

HDL-SR-81-7

April 1982

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NUDACC (Nuclear Damage Assessment Computer Code)
Executive Module: Program Concept and User's Guide

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and Development Command
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER HDL-SR-81-7	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) NUDACC (Nuclear Damage Assessment Computer Code) Executive Module: Program Concept and User's Guide		5. TYPE OF REPORT & PERIOD COVERED Special Report
7. AUTHOR(s) Timothy M. Geipe		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Harry Diamond Laboratories 2800 Powder Mill Road Adelphi, MD 20783		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Materiel Development and Readiness Command Alexandria, VA 22333		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Program Ele: 6.21.20.A
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE April 1982
		13. NUMBER OF PAGES 23
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES HDL Project: X751B7 DRCMS Code: 612120H250011 DA Project: 1L162120AH25		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Nuclear damage assessment Executive module Assessment computer code Nuclear weapons effects		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Nuclear Damage Assessment Computer Code (NUDACC) is a useful tool for assessing the survivability of military units on the nuclear battlefield. Although NUDACC has proven useful in many applications, creating and executing the batch input data have often been cumbersome tasks. Harry Diamond Laboratories' data base management system, RECALL, provides an easy and efficient way to create, edit, and execute input data for NUDACC. A		

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20. ABSTRACT (cont'd)

RECALL-manipulated Executive Module incorporates full screen input from an interactive time sharing option (TSO) terminal. The Executive Module simplifies the user's task of handling NUDACC input data.

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1. INTRODUCTION

The Nuclear Damage Assessment Computer Code (NUDACC)^{1,2} was developed by the Harry Diamond Laboratories (HDL) as a tool for assessing the survivability of personnel and materiel organic to tactical battlefield units after a tactical nuclear attack. NUDACC calculates a probability of survival for personnel and equipment based on a cumulative log-normal function of a particular nuclear weapons effects (NWE) environment. In this respect, NUDACC is different from nuclear damage assessment models that are based on a "cookie-cutter" methodology.

Although in many cases NUDACC is a significant improvement over other methodologies, it too is continually undergoing improvements.³ These improvements are designed to either extend the scope of applicability of the code or make the code easier to use. A major drawback identified by users of the original version of the code² is the mode by which data are input into the code. Large numbers of data are punched on cards and a card deck is created and fed into the computer via a card reader. This process is error prone and time consuming. To alleviate these problems, the NUDACC Executive Module, an interactive input and edit system, was developed. The Executive Module employs a data base management system called RECALL.*

2. NUDACC METHODOLOGY

The current version of NUDACC can perform a static (snapshot) evaluation of NWE equipment damage and personnel casualties after a nuclear burst on the battlefield. All units are considered stationary; the weapons are considered in the order in which their parameters are entered as input data. A narrative of the control logic written in structured form and a subroutine flow chart (fig. 1) follow.

- Read in the unit location, size, and orientation.
- Read in the weapon location and yield.
- Calculate the maximum effects radius.

¹Joseph V. Michalowicz, Ralph G. Moore, and Kenneth W. Sweasy, NUDACC--A Nuclear Damage Assessment Computer Code (U), Harry Diamond Laboratories HDL-PR-78-3 (November 1978). (CONFIDENTIAL)

²Ralph G. Moore, NUDACC (Nuclear Damage Assessment Computer Code) Programmer's Guide, Harry Diamond Laboratories HDL-SR-80-1 (August 1980).

³Timothy M. Geipe, NUDACC (Nuclear Damage Assessment Computer Code) Programmer's Guide: Version II, Harry Diamond Laboratories HDL-SR-81-3 (June 1981).

*Howard Bloom, RECALL User's Guide, Harry Diamond Laboratories (April 1980).

- Read in the equipment for each unit.
 - Read in vulnerability data for all equipment items.
 - Select and detonate each weapon.
- For each unit,
- Calculate the distance from the weapon burst point projected on the ground to the unit.
 - If this distance is less than the maximum effects radius of the weapon, process the unit.
 - Divide the unit into grid squares 50 m on a side, and calculate the distance from the weapon to the center of each of these grid squares (fig. 2).
 - Calculate the various environments at the center of each grid square, and accumulate the dose.
 - Calculate the probability of survival of all items for which data exist as a result of these environments.
 - Calculate the attrition of the items.

The attrition of items (personnel and equipment) is calculated in the following manner:

- If the items have not been distributed over the unit, then distribute the items; otherwise, read the surviving items from a random file.
- Multiply the items in each grid square by the appropriate probability of survival to determine the number surviving at that grid.
- Sum each item over the unit to determine the number of that particular item surviving after that particular weapon, and write those items to a file for further processing; then redistribute surviving personnel and equipment according to the computed values for each grid square, and write the distributed equipment to the random file.

The output from NUDACC is passed to a SORT routine, which reorganizes the data for the NUDPRINT program. The output from NUDPRINT is a printout that has an entry for each unit and lists the personnel and the equipment surviving each critical weapon and the dominant kill mechanism for that item. The job execution sequence is illustrated in figure 3.

