathematical symbols are not employed in the JOSS programs, and are listed to facilitate comparison with the analytic model.

Table 3 identifies the general input quantities that designate the geographical situation and determine the frequency of output.

Table 4 lists the input data that characterize the general combat situation in the area of interest.
Table 5 is a list of the input quantities that pertain to infiltration and border security. A comparison with Figs. 2 and 3 indicates the mechanism by which the program selects its mode of mathematical operation, depending on the available input information. A brief description of these modes is printed on demand during the operation of VERSION I, and given automatically in VERSION II. Mode A represents the condition of minimum knowledge on the user's part that still permits program operation. Under Modes B, C, or D, only two input data points are needed, and the remaining are then computed automatically.

Table 6 lists the output quantities printed before the time-sequenced computations are begun. This information represents, essentially, an analysis of the starting situation.

Table 7 is a list of the principal program output in terms of a situation assessment. The numerical values are printed at each originally specified date of evaluation, and represent a time history of the progress and development of the battle situation.

Table 8 gives the output quantities computed when the end date (or the originally specified date for re-evaluation) is reached. In VERSION I this information is printed in sentence form, and represents a projection of the eventual outcome. In practical use, it will indicate whether system data need be changed to achieve a favorable outcome.
Fig. 1 — Simplified Flow Diagram of Basic Program
Fig. 2 — Flow Diagram of Version I of Border-control Program
Fig. 3 — Flow Diagram of Simplified Version II of Border-control Program
Table 1
PROGRAM SYMBOLS FOR VERSION I

<table>
<thead>
<tr>
<th>Program Symbol</th>
<th>Mathematical Symbol</th>
<th>Explanation</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>Area of interest</td>
<td>square miles</td>
</tr>
<tr>
<td>b</td>
<td>1 dT / L dt</td>
<td>Program description control variable</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>dT / dt</td>
<td>Rate of attempted penetrations</td>
<td>per mile per month</td>
</tr>
<tr>
<td>E</td>
<td>dT / dt</td>
<td>Rate of attempted infiltrations</td>
<td>per month</td>
</tr>
<tr>
<td>g</td>
<td>1 dK / N dt</td>
<td>Efficiency of internal area attrition measures</td>
<td>percent per month</td>
</tr>
<tr>
<td>G</td>
<td>1 dR / N dt</td>
<td>Efficiency of guerrilla recruitment</td>
<td>percent per month</td>
</tr>
<tr>
<td>i</td>
<td>t</td>
<td>Calendar date of printout (upper limit of integration)</td>
<td>month</td>
</tr>
<tr>
<td>K(t)</td>
<td>K_t</td>
<td>Total number of guerrillas attrited in the area from time zero up to time t</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>Length of border</td>
<td>miles</td>
</tr>
<tr>
<td>N(t)</td>
<td>N_t</td>
<td>Number of guerrillas in the area at time t</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>∂S / ∂T</td>
<td>Barrier penetration probability</td>
<td>percent</td>
</tr>
<tr>
<td>P</td>
<td>1 - ∂S / ∂T</td>
<td>Barrier interdiction efficiency</td>
<td>percent</td>
</tr>
<tr>
<td>q</td>
<td></td>
<td>Mode identification control variable</td>
<td></td>
</tr>
<tr>
<td>R(t)</td>
<td>R_t</td>
<td>Total number of guerrillas newly recruited in the area from time zero up to time t</td>
<td></td>
</tr>
<tr>
<td>s</td>
<td>1 ds / L dt</td>
<td>Rate of successful penetrations</td>
<td>per mile per month</td>
</tr>
<tr>
<td>S(t)</td>
<td>S_t</td>
<td>Total number of successful infiltrations from time zero up to time t</td>
<td></td>
</tr>
<tr>
<td>Program Symbol</td>
<td>Mathematical Symbol</td>
<td>Explanation</td>
<td>Units</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------</td>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td>t</td>
<td>t</td>
<td>Time variable</td>
<td>months</td>
</tr>
<tr>
<td>u</td>
<td>v</td>
<td>N_0</td>
<td>Number of guerrillas in the area at start of each set of evaluations</td>
</tr>
<tr>
<td>X(2)</td>
<td>S_0</td>
<td>Number of successful infiltrators prior to start of each set of evaluations</td>
<td></td>
</tr>
<tr>
<td>X(3)</td>
<td>R_0</td>
<td>Number of guerrillas recruited in the area prior to start of each set of evaluations</td>
<td></td>
</tr>
<tr>
<td>X(4)</td>
<td>K_0</td>
<td>Number of guerrillas attrited in the area prior to start of each set of evaluations</td>
<td></td>
</tr>
<tr>
<td>X(5)</td>
<td>M_0</td>
<td>Number of defenders in the area at the start of each set of evaluations</td>
<td></td>
</tr>
<tr>
<td>X(9)</td>
<td>t_{t=0}</td>
<td>Calendar date at start of each set of evaluations (lower limit of integration for the set)</td>
<td></td>
</tr>
<tr>
<td>X(11)</td>
<td>\frac{dN}{dt}</td>
<td>Guerrilla survival rate (change in the number of guerrillas per unit of time)</td>
<td></td>
</tr>
<tr>
<td>X(12)</td>
<td>\frac{dS}{dt}</td>
<td>Infiltration rate (number of successful infiltrators per unit of time)</td>
<td></td>
</tr>
<tr>
<td>X(13)</td>
<td>\frac{dR}{dt}</td>
<td>Guerrilla recruitment rate (number of new guerrillas recruited per unit of time)</td>
<td></td>
</tr>
<tr>
<td>X(14)</td>
<td>\frac{dK}{dt}</td>
<td>Guerrilla attrition rate (number of guerrillas attrited per unit of time)</td>
<td></td>
</tr>
<tr>
<td>X(50)</td>
<td>t=t</td>
<td>Time at end of each set of evaluations (upper limit of integration at end of set)</td>
<td></td>
</tr>
<tr>
<td>X(51)</td>
<td>\Delta t</td>
<td>Size of time interval for evaluations within each set</td>
<td></td>
</tr>
</tbody>
</table>

Unit: months
<table>
<thead>
<tr>
<th>Program Symbol</th>
<th>Mathematical Symbol</th>
<th>Explanation</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>X(90)</td>
<td>( \left[ \frac{dN}{dt} \right]_{t=0} )</td>
<td>Balance Rate (indicator of the variation in the guerrilla force strength)</td>
<td>per month</td>
</tr>
<tr>
<td>X(92)</td>
<td>([N]_{t=\infty})</td>
<td>Balance parameter (number of guerrillas after infinite time)</td>
<td></td>
</tr>
<tr>
<td>X(97)</td>
<td>([t]_{N=1000})</td>
<td>Date when number of guerrillas will reach about 1000</td>
<td>month</td>
</tr>
<tr>
<td>X(99)</td>
<td>([t]_{N=0.99N})</td>
<td>Date when 99% of final number of guerrillas in the area is reached</td>
<td>month</td>
</tr>
<tr>
<td>Z</td>
<td>( \frac{dS}{dt} )</td>
<td>Rate of successful infiltrations</td>
<td>per month</td>
</tr>
</tbody>
</table>
# Table 2

