

THIEF

*An Interactive Simulation of Nuclear
Materials Safeguards and Security*



Los Alamos

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Edited by Paul W. Henriksen, Group IS-11

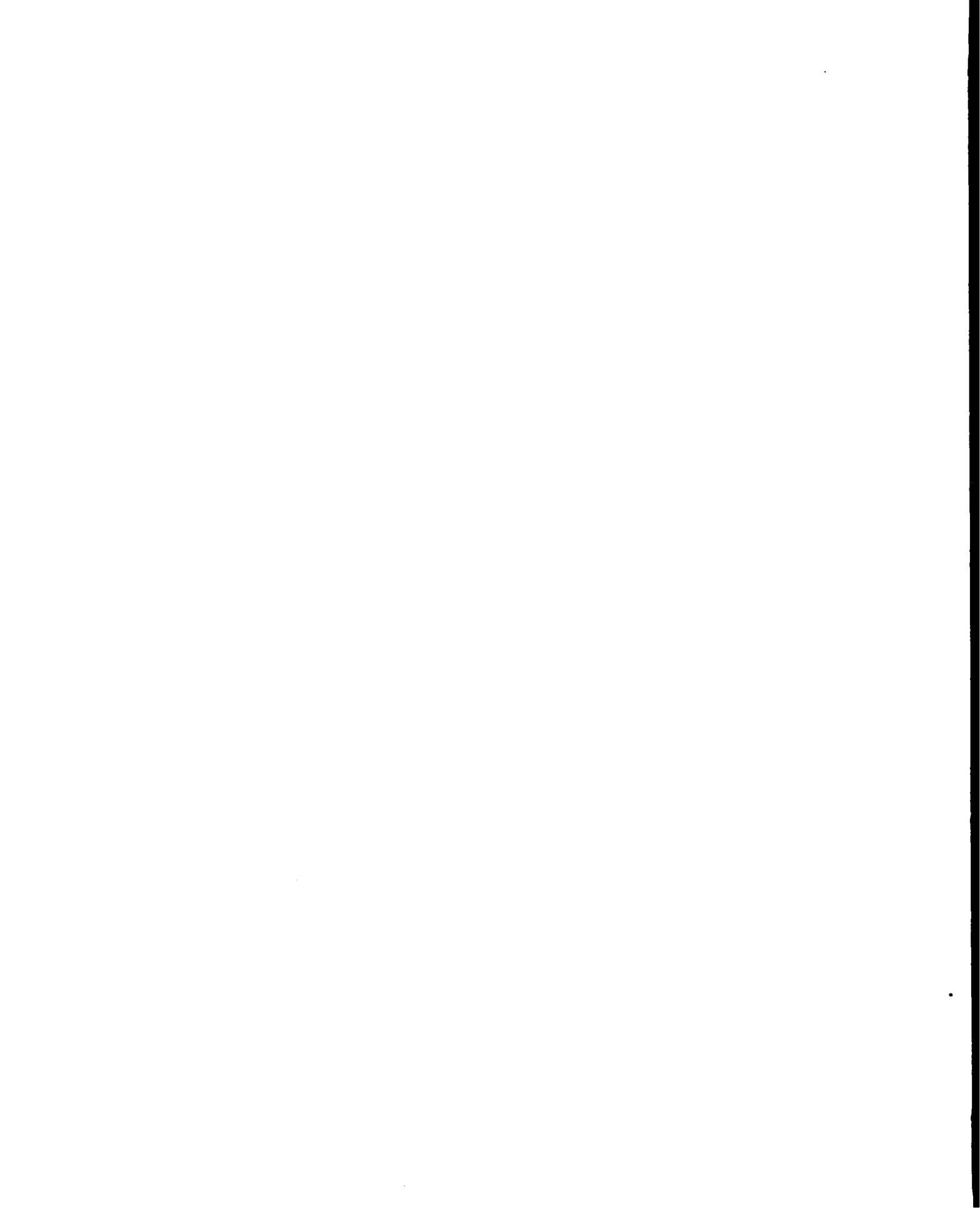
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W. D. Stanbro
P. W. Henriksen





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THIEF

AN INTERACTIVE SIMULATION OF NUCLEAR MATERIALS SAFEGUARDS AND SECURITY

by

W. D. Stanbro and P. W. Henriksen

ABSTRACT

This users manual is a guide to THIEF 2.0, an interactive simulation of safeguards and security at a nuclear facility. The program allows the user to create a model of a particular nuclear facility along with its safeguards features and then play the part of an adversary trying to steal special nuclear material from the facility. The program runs on IBM PC-compatible microcomputers with a minimum of 640 kbytes of RAM, an EGA or VGA graphics card, and preferably a color monitor.

I. INTRODUCTION

A. Overview

THIEF is an interactive simulation of the relationships between physical protection and materials control and accountability (MC&A) elements and an adversary trying to steal special nuclear material (SNM) from a facility. To investigate these relationships, the user first creates a model of an existing, planned, or fictional nuclear processing facility. The physical layout of the plant, process details, physical protection precautions, and MC&A elements may all be modified within certain constraints. The computer simulates the facility. The user plays the role of the adversary and tries to steal SNM. The adversary's knowledge can be modified by changing his or her access to information about the plant and the flow of nuclear materials. The adversary's physical access to parts of the plant at various times of the day can also be specified. Also a collaborator can work with the adversary to provide information and physical access.