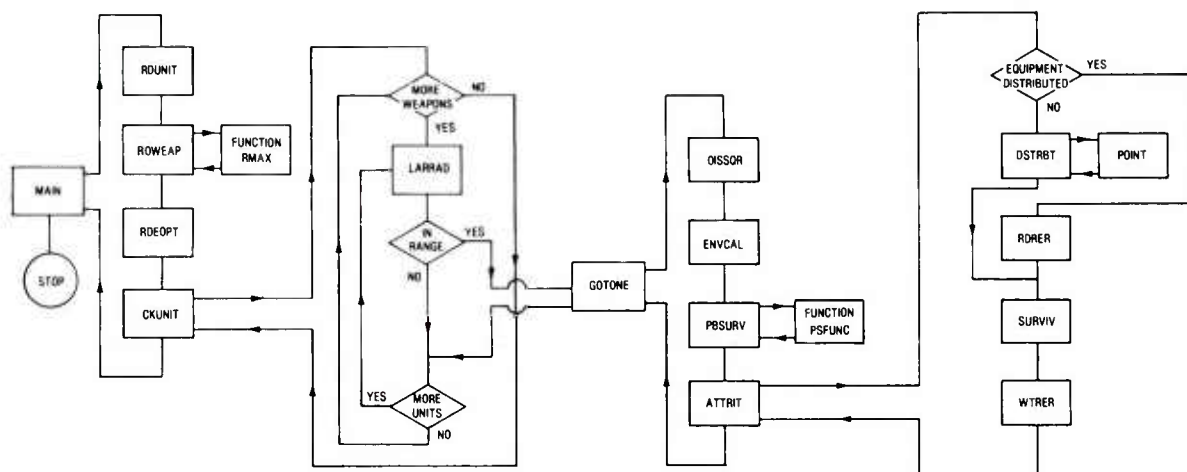


Figure 1. NUDACC subroutine flow chart.

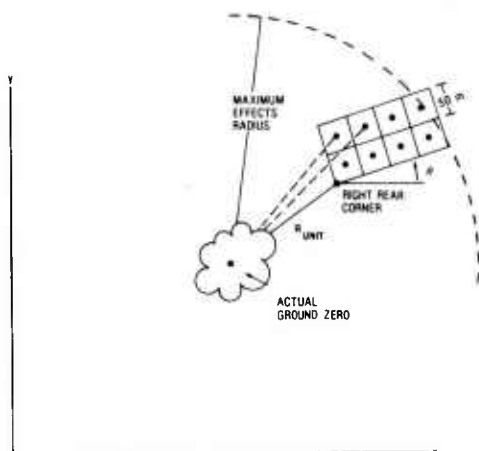


Figure 2. Unit within range.

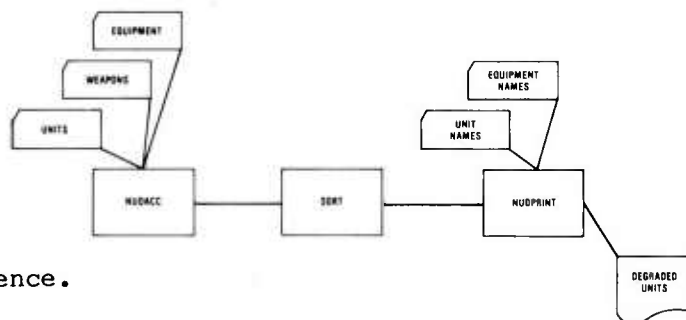


Figure 3. Job execution sequence.

3. NUDACC INPUT DATA REQUIREMENTS

A large input data base is needed to perform nuclear battlefield damage assessments using NUDACC. Included in the data base are (1) all of the tactical unit locations and dimensions, (2) a list of equipment and personnel for each tactical unit, (3) equipment vulnerability data and personnel casualty data (expressed in terms of the log-normal function parameters) for the damage assessment, and (4) weapon burst locations and yields. In a single assessment, NUDACC can handle as many as 600 tactical units, 200 weapons, 45 equipment codes, and 5 personnel postures per unit and up to 200 different sets of equipment vulnerability parameters. It is easy to see that much of the effort involved in making a NUDACC run is inputting all of the data.

The original version of NUDACC^{1,2} required that the tactical unit and the weapon burst locations and equipment lists be punched on cards and that the input card deck be read into the computer. Punching card decks is not a simple task for the user. Care has to be taken to ensure that the data are punched in the correct card columns.

Vulnerability data used by the original version of the code resided in a large data array within the FORTRAN code of the NUDACC program. These data were difficult to edit, add to, and delete due to the complex nature of the storage scheme. Moreover, running this version of NUDACC was found to be cumbersome and time consuming.

4. STRUCTURE OF NUDACC EXECUTIVE MODULE

4.1 General

The NUDACC Executive Module is designed to simplify the task of inputting and editing the large quantity of NUDACC input data. These are the changes to the original version of NUDACC: (1) the input card decks are replaced by sequential data sets, and (2) the data within the FORTRAN code are removed and placed in a sequential data set. The NUDACC Executive Module manipulates these data sets in the less cumbersome interactive environment. This system greatly simplifies the task of working with NUDACC input data.

The NUDACC Executive Module is a collection of data sets that function together under RECALL, an HDL data base management system.

¹Joseph V. Michalowicz, Ralph G. Moore, and Kenneth W. Sweasy, NUDACC--A Nuclear Damage Assessment Computer Code (U), Harry Diamond Laboratories HDL-PR-78-3 (November 1978). (CONFIDENTIAL)

²Ralph G. Moore, NUDACC (Nuclear Damage Assessment Computer Code) Programmer's Guide, Harry Diamond Laboratories HDL-SR-80-1 (August 1980).

Sections 4.2 and 4.3 briefly describe RECALL, the structure and the function of the data sets that make up the NUDACC Executive Module, and their relationship to RECALL.