**PROGRAM SYMBOLS FOR VERSION II**

<table>
<thead>
<tr>
<th>Program Symbol</th>
<th>Mathematical Symbol</th>
<th>Explanation</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>Area of interest</td>
<td>square miles</td>
</tr>
<tr>
<td>e</td>
<td>( \frac{dT}{dt} )</td>
<td>Rate of attempted infiltrations</td>
<td>per month</td>
</tr>
<tr>
<td>E</td>
<td>( \frac{1}{L} \frac{dL}{dt} )</td>
<td>Rate of attempted penetrations</td>
<td>per mile per month</td>
</tr>
<tr>
<td>F</td>
<td>( t = t )</td>
<td>Time at end of evaluations (upper limit of integration)</td>
<td>months</td>
</tr>
<tr>
<td>G</td>
<td>( \frac{1}{N} \frac{dN}{dt} )</td>
<td>Efficiency of internal area attrition measures</td>
<td>percent per month</td>
</tr>
<tr>
<td>K(t)</td>
<td>( K_t )</td>
<td>Total number of guerrillas attrited in the area from time zero up to time ( t )</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>Length of border</td>
<td>miles</td>
</tr>
<tr>
<td>N</td>
<td>( N_0 )</td>
<td>Number of guerrillas in the area at time zero</td>
<td></td>
</tr>
<tr>
<td>N(t)</td>
<td>( N_t )</td>
<td>Number of guerrillas in the area at time ( t )</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>( \frac{dS}{dT} )</td>
<td>Barrier penetration probability</td>
<td>percent</td>
</tr>
<tr>
<td>Q</td>
<td>( S_o )</td>
<td>Number of successful infiltrators prior to start of evaluations (equal to zero in this version)</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>( K_o )</td>
<td>Number of guerrillas attrited in the area prior to start of evaluations (equal to zero in this version)</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>( \frac{1}{L} \frac{dS}{dt} )</td>
<td>Rate of successful penetrations</td>
<td>per mile per month</td>
</tr>
<tr>
<td>S(t)</td>
<td>( S_t )</td>
<td>Total number of successful infiltrators from time zero up to time ( t )</td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>( t )</td>
<td>Time variable</td>
<td>months</td>
</tr>
</tbody>
</table>
Table 2 — continued

<table>
<thead>
<tr>
<th>Program Symbol</th>
<th>Mathematical Symbol</th>
<th>Explanation</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>u</td>
<td>Δt</td>
<td>Size of time interval for evaluations</td>
<td>months</td>
</tr>
<tr>
<td>U</td>
<td>[N]_{t=\infty}</td>
<td>Balance parameter (number of guerrillas after infinite time)</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>\left[ \frac{dN}{dt} \right]_{t=0}</td>
<td>Balance rate (indicator of the variation in the guerrilla force strength)</td>
<td>per month</td>
</tr>
<tr>
<td>W</td>
<td>\frac{dK}{dt}</td>
<td>Guerrilla attrition rate (number of guerrillas attrited per unit of time)</td>
<td>per month</td>
</tr>
<tr>
<td>X</td>
<td>\frac{dN}{dt}</td>
<td>Guerrilla survival rate (change in the number of guerrillas per unit of time)</td>
<td>per month</td>
</tr>
<tr>
<td>Z</td>
<td>\frac{dS}{dt}</td>
<td>Rate of successful infiltrations</td>
<td>per month</td>
</tr>
</tbody>
</table>
## Table 3
### GENERAL INPUT QUANTITIES

<table>
<thead>
<tr>
<th>Term</th>
<th>Units</th>
<th>Version I</th>
<th>Version II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of interest</td>
<td>square miles</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Length of border</td>
<td>miles</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Size of time intervals of output</td>
<td>months</td>
<td>X(51)</td>
<td>u</td>
</tr>
<tr>
<td>Date of re-evaluation</td>
<td>month</td>
<td>X(50)</td>
<td></td>
</tr>
<tr>
<td>End date</td>
<td>month</td>
<td></td>
<td>F</td>
</tr>
</tbody>
</table>

## Table 4
### COMBAT DATA INPUT QUANTITIES

<table>
<thead>
<tr>
<th>Term</th>
<th>Units</th>
<th>Version I</th>
<th>Version II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of guerrillas in area at month zero</td>
<td>X(1)</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Number of defenders in area at month zero</td>
<td>X(5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficiency of area attrition measures</td>
<td>percent per month</td>
<td>g</td>
<td>g</td>
</tr>
<tr>
<td>Efficiency of guerrilla recruitment</td>
<td>percent per month</td>
<td>G</td>
<td></td>
</tr>
<tr>
<td>Term</td>
<td>Units</td>
<td>Version I</td>
<td>Version II</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>MODE A</td>
<td>Rate of successful infiltrations or penetrations</td>
<td>per month</td>
<td>Z</td>
</tr>
<tr>
<td></td>
<td></td>
<td>per mile</td>
<td>s</td>
</tr>
<tr>
<td>MODE B</td>
<td>Rate of successful infiltrations or penetrations</td>
<td>per month</td>
<td>Z</td>
</tr>
<tr>
<td></td>
<td></td>
<td>per mile</td>
<td>s</td>
</tr>
<tr>
<td></td>
<td>AND</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Barrier interdiction efficiency or Barrier penetration probability</td>
<td>percent</td>
<td>P</td>
</tr>
<tr>
<td>MODE C</td>
<td>Rate of successful infiltrations or penetrations</td>
<td>per month</td>
<td>Z</td>
</tr>
<tr>
<td></td>
<td></td>
<td>per mile</td>
<td>s</td>
</tr>
<tr>
<td></td>
<td>AND</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rate of attempted infiltrations or penetrations</td>
<td>per month</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>per mile</td>
<td>e</td>
</tr>
<tr>
<td>MODE D</td>
<td>Barrier interdiction efficiency or Barrier penetration probability</td>
<td>percent</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>AND</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rate of attempted infiltrations or penetrations</td>
<td>per month</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>per mile</td>
<td>e</td>
</tr>
</tbody>
</table>

\[ p = 1 - P \]
### Table 6

**OUTPUT QUANTITIES - RECAPITULATION OF INPUT DATA AND IMPLICATIONS**

<table>
<thead>
<tr>
<th>Term</th>
<th>Units</th>
<th>Symbol</th>
<th>Version I</th>
<th>Version II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of border</td>
<td>miles</td>
<td>L</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Infiltration area</td>
<td>square miles</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Border parameter</td>
<td>miles per square mile</td>
<td>L/A</td>
<td>L/A</td>
<td></td>
</tr>
<tr>
<td>Initial number of guerrillas in area</td>
<td></td>
<td>X(1)</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Initial number of defenders in area</td>
<td></td>
<td>X(5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of attempted infiltrations and</td>
<td>per month</td>
<td>E</td>
<td>e</td>
<td></td>
</tr>
<tr>
<td>penetrations</td>
<td>per mile per month</td>
<td>e</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Barrier penetration probability</td>
<td>percent</td>
<td>p</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>Barrier interdiction efficiency</td>
<td>percent</td>
<td>P</td>
<td>1-p</td>
<td></td>
</tr>
<tr>
<td>Rate of successful infiltrations and</td>
<td>per month</td>
<td>Z</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>penetrations</td>
<td>per mile per month</td>
<td>s</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Internal security efficiency</td>
<td>percent per month</td>
<td>g</td>
<td>g</td>
<td></td>
</tr>
<tr>
<td></td>
<td>percent per month per defender</td>
<td>g/X(5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guerrilla recruitment efficiency</td>
<td>percent per month</td>
<td>G</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of guerrilla group that recruits ten</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>new guerrillas each month</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7
OUTPUT QUANTITIES - SITUATION ASSESSMENT