The program employs a "user friendly" graphical interface to allow users with limited computer experience to use the simulation with ease. The program is implemented in Turbo C and C++ for IBM PC-compatible computers with 640 kbytes of RAM, EGA or VGA graphics, and, if possible, a color monitor.

B. Setting and Assumptions

1. Threat

In THIEF the threat is a plant employee (the adversary) who desires to remove significant amounts of SNM from the plant. To do this the adversary will not resort to violence, but will use any other avenue to steal SNM. The adversary has access to at least some areas of the plant where nuclear materials are processed and also may have access to information about the plant's materials accounting system. The adversary's physical and information access can be varied to simulate different employees. For example, the adversary may be allowed access to specific buildings in the plant or to any building in the plant; the adversary's knowledge of materials accounting reports published each accounting period and the cumulative data on the accounting system's performance may also be restricted. Limiting access increases the probability of detection if the adversary carries out any action in a restricted building. The hours the adversary can be in the plant can also be limited. Actions outside of normal working hours also increase the probability of detection. The program also allows the existence of a collaborator to facilitate stealing SNM. It is important that the restrictions be realistic for the plant in question, so that the simulation creates useful data on how the safeguards can be improved.

2. Facility Description

The facility is described in THIEF on three different levels. The first level encompasses the entire plant and shows the arrangement of the fenced enclosure and buildings. The model is presently limited to one enclosure and two buildings.

The second level of description indicates the processes in each building. The processes are designated by symbols that indicate such things as pipes, reactors, mixers, and separators. The detectors and instruments used at various points in the facility are also designated.

At the third level of detail the program lists the attributes of points throughout the facility that the user has defined. An adversary acts with reference to these points, which are uniquely numbered and include the physical barriers in the facility and the parts of the plant through which the SNM flows. For example each portion of the fence has a number; if the adversary wants to throw some SNM over the fence, the user must specify the part of the fence over which it will be thrown. Other numbered points include the location in a process stream where material enters a materials balance area (MBA) and the portals through the enclosures and buildings. Such points might have instruments to measure concentration and flow for accounting purposes, or a detector to indicate the presence of radioactive material or unusual

amounts of metal. A map of an example enclosure and buildings with the parts numbered is included in Section IV.

II. SYSTEM REQUIREMENTS AND INSTALLATION

A. System Requirements

THIEF runs on IBM PC-compatible computers with at least 640 kbytes of memory. An EGA or VGA graphics card is also required. The program runs under PC-DOS or MS-DOS versions 2.0 or later. A math coprocessor chip is not required, but will be used if it is available. THIEF is best run from a hard disk. However, it can be run from a high-density 5 1/4 in. floppy disk or either a high- or low-density 3 1/2 in. floppy disk.

B. Installation

Installation on a Hard Disk. Create a directory on your hard disk to hold the THIEF program and its data files. Next copy all of the files from the distribution disk into this directory. THIEF will always look in the current default directory for its input files. It will also save its output files to this directory. You are now ready to run THIEF.

Installation on a Floppy Disk. Copy all of the files on the distribution disk to the floppy disk. THIEF assumes that the floppy disk with the program and the data will be in the computer's default drive. The floppy disk must be a high-density 5 1/4 in. disk, a low-density 3 1/2 in. disk, or a high-density 3 1/2 in. disk.

Files Supplied with THIEF. Two types of files are supplied on the THIEF distribution disk. Files with the extension .EXE contain the executable code. Files with the extension .DAT contain the input data for an example scenario. When it is run, THIEF produces a third type of file with the extension .PRN. This file, an ASCII text file that is compatible with Lotus 1-2-3, contains the output data. THIEF expects all of these files to be in the default drive or directory when it runs.

III. STARTING THIEF

To start THIEF, first make the drive and directory containing the THIEF files the default drive and directory, for example, by typing `cd \thief <ret>`. Next type `thief2 <ret>`. You will see a title screen. Follow the directions on the screen until you get to the Main Menu, as shown below.

THIEF

I)input or edit a scenario (Archive old scenarios first)
A)rchive or retrieve an old scenario
R)un THIEF (Archive output first)
archive O)utput
Q)uit

Choice: ---

Option **I**, described in Section V, allows you to create your own THIEF scenario by editing the example scenario or entering a completely new facility description. This choice will change the example scenario, so first archive it (choice **A**) if you wish to save it. Saving the example scenario is highly recommended because it is complete and will be useful for reference later. The archiving-scenarios option is explained further in Section VI.

The **R** option runs the THIEF program. This is explained in Section IV. Running THIEF will destroy the existing output file, which contains the results from the previous playing of the game. Use choice **O**, described in Section VI, to save an existing output file for evaluation.

The final choice, **Q**, allows you to exit from THIEF.

Practical Note: Type the single letter preceding the closing parenthesis to access that option. Most menu choices in THIEF are made in this fashion.

IV. RUNNING THIEF

A. Options

By selecting the **R** option from the main menu when using the example scenario, you will see the main THIEF screen as shown in Fig. 1. If the scenario is changed, the main THIEF screen will change accordingly. The four sections of this screen display the basic information and commands needed to play the game. Let's discuss the commands individually.