4.2 RECALL

RECALL is an in-house data base management system developed and used at HDL. Manipulation and display of small to medium sized data bases are the primary functions of this system. Primarily an interactive system, RECALL is programmable, has batch capability, and incorporates the full screen input capability of the IBM 3270 series terminal. Because RECALL interfaces with a number of other systems including Tektronix and CALCOMP plot facilities, FORTRAN, and the IBM System 2000, RECALL is a versatile system.

RECALL requires two data sets (the base and structure files) for storage of information. The base file is a sequential data set that contains the actual data. Each record in this data set is of fixed length and is divided into fields of fixed length. Each field is assigned a name, a length in characters, the number of decimal places if the data are numeric, and a data type (such as character data or numeric data). The other data set, the structure file, stores the name, length, type, and decimal place information for each field, the number of records in the base file, and the file creation date. Figure 4 illustrates sample base and structure files.

UNIT NUMBER	UNIT LENGTH	UNIT WIDTH	UNIT ANGLE
1101101	450	300	0
1101102	500	200	45
1101103	350	300	30
1101104	250	400	0

BASE FILE

1101101	450	300	0
1101102	500	200	45
1101103	350	300	30
1101104	250	400	0

STRUCTURE FILE

REC=	4	DATE=08/20/81
UNIT.NUMBER	7	1 0
UNIT.LENGTH	4	N 0
UNIT.WIDTH	4	N 0
UNIT.ANGLE	3	N 0

Figure 4. Sample base and structure files.

4.3 NUDACC Data Sets

NUDACC input data can be divided into two types: scenario data and vulnerability data. The scenario data include tactical unit dimensions and locations, equipment lists, and weapon burst locations and yields. Changes to these data must be made for every new scenario assessed by NUDACC. Vulnerability data consist of log-normal parameters, dominant kill codes, and transmission factors for equipment items for several NWE environments. This data set is changed only when new equipment items are added to the data set or when vulnerability parameters are updated due to new equipment analysis and test results.

From these two groups of data, NUDACC requires six unique input data sets. Each of these data sets is briefly described in sections 4.3.1 to 4.3.6.

4.3.1 Unit Data Set

The unit data set contains the location (x and y coordinates) and the orientation of units on the battlefield. Each record contains the data for one unit. These data consist of a unit identification number, the coordinates of the right rear corner of the unit (the corner to the right and the rear of an observer located in the center of the unit and looking forward), the unit's angle of rotation with respect to the coordinate abscissa, and the length and the width of the unit.

4.3.2 Equipment List Data Set

The equipment list data set is information about the personnel and the materiel contained in each unit. Each record contains a unit identification number, up to nine sets of equipment codes and corresponding amounts of equipment, and, since more than one record may contain data for a single unit, a number to indicate the record count for that unit.

4.3.3 Weapon Data Set

The weapon data set contains data about the weapons deployed on the simulated battlefield. Each record in this data set contains a weapon yield, the weapon circular error probable (cep), and the coordinates of the desired ground zero (DZG) for the weapon.

4.3.4 Vulnerability Data Set

The vulnerability data set contains personnel casualty data and equipment vulnerability data. One record contains personnel casualty data for a personnel posture or vulnerability data for a single

equipment item. The data include log-normal parameters for each NWE environment, associated transmission factor, and a dominant kill mechanism code.

4.3.5 Unit Name Data Set

The unit name data set, used by the NUDPRINT part of NUDACC (fig. 3), contains unit names. Each record consists of a unit identification number and the name of the corresponding unit.

4.3.6 Equipment Name Data Set

The equipment name data set, also used by NUDPRINT, contains equipment names. Each record consists of an equipment code and the name of the corresponding equipment item.

5. PROGRAMMING APPROACH

5.1 General

Each data set described in section 4, except for the vulnerability data set, was previously entered into NUDACC via card decks. Because of the operating capabilities of RECALL, disk storage of the data sets is necessary. In order to avoid altering the NUDACC input formats, the strategy used to store these data on disk was to structure the data set base files like card decks; that is, each 80-character record in a disk data set corresponds to an 80-column punch card. This approach involves placing fields of blanks between fields of data in order to space the input data correctly. In RECALL, this spacing of data is easily accomplished by defining a field and filling it with blanks. These disk data set records, called card images, are then passed to NUDACC in place of the card decks. Figure 5 shows a unit data card and the corresponding card image.

5.2 Master Data Sets and Generated Data Sets

Ease of input is of primary concern to the user. In an effort to accommodate this concern, the six NUDACC input data sets can be combined into four data sets. The reasoning behind this approach is that four data sets of related data would be more easily handled than six unique data sets. RECALL would then use these four data sets as card images and extract data from two of these data sets to generate the last two card image data sets required for a NUDACC run.

data set and the equipment list data set are left unchanged; however, they are renamed master data sets. Table 1 lists the names of these RECALL master data sets and shows the relationship between the master data sets and the generated data sets.

The master unit data set and the master vulnerability data set, although they are greater than 80 characters in length, can still be used as card images since the FORTRAN code reads only the first 80 characters of each record and ignores the additional data at the end of each record. Thus, the master and generated data set system employed by the NUDACC Executive Module saves storage space, requires no alterations to the NUDACC input formats, and is entirely transparent to the user.