<table>
<thead>
<tr>
<th>Term</th>
<th>Units</th>
<th>Symbol</th>
<th>Version I</th>
<th>Version II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calendar date</td>
<td>month</td>
<td>1</td>
<td>t</td>
<td></td>
</tr>
<tr>
<td>Attempted infiltrations:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>number</td>
<td>$E \cdot i$</td>
<td>$e \cdot t$</td>
<td></td>
</tr>
<tr>
<td>Linear density</td>
<td>per mile</td>
<td>$e \cdot i$</td>
<td>$E \cdot t$</td>
<td></td>
</tr>
<tr>
<td>Rate of change</td>
<td>per month</td>
<td>$E$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attempted infiltrations intercepted at barrier:</td>
<td></td>
<td>$E \cdot i - S(t)$</td>
<td>$e \cdot t - S(t)$</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>number</td>
<td>$[E \cdot i - S(t)]/L$</td>
<td>$[e \cdot t - S(t)]/L$</td>
<td></td>
</tr>
<tr>
<td>Linear density</td>
<td>per mile</td>
<td>$E \cdot X(12)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of change</td>
<td>per month</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infiltrators across border:</td>
<td></td>
<td>$S(t)$</td>
<td>$S(t)$</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>number</td>
<td>$S(t)/L$</td>
<td>$S(t)/L$</td>
<td></td>
</tr>
<tr>
<td>Linear density</td>
<td>per mile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of change</td>
<td>per month</td>
<td>$X(12)$</td>
<td>$Z$</td>
<td></td>
</tr>
<tr>
<td>Guerrillas recruited in area:</td>
<td></td>
<td>$R(t)$</td>
<td>$K(t)$</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>number</td>
<td>$P(t)/A$</td>
<td>$K(t)/A$</td>
<td></td>
</tr>
<tr>
<td>Area density</td>
<td>per mile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of change</td>
<td>per month</td>
<td>$X(13)$</td>
<td>$W$</td>
<td></td>
</tr>
<tr>
<td>Guerrillas attrited in area:</td>
<td></td>
<td>$K(t)$</td>
<td>$K(t)$</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>number</td>
<td>$K(t)/A$</td>
<td>$K(t)/A$</td>
<td></td>
</tr>
<tr>
<td>Area density</td>
<td>per mile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of change</td>
<td>per month</td>
<td>$X(14)$</td>
<td>$W$</td>
<td></td>
</tr>
<tr>
<td>Guerrillas in area:</td>
<td></td>
<td>$N(t)$</td>
<td>$N(t)$</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>number</td>
<td>$N(t)/A$</td>
<td>$N(t)/A$</td>
<td></td>
</tr>
<tr>
<td>Area density</td>
<td>per mile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of change</td>
<td>per month</td>
<td>$X(11)$</td>
<td>$X$</td>
<td></td>
</tr>
</tbody>
</table>
Table 8  
OUTPUT QUANTITIES - PROJECTED OUTCOME*

<table>
<thead>
<tr>
<th>Term</th>
<th>Units</th>
<th>Symbol</th>
<th>Version I</th>
<th>Version II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balance rate</td>
<td>per month</td>
<td>X(90)</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(initial rate of change in the number of guerrillas)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Guerrilla force strength increasing&quot;</td>
<td></td>
<td></td>
<td></td>
<td>X(90)&gt;0</td>
</tr>
<tr>
<td>or</td>
<td></td>
<td></td>
<td></td>
<td>X(90)&lt;0</td>
</tr>
<tr>
<td>or</td>
<td></td>
<td></td>
<td></td>
<td>X(90)=0</td>
</tr>
<tr>
<td>&quot;Guerrilla force strength decreasing&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance parameter</td>
<td></td>
<td>X(92)</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>(Number of guerrillas after infinite time)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;An infinite number of guerrillas after infinite time&quot;</td>
<td></td>
<td></td>
<td>g&lt;G or</td>
<td>g=G and s≠0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date when 99% of balance parameter is reached</td>
<td>month</td>
<td>X(99)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date when number of guerrillas will reach about 1000</td>
<td>month</td>
<td>X(97)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final attrition rate</td>
<td>per month</td>
<td>g·X(92)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(after infinite time)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final recruitment rate</td>
<td>per month</td>
<td>G·X(92)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(after infinite time)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The output of Version I is in sentence form and only the terms which apply to the specific case being evaluated will be printed.
IV. PROGRAM DOCUMENTATION

VERSION I of the JOSS border-control model is reproduced on pages 21 through 29, as filed as items 1 (BRD1) and 2 in library 51. Because of size limitations, it is split into two file items. VERSION II is reproduced on pages 30 through 34, as filed as item 3 (BRD2) in library 51.

The general program flow will be most easily recognized by referring to the tables and diagrams of the previous section. Essentially, parts 1 and 2 in both versions control the program execution, and step 2.9 is the principal computation command.

It may appear that some of the individual program steps are not optimally expressed or are even superfluous (e.g., steps 5.3 and 5.4 in VERSION II); the reason is to be found in the versatility of the basic program. As discussed in RM-6250-ARPA, the analytical model permits the investigation of various enemy strategies that require slightly modified equations and conditions.

Although the basic program has been constructed for convenient modification, this may require the services of an experienced programmer/analyst.
Use library 51.
Roger.
Recall item 1 (BRD1).
Done.
Type size.
   size =  666
Type all.

1.01 * To start type : Do part 1.
   1.1 Type " BORDER CONTROL MODEL".
   1.11 Set i=0.
   1.12 Line.
   1.14 Type " Version I : Analysis and Projections ".
   1.16 Line.
   1.2 Do part 9.
   1.25 Line.
   1.3 Do part 3.
   1.35 Line.
   1.4 Do part 4.
   1.45 Line.
   1.5 Do part 5.
   1.51 Line.
   1.52 Type " STAND BY".
   1.53 Line.
   1.54 Delete step 1.45,step 1.51,step 1.52,step 1.53.
   1.55 Delete step 1.11,step 1.12,step 1.16,step 1.25,step 1.35.
   1.56 Delete step 1.2,step 1.3,step 1.4,step 1.5.
   1.57 Delete part 3,part 4,part 5,part 6,part 13.
   1.58 Delete step 1.54,step 1.55,step 1.56,step 1.57.
   1.59 Recall item 2.
   1.6 Do part 6.
   1.65 Line.
   1.66 Set q=0.
   1.67 Set v=0.
   1.68 Set u=0.
   1.7 Do part 7.
   1.75 Line.
   1.8 Do part 10.
   1.85 To step 1.95 if s<0 and p>0.
   1.86 Do step 30.2 if s<0 and p<0.
   1.87 To step 1.75 if s<0 and p<0.
   1.9 Do part 11.
   1.92 Type "Insufficient Data ......." if s<0 and e<0.
   1.93 To step 1.65 if s<0 and e<0.
   1.95 Do part 2.
   1.952 Line.
   1.96 Type " Ready for different assumptions and/or data.".
   1.962 Page.
   1.965 Delete E,Z,e,p,s.
   1.981 Do part 50.
   1.982 To step 1.6.

3.1 Type " GEOGRAPHICAL DATA".
3.2 Demand A as "Area of Interest [square miles]".
3.25 Do step 30.1 if A<0.
3.26 To step 3.2 if A<0.
3.3 Demand L as "Length of Border [miles]."
3.35 Do step 30.1 if L<0.
3.36 To step 3.3 if L<0.

3.35 Do step 30.1 if A<0.
3.36 To step 3.3 if A<0.

3.3 Demand L as "Length of Border [miles]."
3.36 To step 3.3 if L<0.

4.1 Type "CALENDAR".
4.2 Type "Starting date is Month Zero.".
4.3 Type "What date of re-evaluation is wanted?".
4.32 Demand X(50) as "(New input data after how many months?)
4.4 Type "Size of time intervals of output:"
4.44 Demand X(51) as "(Results every how many months?)
4.45 Type "Please reduce size," if X(51)>X(50).
4.46 To step 4.4 if X(51)>X(50).
4.5 Type "I suggest a longer time interval," if X(50)/X(51) > 12.
4.6 To step 4.4 if X(50)/X(51)>12.

5.1 Type "STARTING SITUATION".
5.2 Demand X(1) as "Initial Number of Guerrillas in Area at Month Zero".
5.21 Do step 30.1 if X(1)=-1.
5.22 To step 5.2 if X(1)=-1.
5.3 Set X(2)=0.
5.4 Set X(4)=0.
5.5 Set X(3)=0.
5.6 Line.
5.61 Demand X(5) as "Initial Number of Defenders in Area at Month Zero".
5.62 Do step 30.1 if X(5)=-1.
5.63 To step 5.61 if X(5)=-1.