1. Controls

In the upper left corner is the Controls menu. Pressing **S** starts the game. The word **START** appears on the right side of the Status screen and a window pops up with the account balance information. Pressing **S** a second time calls up a window that asks if you really want to quit the game. You may answer yes or no.

Pressing **I** calls up a menu of basic elements of the game for which you might want further information. The game pauses while these information screens are active. **F**, for facility status, indicates if the facility is operating, gives the status of the vehicles entering or leaving the facility, and lists the detectors that are in use on the vehicles. **T**, for thief characteristics,

tells you the types of information that the adversary can know and where and when the adversary can be in the facility. **C**, for collaborator characteristics, calls up similar data for the adversary's collaborator in the facility. **P**, for points, gives information on the characteristics of the facility at any point. This point can be on the facility layout map or in the maps of the processing equipment. **R**, for accounting records, brings up a chart of the inventory differences for the MBAs. **I**, for instruments, gives information on the instruments used to analyze materials in the facility. First you will see the question "Which Instrument?" You will need to supply the name of the instrument. For the example scenario, the following instruments are used:

- chemistry—chemical analyzer,
- nda—nondestructive assay device,
- ms—mass spectroscope,
- count—item counter, and
- flow—flow measurement device

If you create your own scenario, you may enter the name of any instrument you create.

Pressing **D** for detectors prompts the question "Which Detector?" Again type in the name of the detector for which you desire information. The following is a list of the detectors used in the example scenario.

CONTROLS		ORDERS	
toggle S)tart/S)top	Q)uit orders	M)ove	
I)nfomation	toggle ctrl-M)aps	L)oad	
toggle M)aps	ctrl-I)nfomation	U)nload	
toggle P)ause	use util)ty line	B)reach	
C)lock	O)rders	U)nload to U)ehicle	T)hrow

STATUS	
Day: 1, Monday	
Time: 0000	
THIEF	
SNM: 0	Shielding: 0
Enclosure: Outside	
Building: Outside	
SNM CACHED	
Enclosure 1: 0	
Building 1: 0	
Building 2: 0	
SNM STOLEN	
Total: 0	

Fig. 1. Main THIEF screen for running the simulation.

- radiation: detects radiation from people
- metal: detects metal
- breach: detects forced entry or exit
- vehicle_SI: inspector for vehicles
- vehicle_radiation: detects radiation in vehicles
- SI: security inspector
- motion: detects illegal motions
- co-worker: employee to report illegal acts

Pressing **S** for symbols brings up a table of the symbols and their names. There are several screens of these symbols.

The next command is **toggle M)aps**. The default display is the facility map shown in the lower left corner of Fig. 1. Press **M** to get a diagram of the processing line for Building 1. Press **M** again to get a map of the processing line for Building 2. The game will continue to run while these maps are up on the screen. Press **M** again to return to the overall facility map. These maps are displayed in Figs. 2 and 3.

Toggle P)ause allows you to pause the game at any time. Press **P** to activate this option.

The **C)lock** command allows you to set the speed of the game clock to fast, medium, or slow. Press **F**, **M**, or **S** to select the speed.

The last command in that portion of the screen is the bridge to the upper right portion of the screen. Press **O** to begin giving orders. A small window will appear on the right side of the Orders square. You may now order the adversary to move, take things, and remove them from the facility. When you have finished making the adversary do things, press **Q** to exit the Orders portion of the screen.

2. Orders

The maps and information screens are still available while in the Orders mode. To toggle them on or off press **Control-M**. You will get the same information screens as in the Controls portion of THIEF.

Seven basic actions are allowed for the adversary: moving, loading, unloading, breaching, throwing, using the utility line, and unloading material to a vehicle. Each command will ask for the information to complete the action, for example, where will the adversary move and how much SNM will be unloaded or loaded. Location on the map is designated by the point number shown on the map. Each action uses up five minutes of simulated clock time. This usually does not affect playing the game, but time does fly. Enter information as prompted on the screen. Press **Q** to quit the Orders screen and return to the game.

3. Maps

The lower left portion of the screen gives a map of the facility that can be replaced with maps of the processing lines in the buildings at the user's discretion, as explained above.

4. Status

The lower right portion of the screen is the status box. It displays the day and the time, the location of the adversary, and the amounts of SNM that have been stolen or cached.

Before starting the game, look through the various options to gain a feel for the nature of the scenario. The adversary may take no actions until the game starts. Starting the game displays