TABLE 1. DATA SETS USED BY NUDACC EXECUTIVE MODULE

NUDACC data set	Master data set	Generated data set
Unit data set Unit name data set	MASTER.UNIT	UNIT.NAME
Equipment list data set	MASTER.LIST	
Weapon data set	MASTER.WEAPON	
Vulnerability data set Equipment name data set	MASTER.VULNER	EQUIP.NAME

5.3 Screen Images

An integral part of the NUDACC Executive Module is the full screen input feature provided by RECALL. Full screen input is a feature that uses the entire terminal screen as a prompt message and input medium. This section describes the use of full screen input by the NUDACC Executive Module.

The most essential part of the full screen input process is the screen image. A screen image is a user-defined image of an 80-column, 24-line terminal screen. A collection of screen images is stored in a partitioned data set by RECALL. Any text in the screen image appears on the terminal screen as a prompt message when the screen image is accessed. The underscore character in the screen image appears as a blank on the terminal screen and allows a character to be input or displayed at that location when the screen image is accessed. A string of underscores is called an input field and is used for input or display of data. A screen image can be defined with several prompt messages and input fields for the input of an entire data set record.

This is a powerful input device and has many uses and features. The NUDACC Executive Module uses screen images to input data into the four master data sets, to edit data within the four master data sets, and to prompt the user for menu options. Special cursor moving keys allow the user to quickly move the cursor to any input field on the terminal screen, making full screen input as time saving as it is useful.

5.4 Control Files and Report Forms

One of the biggest advantages provided by RECALL to the NUDACC Executive Module is display capability. The data base can be displayed on a hard copy printout allowing the user to check the input data for errors before a NUDACC run is made. The generation of hard copy printouts of NUDACC input data requires two types of RECALL data sets.

The first of these data sets is called a control file. Since the hard copy printout is produced by a batch computer process, the control file contains the necessary job control language (JCL) and RECALL commands to control the allocation of data sets and execution of the batch RECALL job. This data set is submitted directly from the interactive terminal, and no card reading processes are required.

The other data set is called a report form. A report form is a set of format instructions for the printed report. Included in this set of instructions are the names of the fields from which data are to be taken, column widths, column headings, and page titles. This data set, like the data set generation process, is transparent to the user.

5.5 Command File

If any one data set could be called the heart of the NUDACC Executive Module, it would be the command file. The command file is a list of control statements and RECALL commands comprising a program that controls the manipulation of data sets as well as allowing user input.

The command file controls the accessing of screen images and menus, the generation of the additional data sets required for a NUDACC run, and the submission of control files to print reports and run the NUDACC program. The most important task performed by the command file is the prompting of the user for control information, input data, and data editing, the features that make the NUDACC Executive Module so easy to use.

6. USING NUDACC EXECUTIVE MODULE

6.1 General

The following is a guide to using the NUDACC Executive Module. It is assumed that the user has a valid account on the IBM 370 Model 168 computer at HDL, has access to an IBM 3270 series terminal, is able to log on to time sharing option (TSO), and has the RECALL data sets necessary for operating the NUDACC Executive Module within the account.

6.2 Accessing NUDACC Executive Module

To use the NUDACC Executive Module, the user must gain access to RECALL. This TSO command is typed:

RECALL

The computer returns a message welcoming the user to RECALL and then prints a question mark (?). This is a prompt indicating that RECALL is ready to accept a RECALL command.

Next, the user must gain access to the NUDACC Executive Module. To implement the NUDACC Executive Module, this RECALL command is typed:

EXEC NUDFE

After the user enters this, control is given to the NUDACC Executive Module.

6.3 Primary Option Menu

The first input menu to appear on the screen is the primary option menu (fig. 6). This menu lists the six options available to the user under the NUDACC Executive Module and prompts the user to select an option. To choose an option, the user enters any valid option number listed and presses the ENTER key. Entry of an invalid option on this or any other menu elicits a warning tone from the terminal.

6.4 Entering New Scenario

Selection of option 1 from the primary option menu indicates that the user wishes to enter a new scenario. Since the new scenario consists of unit information, equipment lists, and weapon information, the user is prompted by input screens for each different set of information. Figures 7 to 9 show the input screens associated with entering these data.