9.1 Type "Would you like a brief program description?"
9.15 Demand b as "Answer yes (1) or no (0)"
9.2 To step 9.65 if b=0.
9.27 Type "There are four different modes of operation available,".
9.28 Type "depending on the type of input information given."
9.29 Line.
9.3 Type "Mode A: Infiltration or Penetration Rate only."
9.35 Line.
9.4 Type "Mode B: Infiltration or Penetration Rate, AND".
9.43 Type "Barrier Efficiency."
9.45 Line.
9.5 Type "Mode C: Infiltration or Penetration Rate, AND"
9.53 Type "Threat Characteristics."
9.55 Line.
9.6 Type "Mode D: Barrier Efficiency, AND"
9.63 Type "Threat Characteristics."
9.65 Line.
9.7 Type "If there is no input to a question, please answer = -1."
9.8 Line.
9.81 Type "The program will automatically select the appropriate mode."

13.1 Type "This program evaluates the performance of counter-"
13.2 Type "infiltration programs in a country subjected to".
13.4 Type "guerrilla activity. It permits the investigation of a".
13.5 Type "variety of situations and presents the results in terms ".
13.6 Type "of situation projections and eventual outcome. Changes in".
13.7 Type "the efficiencies of border control and area security".
13.8 Type "systems can be made at any desired time to evaluate".
13.9 Type "the probable consequences. The program is based on the ".
13.91 Type "basic model of border control, described in RM-6250-ARPA.".
13.92 Line.

30.1 Type "This is a required input for this program version.".
Usa library 51.
Roger.
Recall item 2 (BRD2).
Done.

Type size.

\[
\text{size} = 1485
\]

Type all.

2.01 Page if \( S > 20 \).
2.1 Type "YOUR INPUT DATA AND IMPLICATIONS:"
2.15 Line.
2.2 Type L in form 1.
2.25 Type A in form 2.
2.28 Type L/A in form 3.
2.29 Line.
2.3 Type X(1) in form 4.
2.31 Type X(5) in form 30.
2.32 Line.
2.33 Type E in form 8 if \( E \geq 0 \).
2.335 Type e in form 9 if \( e \geq 0 \).
2.338 Line.
2.34 Type 100-\( p \) in form 7 if \( p \geq 0 \).
2.345 Type 100-\( 1-p \) in form 19 if \( p \geq 0 \).
2.346 Type form 29 if \( p \geq 0 \).
2.348 Line.
2.4 Type Z in form 5.
2.45 Type s in form 6.
2.48 Line.
2.55 Type 100-\( g \) in form 18 if \( g \geq 0 \).
2.56 Type 100-\( g/X(5) \) in form 36 if \( g > 0 \) and \( X(5) > 0 \).
2.565 To step 2.58 if \( g \leq 0 \) or \( X(5) \leq 0 \).
2.57 Type "\( \text{per defender} \)"
2.58 Line.
2.6 Type 100-\( G \) in form 31 if \( G \geq 0 \).
2.65 Type 100-\( G/X(5) \) in form 34 if \( G > 0 \).
2.66 Type "ten new guerrillas each month in the area."
if \( G > 0 \).
2.68 Line.
2.7 Do part 15.
2.8 Page.
2.82 Type "RESULTS".
2.84 Line.
2.85 Type form 33.
2.86 Type form 10.
2.9 Do part 20 for \( t=0[X(51)]X(50) \).
2.92 Line.
2.93 Do part 18.

6.01 Type "INPUT DATA".
6.02 Line.
6.1 Type "INTERNAL SECURITY".
6.2 Type "Efficiency of (Internal) Area Attrition Measures".
6.3 Demand \( g \) as "[percent of Guerrilla Force attrited per month; e.g. 15]."
6.4 Do part 32 if \( g > 100 \).
6.5 To step 6.2 if \( g > 100 \).
6.6 Set \( g = g/100 \). 
6.7 Line. 
6.71 Type "Efficiency of Guerrilla Recruitment". 
6.72 Type " [percent increase of Guerrilla Force per month due to ". 
6.73 Demand \( G \) as " new recruitments; e.g.: 4]". 
6.75 Do part 32 if \( G > 100 \). 
6.76 To step 6.71 if \( G > 100 \). 
6.8 Set \( G = G/100 \). 
6.9 Do step 30.2 if \( g < 0 \) and \( G < 0 \). 
6.91 To step 6.1 if \( g < 0 \) and \( G < 0 \). 
6.92 Set \( g = 0 \) if \( g < 0 \). 
6.93 Set \( G = 0 \) if \( G < 0 \). 

7.1 Type " BARRIER CHARACTERISTICS". 
7.15 Line. 
7.2 Demand \( Z \) as "Rate of Successful Infiltration [per month]". 
7.3 Set \( s = Z/L \) if \( Z > 0 \). 
7.4 To step 7.7 if \( Z > 0 \). 
7.5 Demand \( s \) as "Rate of Successful Penetration [per mile per month]". 
7.6 Set \( Z = s 	imes L \) if \( s > 0 \). 
7.7 Line. 
7.8 Set \( q = 1 \) if \( Z > 0 \). 

10.1 Type "Barrier Interdiction Efficiency". 
10.11 Demand \( P \) as " [give as Probability of NON-Penetration in per cent]". 
10.12 Do part 32 if \( P > 100 \). 
10.13 To step 10.1 if \( P > 100 \). 
10.14 Set \( p = 100 - P \) if \( P = 1 \). 
10.15 Set \( p = -1 \) if \( P = -1 \). 
10.16 Do part 31 if \( s > 0 \) and \( p = 0 \). 
10.17 To step 10.1 if \( s > 0 \) and \( p = 0 \). 
10.18 Set \( p = p/100 \) if \( p > 0 \). 
10.2 To step 10.5 if \( s < 0 \). 
10.25 To step 10.5 if \( p < 0 \). 
10.3 Set \( e = s/p \). 
10.4 Set \( E = L 	imes e \). 
10.5 Line. 
10.6 Set \( v = 1 \) if \( p > 0 \). 

11.1 Type " THREAT CHARACTERISTICS". 
11.2 Demand \( E \) as "Rate of Attempted Infiltrations [per month]". 
11.21 Do part 33 if \( s > 0 \) and \( E = 0 \). 
11.22 To step 11.1 if \( s > 0 \) and \( E = 0 \). 
11.3 Set \( e = E/L \) if \( E > 0 \). 
11.4 To step 11.7 if \( E > 0 \). 
11.5 Demand \( e \) as "Rate of Attempted Penetrations [per mile per month]". 
11.51 Do part 33 if \( s > 0 \) and \( e = 0 \). 
11.52 To step 11.5 if \( s > 0 \) and \( e = 0 \). 
11.55 To step 11.9 if \( e < 0 \). 
11.6 Set \( E = L 	imes e \) if \( e = 0 \). 
11.7 Set \( p = s/e \) if \( s > 0 \) and \( e > 0 \). 
11.8 Set \( s = p 	imes e \) if \( s < 0 \). 
11.85 Set \( Z = s 	imes L \). 
11.86 Set \( u = 1 \) if \( E > 0 \).
11.9 Line.

15.1 Type " According to the input given, the program is operating".
15.2 Type " in MODE A." if \( q=1 \) and \( v=0 \) and \( u=0 \).
15.3 Type " in MODE B." if \( q=1 \) and \( v=1 \).
15.4 Type " in MODE C." if \( q=1 \) and \( v=0 \) and \( u=1 \).
15.5 Type " in MODE D." if \( q=0 \) and \( v=1 \) and \( u=1 \).

