NUCDAM CONTROL DOCUMENT
VOLUME I

K-84-96U(R)

19 June 1984

KAMAN SCIENCES CORPORATION
SYSTEMS DIRECTORATE
1911 Jefferson Davis Hwy., Arlington, VA 22202

A KAMAN COMPANY

KAMAN SCIENCES CORPORATION
SYSTEMS DIRECTORATE • Telephone (703) 521-0800
a Kaman Company 1911 Jefferson Davis Hwy. • Suite 1200 • Arlington, VA 22202

NUCDAM CONTROL DOCUMENT
VOLUME I

K-84-96U(R) 19 June 1984

Accession For	
NTIS GRA&I	X
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

K-84-96U(R) AD-A159 985

4. TITLE (and Subtitle) NUCDAM Control Document Volume I	5. TYPE OF REPORT & PERIOD COVERED User Information - 18 Apr 83 - 16 Jun 84
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Donald Griffin Anthony Portare	8. CONTRACT OR GRANT NUMBER(s) N00014-83-C-0212
9. PERFORMING ORGANIZATION NAME AND ADDRESS Kaman Sciences Corporation 1911 Jefferson Davis Highway, #1200 Arlington, VA 22202	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Office of the Chief of Naval Operations Department of the Navy Washington, DC 20350	12. REPORT DATE 19 June 1984
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) UNCLASSIFIED
	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

NOSC
BGTCSF
Tactical Engagement Training
NWISS
Nuclear Damage Assessment
NUCDAM
Tactical Nuclear Weapon

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

This report contains user information about the various versions of NUCDAM currently operating in the Fleet and the configuration management plan by which changes to NUCDAM are initiated.

Additional keywords: computer program documentation; microcomputers; user manuals.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This document is one of three documents explaining the Nuclear Damage Assessment Code (NUCDAM). Volume I contains user information about the various versions of NUCDAM currently operating in the Fleet and the configuration management plan by which changes to NUCDAM are initiated. Volume II is a classified document which contains explanations and listings of the environment and impairment routines utilized by the NUCDAM code. Volume III is a classified document that contains information about the necessary vulnerability data associated with the operation of this code.

2.0 BACKGROUND

The Nuclear Damage Assessment Module (NUCDAM) was developed by Kaman Sciences Corporation (KSC) for CNO (OP-654), to be used in the Naval Nuclear Warfare Simulation (NNWS) for calculating damage to naval units involved in tactical nuclear weapon engagements at sea. The environment programs were developed in three phases.

The Phase I damage assessment model (Reference 1) included the capability to calculate damage to submarines and surface ships from underwater nuclear bursts created by Anti-Submarine Warfare (ASW) engagements. This included calculating damage from the effects of peak translational velocity (ft/sec), excessive impulse (psi-sec) and energy flux density (ft-psi).

The Phase II damage assessment model (Reference 2) expanded the Phase I model to include the capability to calculate damage to surface ships from air and surface nuclear bursts produced by Anti-Surface Warfare (ASUW) engagements. In addition to ASUW engagements, the nuclear effects include calculating damage from the effects of overpressure (psi), EMP (v/m), neutron fluence for 1 MV equivalent (n/cm^2), total ionizing dose (rems), and thermal exposure (cal/cm^2).

The Phase III effort (Reference 3) incorporated into Phase II the nuclear weapons effects that may influence the outcome of ASW engagements. These additional nuclear weapons effects from underwater bursts included the blast overpressure along the surface of the water (psi), the peak dose rate from the base surge (RADS/HR), the total dose from the base surge (RADS) and the peak translational velocity (ft/sec) which include the effects of bottom reflection. The modifications of NUCDAM also involved changes to the blast overpressure and radiation routines to incorporate more up-to-date information since they were originally developed in Phase II.