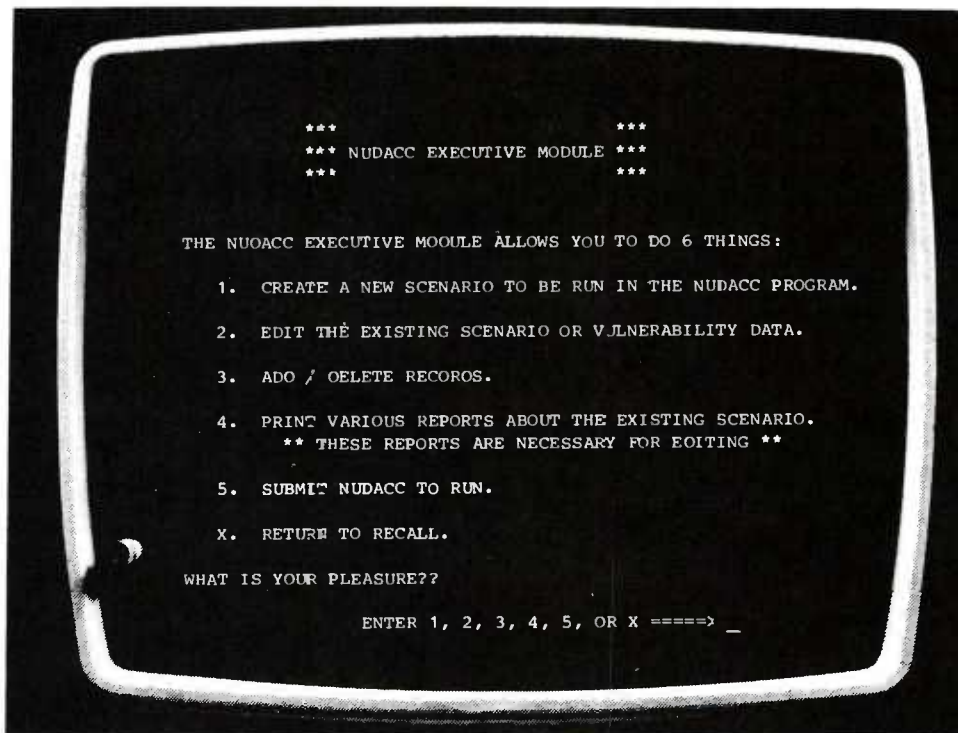


Figure 6. Primary option menu (simulation).

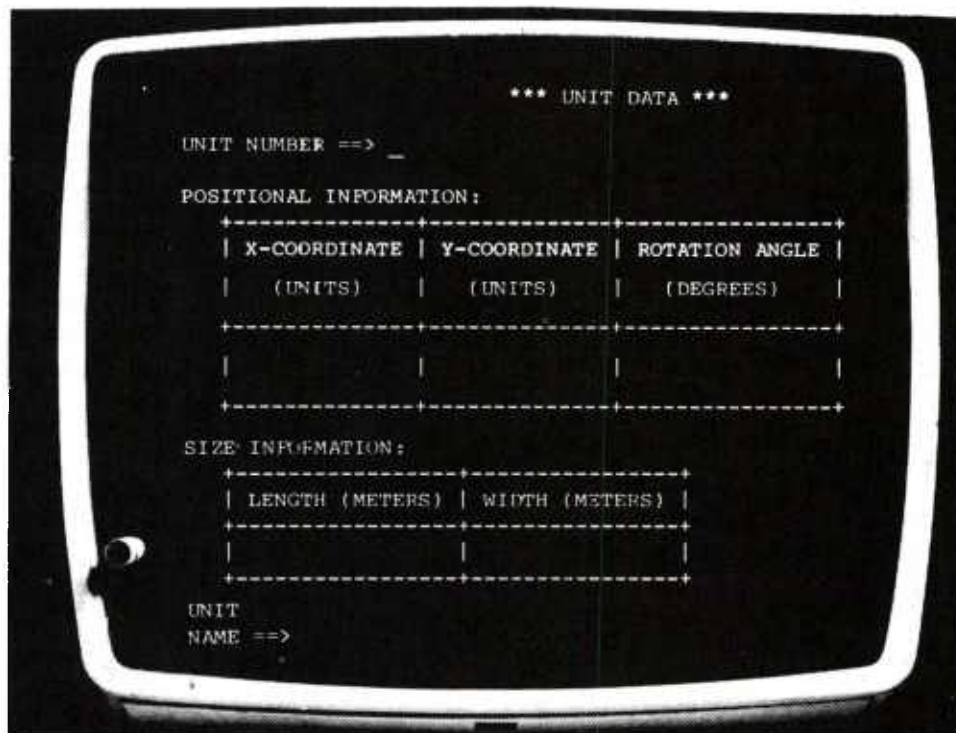


Figure 7. Unit data screen image (simulation).

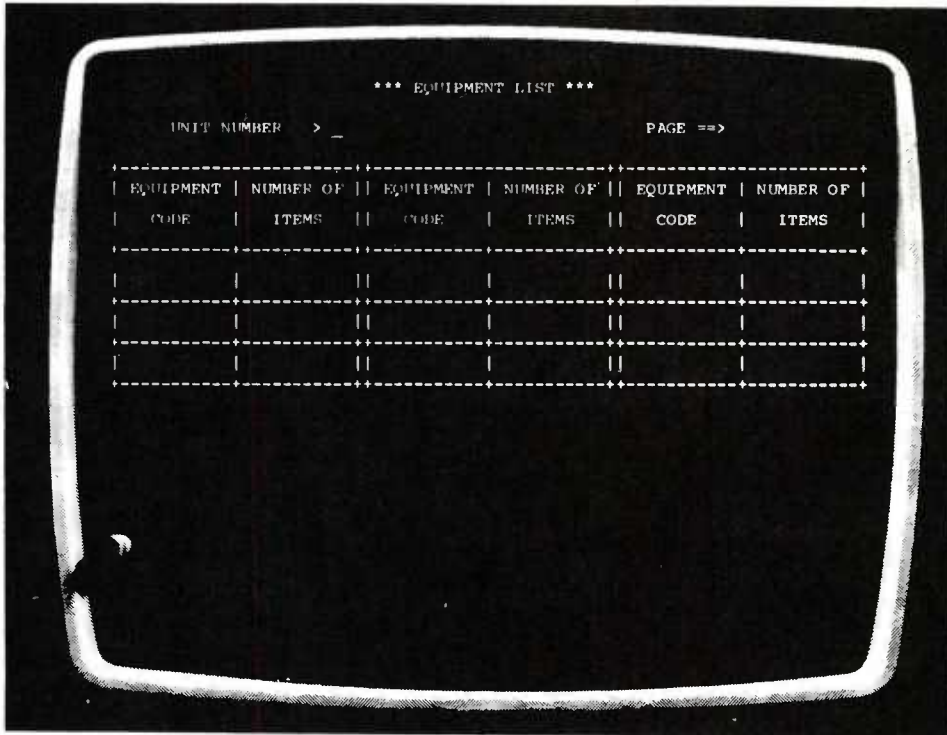


Figure 8. Equipment list screen image (simulation).