18.10 Page.
18.11 Type " PROJECTED OUTCOME".
18.12 Type " (Eventual Balance Situation)".
18.21 Set \( X(90) = s \cdot L - X(1) \cdot (g - G) \).
18.25 Do part 19 if \( gsG \).
18.26 To step 18.9 if \( gsG \).
18.31 Set \( X(92) = s \cdot L / (g - G) \).
18.35 Type " The Guerrilla force strength has been increasing" if \( X(90)>0 \).
18.36 Type " The Guerrilla force strength has been decreasing" if \( X(90)<0 \).
18.37 Type \( X(9) \) in form 21 if \( X(90) \neq 0 \).
18.41 Type " The Guerrilla force strength has remained constant." if \( X(90)=0 \).
18.45 Type " There will be eventually (after infinite time)".
18.46 Type \( X(92) \) in form 11.
18.51 To step 18.59 if \( s=0 \) or \( X(90)<0 \).
18.55 Set \( X(99) = X(9) + (log(X(90) / (s*L^((1-0.01)))) / (g-G) \) if \( X(90)<0 \).
18.56 Set \( X(99) = X(9) + (log(X(90) / (s*L^((1-0.09)))) / (g-G) \) if \( X(90)>0 \).
18.561 To step 18.59 if \( X(99)<0 \).
18.57 Type "If conditions remain unchanged, 99 per cent of this number".
18.58 Type \( X(99) \) in form 12.
18.59 To step 18.7 if \( X(1) \leq 1000 \) and \( X(92) \leq 1000 \).
18.60 To step 18.7 if \( X(1) \geq 1000 \) and \( X(92) \geq 1000 \).
18.61 To step 18.7 if \( s \cdot L - 1000 \cdot (g-G) = 0 \).
18.62 To step 18.7 if \( X(90) / (s*L-1000*(g-G)) \leq 0 \).
18.63 Set \( X(97) = X(9) + (log(X(90) / (s*L - 1000*(g-G)) )) / (g-G) \).
18.64 Type " The number of Guerrillas will reach about 1000".
18.65 Type \( X(97) \) in form 20.
18.7 Line.
18.81 Type \( g \cdot X(92) \) in form 13.
18.82 Type \( G \cdot X(92) \) in form 14.
18.9 Line.

19.1 Do step 18.41 if \( g=G \) and \( s=0 \).
19.2 To step 19.7 if \( g=G \) and \( s=0 \).
19.3 Do step 18.35.
19.4 Do step 18.37.
19.5 Do step 18.45.
19.6 Type " An infinite number of guerrillas in the area.".
19.7 Line.

20.0 Set \( X(9)=1 \) if \( t=0 \).
20.01 To step 20.05 if \( t=0 \).
20.02 Set \( i=i+X(51) \).
20.05 To step 20.41 if \( g=G \).
20.1 Set \( N(t)=[s+L/(g-G)]*[1-exp([-g-G]*t)]+X(1)*exp([-g-G]*t) \).
20.2 Set \( S(t)=X(2)+s*L*t \).
20.3 Set \( K(t)=X(4)+[g/(g-G)]*[X(1)+S(t)-X(2)-N(t)] \).
20.4 Set \( R(t) = X(3) + \left[ \frac{G}{(G-G)} \right] \cdot [X(1) + S(t) - X(2) - N(t)] \).

20.405 To step 20.5 if \( g \leq G \).

20.41 Set \( N(t) = X(1) + s \cdot L \cdot t \).

20.42 Set \( S(t) = X(2) + s \cdot L \cdot t \).

20.43 Set \( K(t) = X(4) + g \cdot X(1) + t \cdot (g \cdot s \cdot L \cdot t^2) / 2 \).

20.44 Set \( R(t) = X(3) + g \cdot X(1) + t \cdot (G \cdot s \cdot L \cdot t^2) / 2 \).

20.5 Set \( X(11) = s \cdot L - (g - G) \cdot N(t) \).

20.6 Set \( X(14) = g \cdot N(t) \).

20.7 Set \( X(13) = G \cdot N(t) \).

20.8 Set \( X(12) = Z \).

20.9 Do part 21.

21.0 Page if \( S > 50 \).

21.05 Do part 22 if \( e \geq 0 \).

21.1 Line.

21.3 Type \( i, S(t), S(t)/L, X(12) \) in form 15 if \( e < 0 \).

21.35 Type \( S(t), S(t)/L, X(12) \) in form 25 if \( e \geq 0 \).

21.4 Type \( R(t), R(t)/A, X(13) \) in form 32.

21.45 Line.

21.5 Type \( K(t), K(t)/A, X(14) \) in form 16.

21.55 Line.

21.6 Type \( N(t), N(t)/A, X(11) \) in form 17.

21.9 Line.

22.1 Line.

22.2 Type \( i, E+i, e+i, E \) in form 22.

22.25 Type form 24.

22.3 Type \( E+i = S(t), [E+i-S(t)]/L, E-X(12) \) in form 23.

30.2 Type "Insufficient Data .......".

30.3 Type " Please Reconsider.".

31.1 Type " You have already given a successful Infiltration or Penetration".

31.2 Type " Rate, therefore the Penetration Probability must be > 0".

31.3 Do step 30.3.

32.1 Type " You must be kidding, more than 100 o/o ?".

32.2 Do step 30.3.

33.1 Type " You have already given a successful Infiltration or Penetration".

33.2 Type " Rate, therefore the Rate of Attempted Infiltrations or".

33.3 Type " Penetrations must be > 0".

33.4 Do step 30.3.

50.1 Type " CHANGE OF SITUATION:".

50.15 Line.

50.2 Set \( X(1) = N(t) \).

50.3 Set \( X(2) = S(t) \).

50.4 Set \( X(4) = K(t) \).

50.5 Set \( X(3) = R(t) \).

Form 1:
Length of Border: ______ miles
Form 2:
Infiltration Area: ______ square miles

Form 3:
Border Parameter: ______ miles per square mile

Form 4:
Initial Number of Guerrillas in Area: ______

Form 5:
Rate of Successful Infiltrations: ______ per month

Form 6:
Rate of Successful Penetrations: ______ per mile per month

Form 7:
Barrier Penetration Probability: ______ percent

Form 8:
Rate of Attempted Infiltrations: ______ per month

Form 9:
Rate of Attempted Penetrations: ______ per mile per month

Form 10:
Month | NUMBERS | DENSITY | OF CHANGE

Form 11:
______ Guerrillas in the area.

Form 12:
will be reached at calendar date: Month ______

Form 13:
The final attrition rate will be _____ per month;

Form 14:
The final recruitment rate will be _____ per month.

Form 15:
_____ Infiltrators across Border: ______ per mile _____ per month

Form 16:
Guerillas attrited in Area: ______ per mile^2 _____ per month

Form 17:
GUERRILLAS in AREA: ______ per mile^2 _____ per month

Form 18:
Internal Security Efficiency: ______ percent attrited per month

Form 19:
Barrier Interdiction Efficiency: ______ percent of infiltration
Form 20:
at calendar date: Month ______

Form 21:
from its initial value at calendar date: Month _____

Form 22:
_____ Attempted Infiltrations: _____ ___ per mile _____ per month

Form 23:
interdicted at Barrier: _____ _____ per mile _____ per month

Form 24:
Attempted infiltrations

Form 25:
Infiltrators across Border: _____ _____ per mile _____ per month

Form 29:
attents stopped.

Form 30:
Initial Number of Defenders in Area: ______

Form 31:
Guerrilla Recruitment Efficiency: _____ percent increase per month

Form 32:
Guerrillas recruited in Area: _____ _____ per mile2 _____ per month

Form 33:
DATE CUMULATIVE AREA TIME RATE

Form 34:
(This means that each group of about _____ guerrillas recruits

Form 36:
_______ percent attrited per month
Use library 51.
Roger.
Recall item 3 (BRD2).
Done.
Type size.

\[ \text{size} = 1042 \]

Type all.