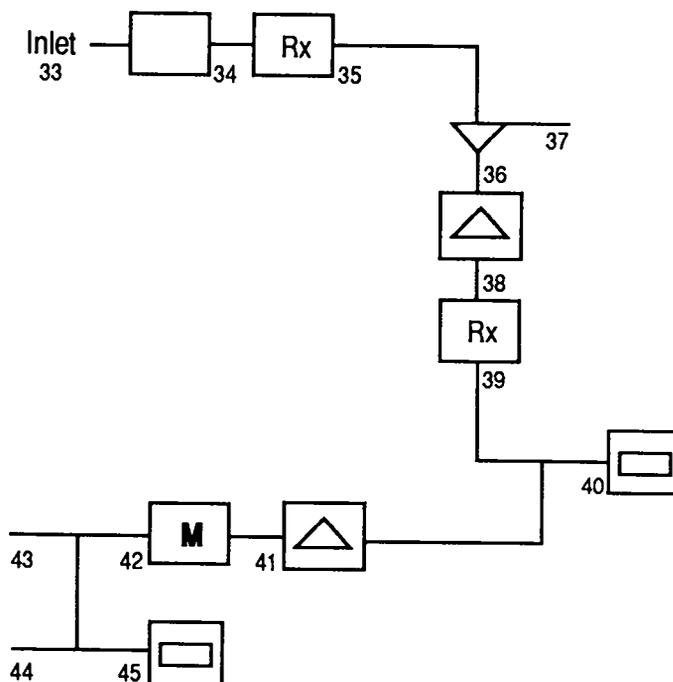


Fig. 2. Process map for Building 1 in the example scenario.

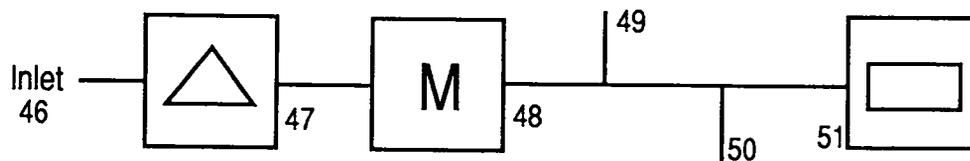


Fig. 3. Process map for Building 2 in the example scenario.

a window giving the MC&A information for the most recent accounting period if the adversary or collaborator has access to this information. A similar window will be displayed after each accounting period. You are also informed when a vehicle enters or leaves the facility.

B. Playing the Game

The goal of the game is to steal enough SNM, the goal quantity, to create a nuclear device (bomb). In the example scenario this amount is arbitrarily set at 5 kg, although you can set the amount to any value. The simulation starts with the adversary outside the facility (Enclosure 0 and Building 0). The first action that you can take upon starting the game is to move into the enclosure, but not into one of the buildings. Upon receiving the order to move, THIEF will ask to which Enclosure, then to which Building, then through which portal you want to move. The first movement requires you to answer Enclosure 1, Building 0, and Portal 22, if the example scenario is used. The next action is up to you, either building may be entered or the adversary may try to breach the walls. After that the adversary can move in and out of the buildings and pick up and move shielding or SNM. All actions are made with reference to the points on the maps shown on the screen.

The adversary's primary actions are to divert various amounts of SNM from the process lines and get the SNM out of the facility. To do so requires cunning. Taking too much at once makes it likely that the portal monitors will catch the adversary. Taking too little makes it probable that the repeated actions will become obvious to someone else in the plant and the adversary will be caught. Deciding how much to take is up to the adversary. Be careful to only try to enter the facility during the times allowed by the game. Getting caught means having to restart THIEF.

Practical Note: To use a vehicle to sneak SNM out of the facility, the adversary has to be in the enclosure but outside the buildings, otherwise the game will display an illegal vehicle use message.

If you win the game, a yellow screen will congratulate you and the program will terminate.

V. ADDING OR CHANGING SCENARIOS

An example scenario is provided with the game. It specifies a facility with one enclosure, two buildings, and a variety of instruments and detectors. Creating an entirely new scenario or changing the provided scenario is an option that you will want to exploit to test the safeguards in a real or planned facility.

Perhaps the most difficult task associated with THIEF is entering the information to create a new scenario because a large amount of information is necessary to define a scenario and some degree of abstraction is necessary to put real facility information into the program. The scenario input module facilitates this process by prompting you in a logical way for the required information. The following screen is displayed when the input option is selected.

THIEF SCENARIO GENERATOR

D)efine scenario

U)iew scenario

Q)uit

Option **D** allows you to define a new scenario or edit an existing scenario. Both options follow the same basic format. You are presented with a series of items for which the characteristics can be changed or left at the default value in parentheses. You have the option of redefining the entire scenario or any part of it. Any changes made during a session will be saved to the current input data file. Therefore, it is important to archive files as described in Section VI to prevent their destruction.

Option **U** allows you to view the current scenario only.

Option **Q** allows you to return to the main menu.

In the **D)efine scenario** option it is logical to first enter the characteristics of the detectors and instruments, then define the enclosure and its point labels, and then construct the process details and assign their point labels. The instruments must be defined before they are installed in the facility. Follow the screens, in order, to accomplish this automatically. Once the points have been defined, the characteristics of the SNM flow for each point can be entered. You may then enter the safeguard system features, including the instruments and detectors to be used, the vehicle schedules, the adversary access characteristics, and the characteristics of the collaborator. In general, as you are queried for information, the current value will be shown, usually in parentheses.

Practical Note: At some places in this option typing **q** will allow you to quit that option. Be sure not to type in **q** at any option in which a text string is the desired response. Typing **q** will substitute **q** for the name of the instrument.

Once the name of the instrument is entered, THIEF will prompt for the systematic error and random error. Enter a number if you want to change the default. You will encounter the following items if you choose the complete scenario option in either the input or view mode.