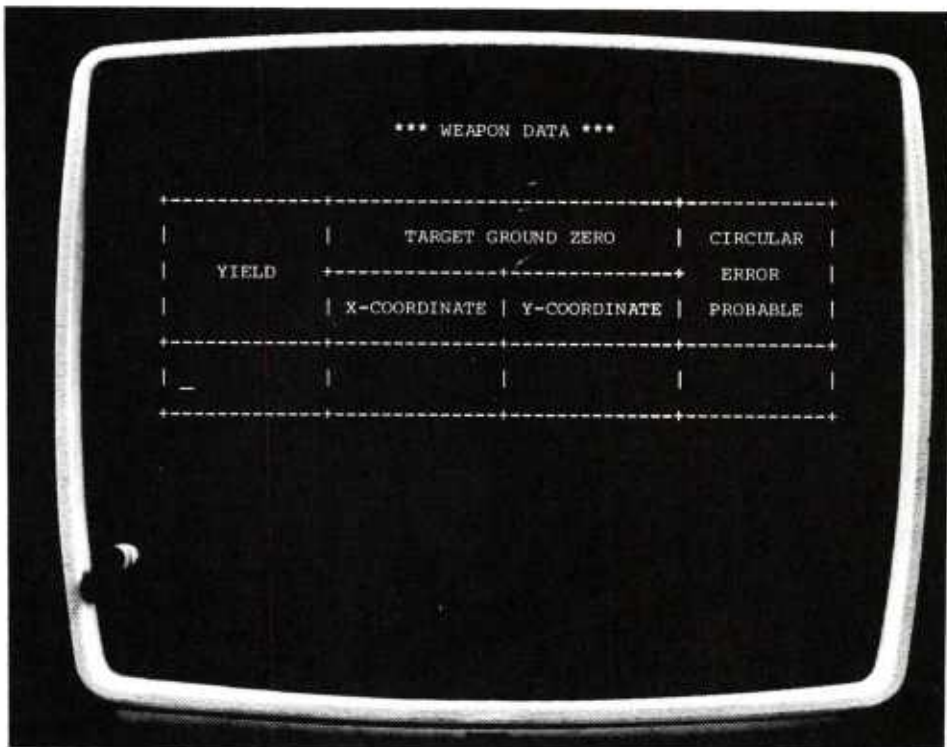


Figure 9. Weapon data screen image (simulation).

Entering data via an input screen involves the use of the cursor moving keys to locate input fields on the input screen. When an input screen appears, the cursor is located at the beginning of the first input field on the input screen. Prompts on the input screen indicate which data are to be entered in that field. After data are placed in that field, the cursor must be moved to the next input field. It is moved by one of two cursor moving keys located on the IBM 3270 terminal keyboard (fig. 10). The key with a right pointing arrow moves the cursor to the next input field. The key with a backward "L" shaped arrow moves the cursor to the first input field of the next line. Should the data fill all the character locations in an input field, the cursor would automatically move to the next input field.

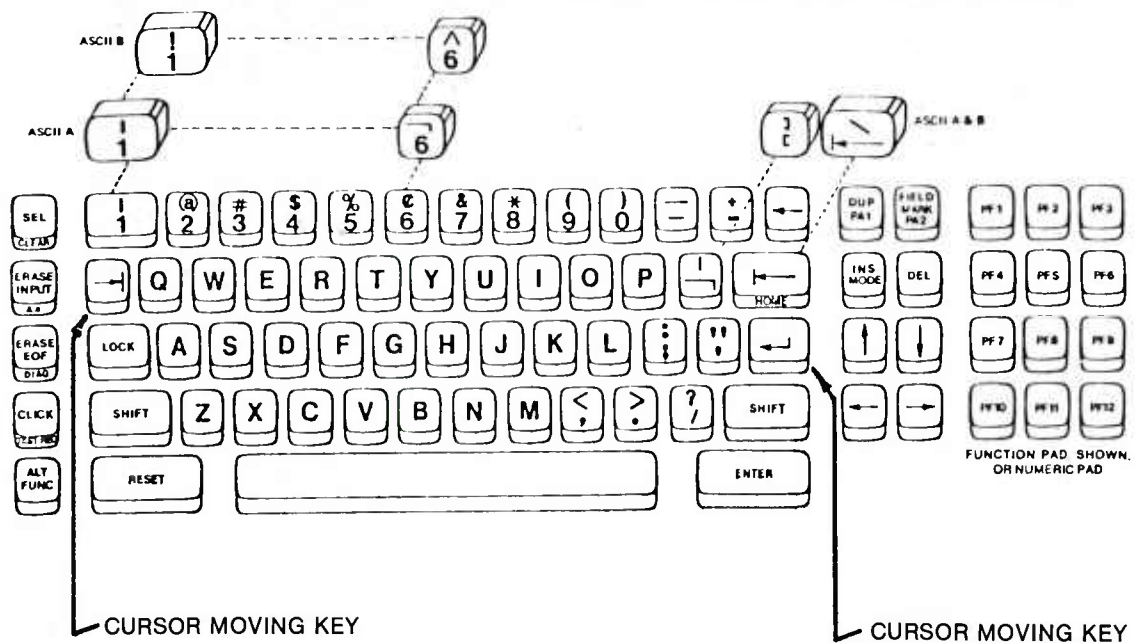


Figure 10. Cursor moving keys on IBM 3270 terminal keyboard.