1.01 # To start type : Do part 1.
1.1 Type " BORDER CONTROL MODEL".
1.12 Line.
1.14 Type " Version II : Continuous Evaluations ".
1.16 Line.
1.2 Do part 9.
1.25 Line.
1.3 Do part 3.
1.35 Line.
1.4 Do part 4.
1.45 Line.
1.5 Do part 5.
1.55 Line.
1.6 Do part 6.
1.65 Line.
1.7 Do part 7.
1.75 Line.
1.8 Do part 10.
1.85 To step 1.95 if s>0 and p>0.
1.86 Type " Insufficient Data ..." if s<0 and p<0.
1.87 To step 1.75 if s<0 and p<0.
1.9 Do part 11.
1.92 Type "Insufficient Data ...." if s<0 and E<0.
1.93 To step 1.65 if s<0 and E<0.
1.95 Do part 2.
1.952 Line.
1.96 Type " Ready for different assumptions and/or data.".
1.962 Page.
1.965 Delete E,Z,e,p,s.
1.98 To step 1.5.

2.01 Page if G>20.
2.1 Type " YOUR INPUT DATA AND IMPLICATIONS: ".
2.15 Line.
2.2 Type L in form 1.
2.25 Type A in form 2.
2.28 Type L/A in form 3.
2.29 Line.
2.3 Type M in form 4.
2.38 Line.
2.4 Type Z in form 5.
2.45 Type s in form 6.
2.48 Line.
2.5 Type 100·p in form 7 if p>0.
2.51 Type 100·(1-p) in form 19 if p>0.
2.515 Type form 29 if p>0.
2.52 Line.
2.55 Type 100*g in form 18.
2.58 Line.
2.6 Type e in form 8 if e>0.
2.65 Type E in form 9 if E>0.
2.68 Line.
2.7 Do part 15.
2.8 Page.
2.82 Type " R E S U L T S".
2.84 Line.
2.86 Type form 10.
2.9 Do part 20 for t=0(u)F.
2.92 Line.
2.94 Type U in form 11.
2.96 Type V in form 12.

3.1 Type " GEOGRAPHICAL DATA".
3.2 Demand A as "Area of Interest [square miles]".
3.25 Type step 30.1 if A<0.
3.26 To step 3.2 if A<0.
3.3 Demand L as "Length of Border [miles]".
3.35 Type step 30.1 if L<0.
3.36 To step 3.3 if L<0.

4.1 Type " CALENDAR".
4.2 Type " Starting date is Month Zero.".
4.3 Demand F as "End date (terminate after how many months):".
4.4 Demand u as "Size of time intervals (results every how many months):".
4.45 Type " Please reduce size." if u>F.
4.46 To step 4.4 if u>F.

5.1 Type " STARTING SITUATION".
5.2 Demand M as "Initial Number of Guerrillas in Area at Month Zero".
5.3 Set Q=0.
5.4 Set R=0.

6.01 Type " INPUT DATA".
6.02 Line.
6.1 Type " INTERNAL SECURITY".
6.2 Type "Efficiency of (Internal) Area Attrition Measures".
6.3 Demand g as " [give as percent attrited per month; e.g.: 50]:".
6.4 Type step 30.1 if g<0.
6.5 To step 6.2 if g<0.
6.6 Set g=g/100.

7.1 Type " BARRIER CHARACTERISTICS".
7.15 Line.
7.2 Demand Z as "Rate of Successful Infiltration [per month]".
7.3 Set s=Z/L if Z>0.
7.4 To step 7.7 if Z>0.
7.5 Demand s as "Rate of Successful Penetration [per mile per month]".
7.6 Set Z=s*L if s>0.
7.7 Line.
There are four different modes of operation available, depending on the type of input information given. Mode A: Infiltration or Penetration Rate only. Mode B: Infiltration or Penetration Rate, AND Barrier Efficiency. Mode C: Infiltration or Penetration Rate, AND Threat Characteristics. Mode D: Barrier Efficiency, AND Threat Characteristics. If there is no input to a question, please answer = -1.

Demand $p$ as "Probability of Penetration in percent".

Set $E=s/p$.

Set $e=1/E$.

Demand $e$ as "Rate of Attempted Infiltrations [per month]".

Set $E=e/L$ if $e>0$.

To step 11.7 if $E<0$.

Demand $E$ as "Rate of Attempted Penetrations [per mile per month]".

To step 11.9 if $E>0$.

Set $e=L-E$ if $E>0$.

Set $p=s/E$ if $s>0$ and $E>0$.

Set $s=p*E$ if $s<0$.

Set $Z=s*L$.

Set $V=Z-g*M$.

Set $U=s*L/g$.

Set $N(t)=(s*L/g)*(1-exp(-g*t))+M*exp(-g*t)$.

Set $S(t)=Q+s*L*t$.

Set $K(t)=R+S(t)-Q-[N(t)-M]$. 

Set $W=Z-V*exp(-g*t)$.

Set $X=V*exp(-g*t)$.

Do part 22 if $E>0$.

Do part 22 if $E<0$.

$S(t)/L,Z$ in form 15 if $E<0$.

$S(t)/L,Z$ in form 25 if $E>0$.

$K(t)/A,W$ in form 16.

$N(t)/A,X$ in form 17.
21.9 Line.

22.1 Line.
22.2 Type \( t \cdot e^{-t} \cdot E^{-t} \) in form 22.
22.25 Type form 24.
22.3 Type \( e^{-t} \cdot S(t) \cdot [e^{-t} - S(t)] / L \) in form 23.

30.1 Type "This is a required input for this program version."

Form 1:
Length of Border: _______ miles

Form 2:
Infiltration Area: _______ square miles

Form 3:
Border Parameter: _______ miles per square mile

Form 4:
Initial Number of Guerrillas in Area: _______

Form 5:
Rate of Successful Infiltrations: _______ per month

Form 6:
Rate of Successful Penetrations: _______ per mile per month

Form 7:
Barrier Penetration Probability: _______ percent

Form 8:
Rate of Attempted Infiltrations: _______ per month

Form 9:
Rate of Attempted Penetrations: _______ per mile per month

Form 10:
MONTH NUMBER DENSITY RATE OF CHANGE

Form 11:
Balance Parameter: ......... Final Guerrillas after infinite time.

Form 12:
Balance Rate: ......... per month initially.

Form 15:
____ infiltrators across Border: _______ _____ per mile _____ per month

Form 16:
Guerillas attrited in Area: _______ _____ per mile\(^2\) _____ per month

Form 17:
GUERRILLAS in AREA: _______ _____ per mile\(^2\) _____ per month
Form 18:
Internal Security Efficiency: __% percent attrited per month

Form 19:
Barrier Interdiction Efficiency: __% percent of infiltration

Form 22:
___ Attempted Infiltrations: ___ ___ per mile

Form 23:
interdicted at Barrier: ___ ___ per mile.

Form 24:
Attempted infiltrations

Form 25:
Infiltrators across Border: ___ ___ per mile ___ per month

Form 29:

attempts stopped.
V. SAMPLE PROGRAM RUNS

An example of a computer run of VERSION I is reproduced on pages 36 through 41. A sample of a computer run of VERSION II is reproduced on pages 42 through 44.

In addition, pages 45 through 49 are examples of the type of projected outcome that is computed in VERSION I (see also Table 8). The concept of "Eventual Number of Guerrillas in the Area" is used as an indicator of the effectiveness of operations. As derived with the analytical model, this number, as well as the "final" attrition and recruitment rates, are projections of the eventual outcome if all operations were continued without change for a mathematically infinite time. For practical purposes, it reflects whether, and to what degree, the trend of battle operations is favorable or unfavorable for the defenders. When mathematical conditions are appropriate (asymptotic solutions), the time when 99 percent of the "final" values are reached is also given.
Do part 1.