A. Instrumentation

The first question is "How many instruments?" The answer is the number of different instruments you wish to use in the facility. The example uses six. If you would like to keep those six and add n more, type in a number equal to n plus six at the prompt. THIEF will accept up to 20 instruments. Instrument number 1 is "no instrument," designating that no instrument is installed at a certain point in the facility.

The following instruments are used in the example scenario.

1. This number is reserved for the absence of an instrument.
2. "chemistry" (any chemical analysis instrument)
3. "nda" (nondestructive assay instrument)
4. "ms" (mass spectroscopy instrument)
5. "count" (item counter for items passing through the facility)
6. "flow" (flow rate meter)

If you change or add an instrument you will be asked to name it. You may name it anything you want, using up to 39 letters. The next parameter is the systematic error. The number you enter here specifies the multiple of 100% that is the systematic error for the instrument. Thus if you enter 1, the systematic error will be 100% of the experimental value. If the measured value is 1, then the real value could be anything between 0 and 2. If you enter .01 then the systematic error will be 1% of the experimental value. The next parameter is the random error which is also expressed as a multiple of 100%. It is the limit on the random amount by which the measured value could change each time an instrument measures the same item.

These questions are repeated for each instrument up to the number you chose for the facility. If you want to reduce the number of possible instruments in the facility, enter a number of instruments less than the number given by THIEF for the total number of instruments. Then follow the prompts to redefine the instruments in the facility. THIEF will erase the highest numbered instruments listed.

B. Detectors

This portion of the program allows you to specify the types of detectors allowed in the facility. You are first asked how many detectors to be defined. Again enter the number of different kinds of detectors to be used in the facility. If you want to reduce the number of possible detectors in the facility, enter a number less than the number given by THIEF for the total number of detectors in the facility. Then follow the prompts to redefine the detectors in the facility. THIEF will erase the highest numbered detectors. The detectors used in the example scenario are numbered as follows.

1. Reserved for the "no detector" option
2. "radiation" (detects radiation from pedestrians)
3. "vehicle radiation" (detects radiation from vehicles)
4. "metal" (detects the presence of metal)
5. "SI" (human security inspector)
6. "breach" (detects forced entry or exit)
7. "motion" (detects movements)
8. "vehicle SI" (human security inspector for vehicles)
9. "co-worker" (employee to report on illegal acts)

You are then asked to specify the radiation shielding factor. This is the number of kilograms of shielding needed to completely shield 1 kg of SNM. You will now be presented with a series of screens for each detector you specified. First name the detector; you may choose any name you wish, using up to 39 characters. Next give the sensitivity of the detector. This number is the number of kilograms of material that will give the maximum probability of detection. The program assumes that there are maximum and minimum probabilities of detection and a linear relationship between them. The program next prompts for the minimum detection probability and then the maximum detection probability. Then the program asks if the detector is a vehicle detector. Answer yes or no.

The next screen allows you to choose the algorithm that determines the detection probability to apply to each detector. You are given five choices. Each choice represents a different algorithm for representing the response of the detector. These five algorithms use the parameters of sensitivity, maximum probability, and minimum probability in different ways to represent different types of detectors as follows.

1. Adversary's Presence.

This type of algorithm would be appropriate for a security inspector charged with seeing that certain access rules are obeyed. It might also be used for a motion detector at a point where access is forbidden at certain times of the day. This algorithm sets the detection probability equal to the maximum probability parameter if certain conditions are met; the probability is set to zero otherwise. The other parameters are not used. The conditions depend on whether the adversary or a collaborator has access to a building at that time and day, whether the two-man rule is in effect, or whether access is allowed to SNM.

2. Amount of SNM and Shielding.

This second type of algorithm would apply to a radiation detector because the detection probability depends on the amount of SNM and shielding material. The probability of detection varies linearly between the minimum and maximum probabilities. The slope is given by the sensitivity, which is the amount of unshielded material giving the maximum probability of detection. The shielding reduces the effective amount of SNM. To compute the effective amount of SNM, subtract from the amount of SNM the amount of shielding divided by the shielding factor described above.

This algorithm models the overall response of a system that includes the humans who must respond to an alarm. This means that the maximum probability may be less than one because a human could miss an alarm. Conversely, the minimum probability may be greater than zero because of the chance that SNM would be discovered even if an alarm were not tripped.

3. Mass of SNM Moving.

This would apply to a detector designed to monitor SNM moving through or over a point, such as SNM being thrown over a fence. The response for this type 3 algorithm depends on

the amount of SNM. An example might be a microwave beam between a double fence. All the parameters used for the type 2 algorithm above are used here.

4. Continuity Being Broken.

A detector using this type 4 algorithm would be used to detect a hole in a fence or a broken wall. The detection probability is set equal to the maximum probability parameter and the other parameters are not used.

5. Mass of Shielding.

This type 5 algorithm would apply to a metal detector that responds to the amount of shielding. All three parameters are used in the same manner as algorithm 2.

These screens are repeated for each type of detector.

C. Facility

This section lets you specify the number of buildings and their location on the board used in the game. The first prompt is for the number of buildings: 0, 1, or 2. The next prompt is for the building labels. First you are asked for the row, 0 to 7, and then the column, 0 to 7, for the center of the building. Figure 4 is a grid representing the screen. THIEF then prompts for the text to describe the building. Type in anything you like; it will appear on the screen in the middle of the building, similarly for Building 2, if it exists.