After data are entered into one or more of the input fields, pressing the ENTER key loads those data into one record of the associated data set. The input screen appears again with all of the input fields blank. This appearance indicates that the previous data have been loaded and more may be entered. This process can be continued until all of the input fields are left blank and the ENTER key is pressed. Then the data set is saved, and a new input screen or option menu appears.

6.5 Editing Data Sets

When option 2 is chosen from the primary option menu, the user is prompted by the edit data set menu (fig. 11). This menu includes prompts to choose a master data set to edit and a record range.

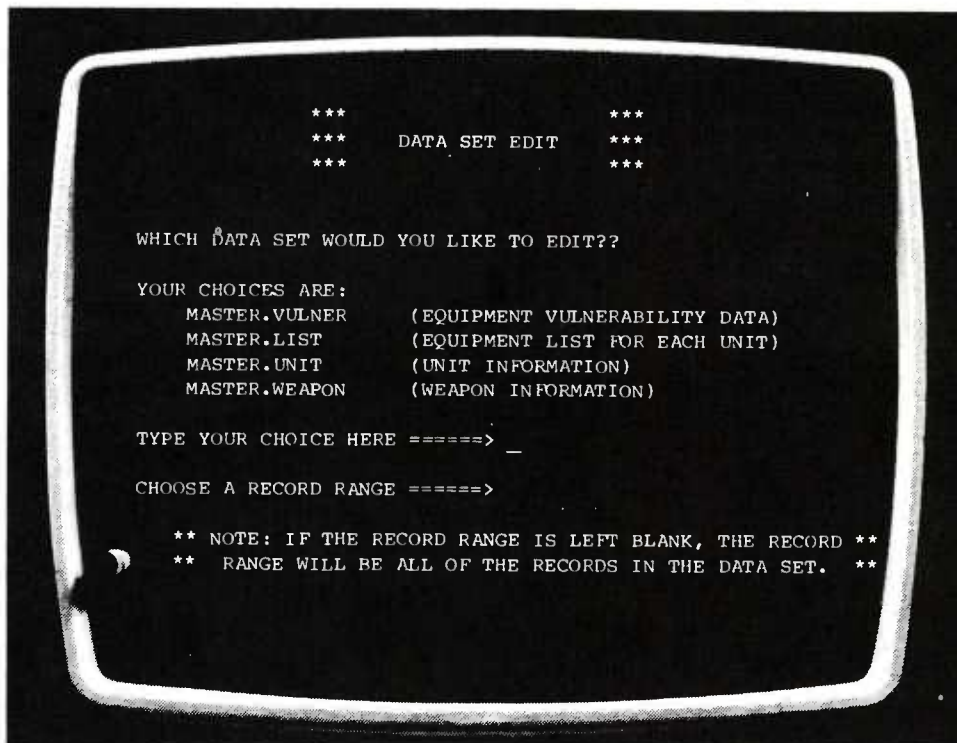


Figure 11. Data set edit menu (simulation).

A record range is a list of records from the data set to be edited. A simple list of record numbers separated by commas (,) is a valid record range. To save typing, a colon (:) may be used. A colon separating two record numbers indicates that all of the records between and including those two record numbers are part of the record range. Any combination of commas and colons serves as a valid record range; or, if the record range is left blank, the record range consists of all of the records. The following examples of valid record ranges and their explanations illustrate the concept of uses of record ranges.

<u>Example</u>	<u>Meaning</u>
6,9,28	Records 6, 9, and 28 have been chosen.
18:21	Records 18, 19, 20, and 21 have been chosen.
1:3,5,7:9	All the records between and including records 1 and 9 but excluding records 4 and 6 have been chosen.

After the user selects a data set and a record range, the data from the chosen records of that data set are displayed via the edit screen. The edit screen operates identically to the input screen with one exception. Instead of being blank, the input fields contain the data from the current record. To edit these data, the user simply moves the cursor to the fields that need to be edited, changes the data, and presses the ENTER key. Each selected record appears in turn on the input screen until all of the records have been edited.

6.6 Adding and Deleting Records

Choosing option 3 from the primary option menu allows the user to add or delete records from one of the four master data sets (fig. 12). First, the user is prompted to choose to "add" or "delete" and then choose a master data set. If "delete" is chosen, a record range must be provided. If "add" is chosen, an input screen appears as if new data were being input.