BORDER CONTROL MODEL

Version I: Analysis and Projections

Would you like a brief program description? Answer yes (1) or no (0) = 1

This program evaluates the performance of counter-infiltration programs in a country subjected to guerrilla activity. It permits the investigation of a variety of situations and presents the results in terms of situation projections and eventual outcome. Changes in the efficiencies of border control and area security systems can be made at any desired time to evaluate the probable consequences. The program is based on the basic model of border control, described in RM-6250-ARPA.

There are four different modes of operation available, depending on the type of input information given.

Mode A: Infiltration or Penetration Rate only.

Mode B: Infiltration or Penetration Rate, AND Barrier Efficiency.

Mode C: Infiltration or Penetration Rate, AND Threat Characteristics.

Mode D: Barrier Efficiency, AND Threat Characteristics.

If there is no input to a question, please answer = -1.

The program will automatically select the appropriate mode.

GEOGRAPHICAL DATA
Area of Interest [square miles] = 66000
Length of Border [miles] = 1200

CALENDAR
Starting date is Month Zero.
What date of re-evaluation is wanted? (New input data after how many months) = 8
Size of time intervals of output: (Results every how many months?) = 4

STARTING SITUATION
Initial Number of Guerrillas in Area at Month Zero = 100000
Initial Number of Defenders in Area at Month Zero = 500000

STAND BY
**INPUT DATA**

**INTERNAL SECURITY**
Efficiency of (Internal) Area Attrition Measures  
[percent of Guerrilla Force attrited per month; e.g.: 15] = 4

Efficiency of Guerrilla Recruitment  
[percent increase of Guerrilla Force per month due to new recruitments; e.g.: 4] = 1

**BARRIER CHARACTERISTICS**
Rate of Successful Infiltration [per month] = -1  
Rate of Successful Penetration [per mile per month] = -1

Barrier Interdiction Efficiency  
[give as Probability of NON-Penetration in per cent] = 0

**THREAT CHARACTERISTICS**
Rate of Attempted Infiltrations [per month] = 10000

**YOUR INPUT DATA AND IMPLICATIONS:**

<table>
<thead>
<tr>
<th>Length of Border:</th>
<th>1000 miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infiltration Area:</td>
<td>66000 square miles</td>
</tr>
<tr>
<td>Border Parameter:</td>
<td>0.0152 miles per square mile</td>
</tr>
</tbody>
</table>

| Initial Number of Guerrillas in Area: | 100000 |
| Initial Number of Defenders in Area:  | 500000 |

| Rate of Attempted Infiltrations:       | 10000 per month |
| Rate of Attempted Penetrations:        | 10.00 per mile per month |
| Barrier Penetration Probability:       | 100 percent |
| Barrier Interdiction Efficiency:       | 0 percent of infiltration attempts stopped. |

| Rate of Successful Infiltrations:      | 10000 per month |
| Rate of Successful Penetrations:       | 10.00 per mile per month |
| Internal Security Efficiency:          | 4.00 percent attrited per month  
|                                       | 8.0-06 percent attrited per month per defender |

| Guerrilla Recruitment Efficiency:      | 1.0 percent increase per month |
| (This means that each group of about 1000 guerrillas recruits ten new guerrillas each month in the area.) |

According to the input given, the program is operating in MODE D.
<table>
<thead>
<tr>
<th>Month</th>
<th>Attempted Infiltrations:</th>
<th>Attempted infiltrations interdicted at Barrier:</th>
<th>Infiltrators across Border:</th>
<th>Guerillas recruited in Area:</th>
<th>Guerillas attrited in Area:</th>
<th>GUERRILLAS in AREA:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 per mile</td>
<td>0 per mile</td>
<td>0 per mile</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>400000</td>
<td>0</td>
<td>40 per mile</td>
<td>40 per mile</td>
<td>.1 per mile</td>
<td>126385</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 per mile</td>
<td>0 per mile</td>
<td>.2 per mile</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>800000</td>
<td>0</td>
<td>80 per mile</td>
<td>80 per mile</td>
<td>.6 per mile</td>
<td>149787</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 per mile</td>
<td>0 per mile</td>
<td>.2 per mile</td>
<td></td>
</tr>
</tbody>
</table>

**PROJECTED OUTCOME**

(Eventual Balance Situation)
The Guerrilla force strength has been increasing from its initial value at calendar date: Month 0. There will be eventually (after infinite time) 333333 Guerillas in the area.

If conditions remain unchanged, 99 per cent of this number will be reached at calendar date: Month 142.

The final attrition rate will be 13333 per month;
The final recruitment rate will be 3333 per month.
Ready for different assumptions and/or data.

CHANGE OF SITUATION:

INPUT DATA

INTERNAL SECURITY

Efficiency of (Internal) Area Attrition Measures
[percent of Guerrilla Force attrited per month; e.g.: 15] = 8

Efficiency of Guerrilla Recruitment
[percent increase of Guerrilla Force per month due to new recruitments; e.g.: 4] = 1

BARRIER CHARACTERISTICS

Rate of Successful Infiltration [per month] = -1
Rate of Successful Penetration [per mile per month] = -1

Barrier Interdiction Efficiency
[give as Probability of NON-Penetration in per cent] = 75

THREAT CHARACTERISTICS

Rate of Attempted Infiltrations [per month] = 10000

YOUR INPUT DATA AND IMPLICATIONS:

Length of Border: 1000 miles
Infiltration Area: 66000 square miles
Border Parameter: .0152 miles per square mile

Initial Number of Guerrillas in Area: 149787
Initial Number of Defenders in Area: 500000

Rate of Attempted Infiltrations: 10000 per month
Rate of Attempted Penetrations: 10.00 per mile per month

Barrier Penetration Probability: 25 percent
Barrier Interdiction Efficiency: 75 percent of infiltration attempts stopped.

Rate of Successful Infiltrations: 2500 per month
Rate of Successful Penetrations: 2.50 per mile per month

Internal Security Efficiency: 8.00 percent attrited per month
1.6-05 percent attrited per month per defender

Guerrilla Recruitment Efficiency: 1.0 percent increase per month
(This means that each group of about 1000 guerrillas recruits ten new guerrillas each month in the area.)

According to the input given, the program is operating in MODE D.
## RESULTS

<table>
<thead>
<tr>
<th>DATE Month</th>
<th>CUMULATIVE NUMBERS</th>
<th>AREA DENSITY</th>
<th>TIME RATE OF CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Attempted Infiltrations: 80000</td>
<td>80 per mile</td>
<td>10000 per month</td>
</tr>
<tr>
<td></td>
<td>Attempted infiltrations interdicted at Barrier: 0</td>
<td>0 per mile</td>
<td>7500 per month</td>
</tr>
<tr>
<td></td>
<td>Infiltrators across Border: 80000</td>
<td>80 per mile</td>
<td>2500 per month</td>
</tr>
<tr>
<td></td>
<td>Guerillas recruited in Area: 10071</td>
<td>.7 per mile²</td>
<td>1498 per month</td>
</tr>
<tr>
<td></td>
<td>Guerillas attrited in Area: 40284</td>
<td>.6 per mile²</td>
<td>11983 per month</td>
</tr>
<tr>
<td></td>
<td>GUERRILLAS in AREA: 149787</td>
<td>2.3 per mile²</td>
<td>-7985 per month</td>
</tr>
<tr>
<td>12</td>
<td>Attempted Infiltrations: 120000</td>
<td>120 per mile</td>
<td>10000 per month</td>
</tr>
<tr>
<td></td>
<td>Attempted infiltrations interdicted at Barrier: 30000</td>
<td>30 per mile</td>
<td>7500 per month</td>
</tr>
<tr>
<td></td>
<td>Infiltrators across Border: 90000</td>
<td>90 per mile</td>
<td>2500 per month</td>
</tr>
<tr>
<td></td>
<td>Guerillas recruited in Area: 15479</td>
<td>.2 per mile²</td>
<td>1219 per month</td>
</tr>
<tr>
<td></td>
<td>Guerillas attrited in Area: 83551</td>
<td>1.3 per mile²</td>
<td>9754 per month</td>
</tr>
<tr>
<td></td>
<td>GUERRILLAS in AREA: 121928</td>
<td>1.8 per mile²</td>
<td>-6035 per month</td>
</tr>
<tr>
<td>16</td>
<td>Attempted Infiltrations: 160000</td>
<td>160 per mile</td>
<td>10000 per month</td>
</tr>
<tr>
<td></td>
<td>Attempted infiltrations interdicted at Barrier: 60000</td>
<td>60 per mile</td>
<td>7500 per month</td>
</tr>
<tr>
<td></td>
<td>Infiltrators across Border: 100000</td>
<td>100 per mile</td>
<td>2500 per month</td>
</tr>
<tr>
<td></td>
<td>Guerillas recruited in Area: 19916</td>
<td>.3 per mile²</td>
<td>1009 per month</td>
</tr>
<tr>
<td></td>
<td>Guerillas attrited in Area: 119042</td>
<td>1.8 per mile²</td>
<td>8070 per month</td>
</tr>
<tr>
<td></td>
<td>GUERRILLAS in AREA: 100874</td>
<td>1.5 per mile²</td>
<td>-4561 per month</td>
</tr>
</tbody>
</table>