The next prompt is for further definition of the facility. You have three options here. Choose **B** to describe buildings, walls, or fences. Choose 1 to describe Building 1 plant processes, or 2 to describe Building 2 plant processes. [To conclude each of these three sets of screens answer **q** to the prompt at the end and re-enter the **Define scenario** option to do the other two sections.] To fill in the physical map, you must specify the row and column numbers from Fig. 4 for each point on the perimeter of the building or enclosure. Then choose the symbol number for the type of barrier you want from those listed in Fig. 5. Some barriers, such as plain walls and fences, have no other numbers associated with them. Some parts of the perimeters, such as doors, have a number associated with them. These positions on the symbols are numbered 1, 2, or 3 as indicated in Fig. 5. You will be prompted to enter the point number for each position. Number them sequentially starting from some point on the perimeter of the facility. If a perimeter section has fewer than three positions to be specified, enter a carriage return for the null positions. You may choose not to number all the positions.

When you have finished entering all the information for the building or enclosure perimeters you must quit that section and re-enter it to specify the processes for Buildings 1 and 2. In the plant processes section, you will fill in information on the process map through the row, column, and symbol numbers and the point numbers. These questions are repeated for Building 2 if one is in the facility.

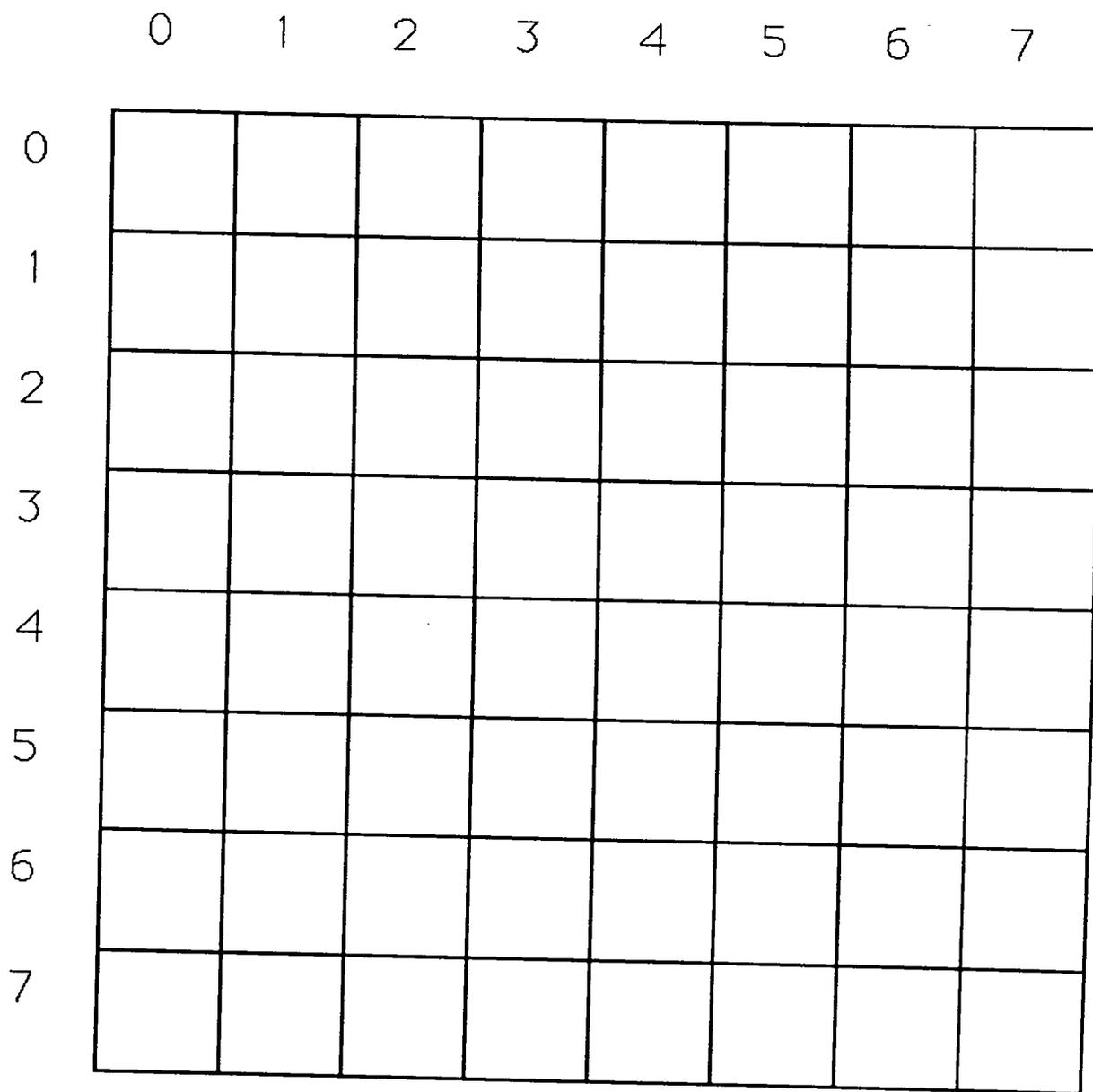


Fig. 4. Sample grid for placing buildings and barriers on the playing screen.