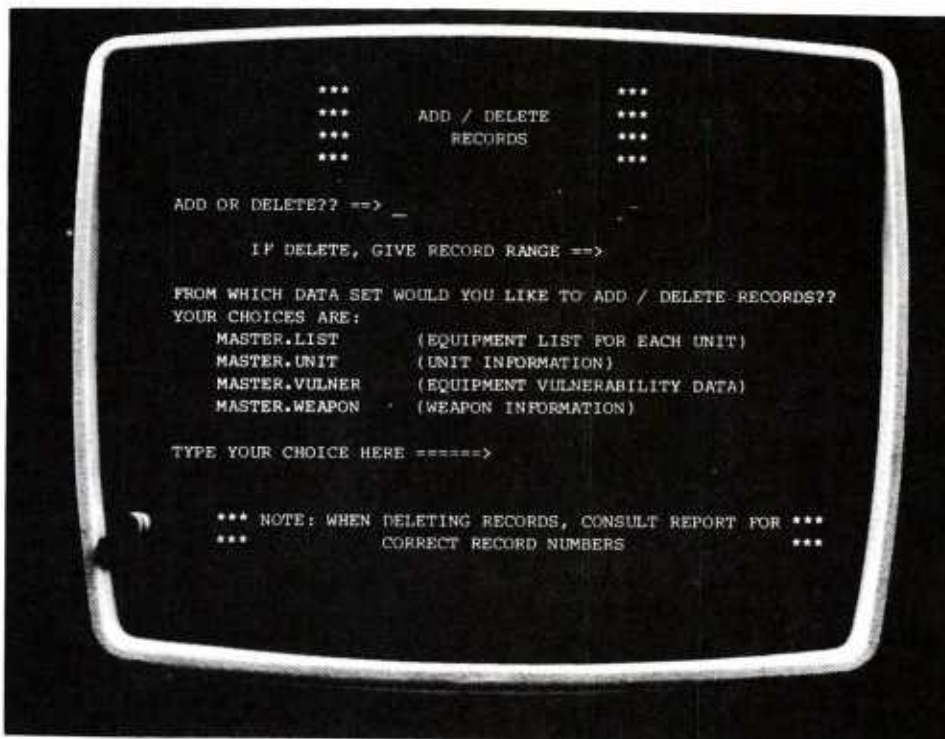


Figure 12. Add/delete menu (simulation).

6.7 Generating Reports

Two reports, a scenario report and a vulnerability data report, are generated by the NUDACC Executive Module. These reports reflect the two types of NUDACC input data: (1) the scenario report is a printout of the unit data, the weapon data, equipment lists, and the unit names, and (2) the vulnerability data report is a printout of the vulnerability data and the equipment names. These reports list all of the data contained in the master data sets in a convenient, easy-to-read format.

To generate a scenario report or a vulnerability data report, the user chooses option 4 from the primary option menu. The report generator menu (fig. 13) prompts the user to choose the report to be printed. The hard copy report is printed in the HDL Computer Center under a title formed from the user's logon identification followed by the character "R" (for example, H12345R).

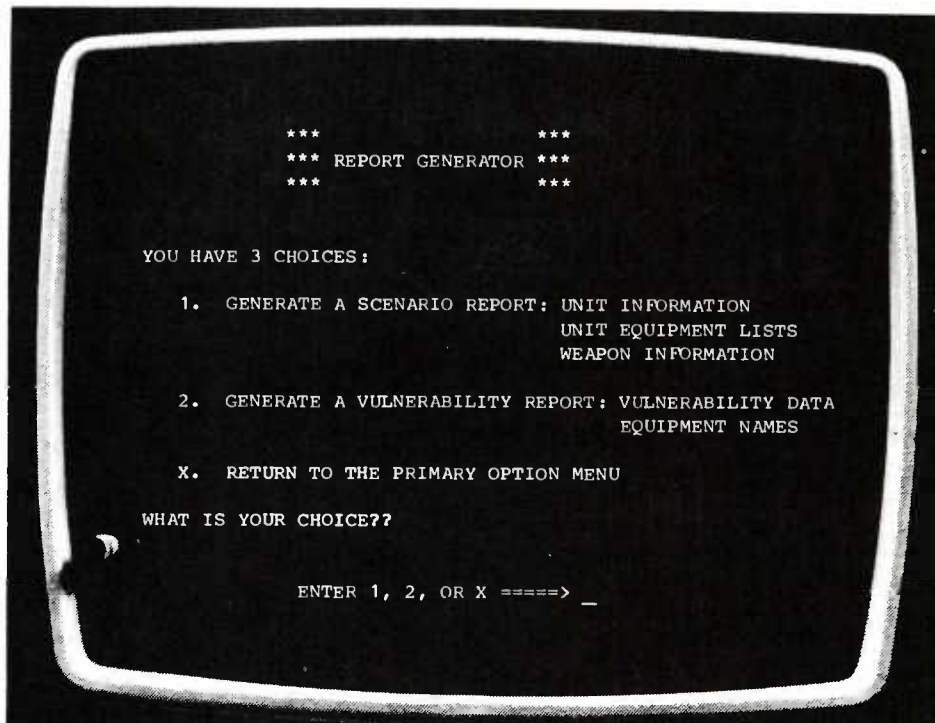


Figure 13. Report generator menu (simulation).

One or both of these reports are necessary if records from the master data sets are to be edited or deleted since these reports provide the record number information needed for choosing record ranges. It is also recommended that these reports be generated before a NUDACC production run is made in order to check for data errors.

6.8 Executing NUDACC Program

To execute a NUDACC production run, the user chooses option 5 from the primary option menu. When this option is chosen, the user is not prompted for information, but is given a message that the NUDACC program has been submitted to run. A RECALL command prompt (?) appears, indicating that the user has returned to RECALL.

6.9 Returning to TSO

When the RECALL command prompt (?) appears--either by choosing option X from the primary option menu or after the NUDACC program has been submitted--the user must exit from RECALL by typing the command:

QUIT::

It is necessary that both colons be typed after the QUIT command, or a RECALL generated prompt appears, asking the user to be sure to save data sets. Should this happen, the user need only press the ENTER key to return to TSO. The TSO prompt, Ready, appears, indicating that the user has successfully returned to TSO.

7. CONCLUSION

The RECALL-manipulated Executive Module described in this report greatly simplifies the task of handling NUDACC input scenario and vulnerability data. With the addition of this module, NUDACC users should find the NUDACC code much easier than before to use for battlefield simulations and analyses.

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