## PROJECTED OUTCOME

(Eventual Balance Situation)  
The Guerrilla force strength has been decreasing from its initial value at calendar date: Month 8. There will be eventually (after infinite time) 35714 Guerillas in the area. If conditions remain unchanged, 99 per cent of this number will be reached at calendar date: Month 90. The final attrition rate will be 2857 per month;  
The final recruitment rate will be 357 per month.
Ready for different assumptions and/or data.

CHANGE OF SITUATION:

INPUT DATA

INTERNAL SECURITY
Efficiency of (Internal) Area Attrition Measures

[percent of Guerrilla Force attrite per month; e.g.: 15] =

I'm at step 6.3.

Delete all.
Do part 1.

BORDER CONTROL MODEL

Version II : Continuous Evaluations

There are four different modes of operation available, depending on the type of input information given.

Mode A: Infiltration or Penetration Rate only.

Mode B: Infiltration or Penetration Rate, AND Barrier Efficiency.

Mode C: Infiltration or Penetration Rate, AND Threat Characteristics.

Mode D: Barrier Efficiency, AND Threat Characteristics.

If there is no input to a question, please answer = -1.

GEOGRAPHICAL DATA
Area of Interest [square miles] = 66000
Length of Border [miles] = 1000

CALENDAR
Starting date is Month Zero.
End date (terminate after how many months?): = 8
Size of time intervals (results every how many months?): = 4

STARTING SITUATION
Initial Number of Guerrillas in Area at Month Zero = 100000

INPUT DATA

INTERNAL SECURITY
Efficiency of (Internal) Area Attrition Measures
[give as percent attrited per month; e.g.: 50]: = 4

BARRIER CHARACTERISTICS
Rate of Successful Infiltration [per month] = -1
Rate of Successful Penetration [per mile per month] = -1

Barrier In-Efficiency
[Probability of Penetration in percent] = 100

THREAT CHARACTERISTICS
Rate of Attempted Infiltrations [per month] = 10000
YOUR INPUT DATA AND IMPLICATIONS:

Length of Border: 1000 miles
Infiltration Area: 66000 square miles
Border Parameter: .0152 miles per square mile

Initial Number of Guerrillas in Area: 100000
Rate of Successful Infiltrations: 10000 per month
Rate of Successful Penetrations: 10 per mile per month
Barrier Penetration Probability: 100.0 percent
Barrier Interdiction Efficiency: .0 percent of infiltration attempts stopped.
Internal Security Efficiency: 4.0 percent attrited per month
Rate of Attempted Infiltrations: 10000 per month
Rate of Attempted Penetrations: 10 per mile per month

RESULTS

<table>
<thead>
<tr>
<th>MONTH</th>
<th>NUMBER</th>
<th>DENSITY</th>
<th>RATE OF CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0 per mile</td>
<td>0 per mile</td>
</tr>
<tr>
<td></td>
<td>Attempted Infiltrations: 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Attempted infiltrations interdicted at Barrier: 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Infiltrators across Border: 0</td>
<td>0 per mile</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Guerrillas attrited in Area: 0</td>
<td>0 per mile*2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GUERRILLAS in AREA: 100000</td>
<td>2 per mile*2</td>
<td></td>
</tr>
</tbody>
</table>

| 4     | 40000  | 40 per mile | 0 per mile |
|       | Attempted Infiltrations: 40000 |               |
|       | Attempted infiltrations interdicted at Barrier: 0 | 0 per mile |
|       | Infiltrators across Border: 40000 | 40 per mile |
|       | Guerrillas attrited in Area: 17822 | 0 per mile*2  |
|       | GUERRILLAS in AREA: 122178 | 2 per mile*2  |

| 8     | 80000  | 80 per mile | 0 per mile |
|       | Attempted Infiltrations: 80000 |               |
|       | Attempted infiltrations interdicted at Barrier: 0 | 0 per mile |
|       | Infiltrators across Border: 80000 | 80 per mile |
|       | Guerrillas attrited in Area: 38922 | 1 per mile*2  |
|       | GUERRILLAS in AREA: 141078 | 2 per mile*2  |


Balance Parameter: 2.500 05 Final Guerrillas after infinite time.
Balance Rate: 6.000 03 per month initially.

Ready for different assumptions and/or data.
PROJECTED OUTCOME
(Eventual Balance Situation)
The Guerrilla force strength has been decreasing from its initial value at calendar date: Month 12. There will be eventually (after infinite time) 0 Guerrillas in the area.
The number of Guerrillas will reach about 1000 at calendar date: Month 64

The final attrition rate will be 0 per month;
The final recruitment rate will be 0 per month.

Ready for different assumptions and/or data.
PROJECTED OUTCOME  
(Eventual Balance Situation)  
The Guerrilla force strength has been decreasing  
from its initial value at calendar date: Month 84.  
There will be eventually (after infinite time)  
2222 Guerrillas in the area.  
If conditions remain unchanged, 99 per cent of this number  
will be reached at calendar date: Month 94  

The final attrition rate will be 2000 per month;  
The final recruitment rate will be 0 per month.  

Ready for different assumptions and/or data.
PROJECTED OUTCOME
(Eventual Balance Situation)
The Guerrilla force strength has remained constant.

Ready for different assumptions and/or data.
PROJECTED OUTCOME
(Eventual Balance Situation)
The Guerrilla force strength has been increasing from its initial value at calendar date: Month 48.
There will be eventually (after infinite time) 125000 Guerrillas in the area.
If conditions remain unchanged, 99 per cent of this number will be reached at calendar date: Month 83.
The final attrition rate will be 12500 per month;
The final recruitment rate will be 2500 per month.

Ready for different assumptions and/or data.
PROJECTED OUTCOME
(Eventual Balance Situation)
The Guerrilla force strength has been increasing
from its initial value at calendar date: Month  72.
There will be eventually (after infinite time)
An infinite number of guerrillas in the area.

Ready for different assumptions and/or data.
VI. CONCLUDING REMARKS

The programs described here are only two of several versions that have been developed as part of the study of infiltration and invasion control. There are other versions that omit many of the descriptive sections and several of the internal program error controls. These have been used to evaluate several candidate border-control systems, since they save computer print-out time and space. With the help of this manual, such modifications can be effected easily.

In addition, other programs provide supplemental quantities that measure the effectiveness of operations, and sub-routines have been devised to permit trade-off analyses.

These programs are not available in the JOSS program library, and the authors may be contacted for further information.