Number	ID	Symbol
0	Blank	
1	Inlet	Inlet 1
2	Tank	
3	Tee	
4	Pipe	
5	Pipe	
6	L joint	
7	L joint	
8	Wall	
9	Wall	
10	Door	
11	Door	
12	Wall corner	
13	Wall corner	
14	Wall corner	
15	Wall corner	
16	Fence	
17	Fence	
18	Gate	
19	Gate	
20	Fence corner	
21	Fence corner	
22	Fence corner	
23	Fence corner	
24	L	
25	L	
26	Tee	
27	Blender	
28	Separator	
29	Reactor	
30	Reactor	
31	Tank	
32	Furnace	
33	Furnace	
34	Vault	
35	Vault	
36	Machine	
37	Machine	
38	Utility Lines	
39	Utility Lines	
40	Utility Lines	
41	Utility Lines	

Fig. 5. Symbols used in THIEF to represent parts of the facility. The numbers on the symbols represent points for that symbol where safeguards instruments and detectors may be assigned. The order in which THIEF will prompt for sequential numbers for that symbol to link it to the facility map is the same as the order of the numbers shown on the symbol.

First you will be prompted for a row number. This designates the row on the process map where the first item in the process line will be displayed. Then you will be asked for the column number for that item. Then the program will ask for the symbol number. This is the number from Fig. 5 that designates the symbol you chose. Next you are asked to name the "point in position 1." Assign a number in sequence with the points on the facility map. Symbols have from 0 to 3 points to label. You do not have to label them all, but you may only assign instruments or detectors to a part of a symbol if that point is numbered. The order in which the points are to be numbered is indicated in Fig. 5 by the numbers 1, 2, or 3.

D. Points

In this section you will give THIEF details about the SNM available at certain points in the facility. THIEF prompts you for the point number or a **q** to quit. To specify a point on the game board type in the number of the point, such as 1. You have defined these points in previous steps. THIEF first asks for building designation (0 for a point not in a building but in the enclosure, 1 for Building 1, or 2 for Building 2). Then THIEF asks for flow rate of material in kg/day, the concentration of the SNM in kg/kg, the inventory in kg, and the fraction of inventory change per accounting period (a number between 0 and 1).

E. Safeguards and Security Systems

THIEF first asks for the number of days in an accounting period (the shorter an accounting period, the more difficult it will be to sneak out a large amount of SNM). Next THIEF asks if the two-man rule is in effect. This means that someone besides the adversary must be in the plant with the adversary if he or she wants to handle SNM legally. Then the program asks for the number of MBAs.

THIEF then asks for the point to safeguard or a **q** to quit. Here you must specify one of the numbered points previously defined in the scenario. You are first prompted for the MBA for that point; choose 0 if the point is not to be in an MBA. The next piece of information is the point type: choose from **I**input, **O**output, **I**nventory point, or **none of the Above**. You must select one of these choices. THIEF does not default to a current value here. Input and output point choices bring up the same series of screens. First you are asked for the volume or mass flow. Type in the number you have chosen for that point, but do not specify the units. Units of kg/day or L/day are implied for the two flows. Concentration comes next. Here THIEF will assign units of kg/L or kg/kg. Be consistent with the volume or mass flow. Inventory measurement comes next. Specify the name of the instrument to make the measurement, choosing from the list of defined instruments entered previously, such as a counter or a mass spectrometer. Be sure to use the same spelling and capitalization for each instrument name that you entered previously. Finally specify the number of measurements you wish to have that instrument make in each accounting period.

Inventory points bring up two additional screens. You will be asked if you want to install tamper indicating devices (TIDs) or perform daily administrative checks (DACs). Both of these safeguards elements are based on the idea of an item.

An item is a sealed container of SNM that can be handled and inventoried as a unit. A TID is a device such as a seal or tag that indicates that an attempt has been made to open a container. If you answer **Y** to the question about TIDs, you will be asked for the probability that tampering will be detected. If any SNM is removed from this point, THIEF will assume that a sealed container has been opened and will detect the removal with the probability specified.

A DAC is a simple counting of all items at the point in question. If you elect to use a DAC at a point, you will be asked for the amount of SNM in an item and the probability of detection. Any diversion of an amount of SNM greater than or equal to the amount in an item will be detected with the probability you just specified. DACs are performed at the beginning of each day.

Finally THIEF will list the detectors that have been designated to safeguard the point and ask if you want to change them. Do so if you wish.

F. Vehicles

First you will be asked for the number of vehicles. You may use as many as four. Then you may specify the time (in military units) when each vehicle will enter the facility and when it will leave the facility.

G. Thief

In this section you specify the characteristics of the adversary and the information to which the adversary has access. First, you are asked if the adversary can have access to materials control and accounting data. Second, you are asked if the adversary can have access to SNM. Third, you are asked if the adversary can have access to physical security information, that is, information about detectors, instruments, or other security devices.

The second screen allows you to designate the buildings to which the adversary may have access. The third screen allows you to set the hours the adversary may legally be in the facility. The fourth screen allows you to set the days of the week on which the adversary may be legally in the facility.

The next screen asks if there is a collaborator. If you answer yes you will be asked the same questions as for the adversary. Answers here may be different than for the adversary.

The **View scenario** option operates in much the same way as the information screens in the game. The Map, Descriptions, Thief, Collaborator, Safeguards, and Vehicles options are also available in the scenario input part of the program. To access these options enter **M**, **D**, **T**, **C**, **S**, or **V**.

The safeguards option specifies the MC&A system, that is, the number of MBAs, the accounting period, and if the two-man rule is in effect, i.e. someone is watching when SNM is accessed. The second screen lists the input, output, and inventory points for the first MBA

and the third screen lists the same information for the second MBA. More screens follow if more MBAs are specified.

The Descriptions section contains information about points, instruments, detectors, and symbols. It lists the instruments and detectors and gives the map and grid numbers for the playing field. Under **P)oint**, type in the number of the point and it will display the flow rate, the concentration, the inventory, and the instruments and detectors at that point. Under **I)nsstrument**, it will ask you to specify an instrument. Enter the name of the instrument from the previously discussed list: chemistry, nda, ms, count, or flow. The program will display the systematic and the random error associated with each instrument. Under **D)etector**, after you enter a name from the list of detectors it will display the sensitivity of the detector and tell you the minimum and maximum probabilities of detection. All eight types of detectors are discussed. Under **S)ymbols**, it will display each of the 41 symbols used in the game, identify each symbol, and display the symbol number. A complete list is included in Fig. 5.

Practical Note: When typing in symbol names that are longer than one word, you must type in the underline character between the words.

Under **L)ist instruments and detectors**, THIEF prints a list of all the instruments and detectors used in the game. The **M)ap grid numbering** option gives the coordinates of each point on the game board.

VI. ARCHIVING DATA FILES

A. Input Data Files

Choosing option **A)** for archive under the main THIEF menu lets you put aside any scenario or run file for later use. You should always use this option before identifying a new scenario, just in case you want to use the previous scenario again. THIEF expects input data files to have a standard name with the extension .DAT. To save input data files, use the **A)** option in the main menu to change the extension from .DAT to another three letter combination. The **A)** option also allows old scenario input files to be made current input files by changing their extension back to .DAT again.

You might also want to archive output files to save the results of playing the game. This is option **O)** under the main menu. See part B below.

Choosing the **A)** option gives you the following screen.

THIEF Archive Utility

A)rchive run files

C)onvert archived files to run files

Q)uit

Choice: _____

Choice **A** asks you for the archive filename extension for the file to be saved. Type in a three letter file name extension. THIEF will convert the .DAT filename extension to the new one. Giving it more than a three letter name will result in the first three letters being used for the extension. The program will save the file and send you back to the THIEF Archive Utility screen. When you enter a new scenario, it will have the file extension .DAT. To reuse a previous file you must now archive the current file before retrieving another one to use.

To get an archived file back, use the **C)onvert archived files to run files** option and type in the file extension you chose when you archived it.

B. Output Data Files

The output data file is named TSAVE.PRN. To avoid writing over this file when a new THIEF run is made, the file must be renamed. The new file will retain the .PRN extension so it is still Lotus 1-2-3 compatible. To archive an output file select **Q** from the main menu. You will be asked for the new file name without the extension. Give it any name you wish, using up to eight letters. DOS rules apply to the characters you may use in specifying the file name. You will then be sent back to the THIEF main menu.

VII. OUTPUT FILE FORMAT

THIEF's output file contains information useful for documenting and reconstructing a run of the program. This information is stored as an ASCII text file that can be read by Lotus 1-2-3. The information is arranged as a matrix with the rows corresponding to different events and the columns containing the information shown in Table I.

The Action Code indicates that an action has been successfully completed by the adversary or gives the reason for a game's termination. The meanings of the Action Codes are shown in Table II.

Table I. Column Identification in Output File

Column Number	Explanation
1	Action Code (see below)
2	Day
3	Hour
4	Minute
5	Enclosure where thief is located
6	Building where thief is located
7	Amount of SNM (kg) held by thief
8	Amount of SNM (kg) stolen (removed from site)

Table II. Action Code Meanings

Action Code	Meaning
0	Thief moves through portal.
1	Thief loads SNM or shielding from cache or point.
2	Thief unloads SNM or shielding to cache or point.
3	Thief breaches barrier to remove SNM.
4	Thief throws SNM over fence.
5	Thief uses utility line to remove SNM.
6	Thief loads SNM on to a vehicle.
7	Vehicle removes SNM from the facility.
1000	Thief detected crossing portal with SNM.
1001	Thief detected loading SNM from a point.
1002	Thief detected unloading SNM to a point.
1003	Thief detected breaching a barrier to remove SNM.
1004	Thief detected throwing SNM over a fence.
1005	Thief detected using a utility line to remove SNM.
1006	SNM detected on a vehicle moving through a portal.
1100	Thief victory. More than goal quantity of SNM diverted.
1200	Inventory difference detected above alarm level.
1250	Inventory difference trend detected is above alarm level (0.5% false alarm rate).
1300	TID found broken.
1400	DAC finds missing item.
2000	User terminated game.

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