The purpose of the NNWS Nuclear Damage Assessment Module (NUCDAM) is to determine the degree of weapon system impairment to a naval unit (submarine or surface ship) that has been subjected to the effects of a nuclear burst. Damage to naval units from a tactical engagement is determined by calculating the nuclear environment based on weapon yield and weapon-target geometry and then relating the calculated environment to damage threshold parameters associated with the target to determine the degree of impairment to the operational attributes (OATs) that describe the naval unit.

The nuclear environments which have been incorporated into the model are underwater shock (including bottom reflection), air blast and radiation from underwater bursts, and blast, thermal, initial radiation, and low altitude EMP from air or surface bursts. Damage predictions are made for the submarine operational attributes of seaworthiness, mobility, weapon delivery, communications, sensors, and personnel and for the surface ship operational attributes of seaworthiness, mobility, weapon delivery (includes ASW, SSM, and CM weapon systems), communications, sensors, aircraft (on carrier deck or ground), and personnel. Damage from multiple or successive bursts is accumulated by one of three methods based on the damage mechanism associated with the affected operational attribute. The availability of each operational attribute is updated based on the damage mechanism associated with the affected operational attribute. The availability of each operational attribute is updated based on the accumulated damage. The ability of a unit to successfully conduct a particular mission is determined by the combined availabilities of the operational attributes required for that mission. In addition to calculating damage and availability, NUCDAM contains an algorithm to calculate repair time delays to determine if and when the damage will be corrected in the affected capability area.

The development of NUCDAM generated a great deal of interest within the Naval training and war gaming community. After the development of Phase II, KSC created a simplified version of NUCDAM along with an appropriate driver to operate on a Radio Shack TRS-80 Model 1 microcomputer for the Naval War College. A version of the TRS-80 NUCDAM was then implemented on the DNA CYBER at LASL. The CNO (OP-654) sponsored the development of a version of Phase II implemented on the WANG 2200 T/VP computer to be used on shipboard.

Under DNA sponsorship, KSC then developed a stand-alone training and tactical decision aid for the Battle Group Training Computer Support Facility (BGTCSF) at the Naval Ocean Systems Center (NOSC) based on Phase III. This version was developed for the VAX 11/780 to be used in conjunction with NWISS training. This version of NUCDAM was then installed on the HQ-DNA CYBER in Washington. Copies of this version have been distributed to CNO (OP-654) for installation on the PDP 11/34, Boeing Aerospace Company, Titan Systems, Inc., and McDonnell Douglas Corporation.

Another microcomputer version of NUCDAM Phase II was developed for the HP9835 to be used for shipboard training in the Fleet. KSC also put this version on its PRO-350. The latest development for a microcomputer has been the use of NUCDAM Phase III in the NAVTAG Companion implemented on the WICAT 150 WS.

3.0 NNWS DESCRIPTION

The NNWS is designed to model a two-sided, theater-wide naval conflict over an extended period of time. Players participate at a level similar to that of a Naval Theater commander through the use of computer-supported interactive graphics. An umpire function is included to control third party actions and other factors beyond the control of either side.

Figure 1 illustrates the various elements modeled in the NNWS. NNWS utilizes a large scale IBM computer to model the actions and encounters of a campaign through stochastic alrogithms dependent on system and platform effectiveness parameters that can vary as a function of environment and tactical situation. Interaction with the simulation is accomplished from minicomputer-controlled player stations. The interactive computer setup allow both sides to direct the employment of any of their assets as the campaign evolves over time. The units of both sides move in accordance with their respective player orders conducting transit, strike, patrol, or support operations.

The player is provided with periodic surveillance information and significant reports from the operating forces as the campaign progresses. Based on this information, the player may reallocate forces, assign strike or patrol missions, or modify the Automated Decision Rules (ADR). When opposing forces encounter one another, they either evade or interact in accordance with the current ADRs specified by the player. The results of interactions that occur within the campaign are stored and analyzed off-line to evaluate the utility of tactical and theater nuclear weapon alternatives, mixes, or employment doctrines.

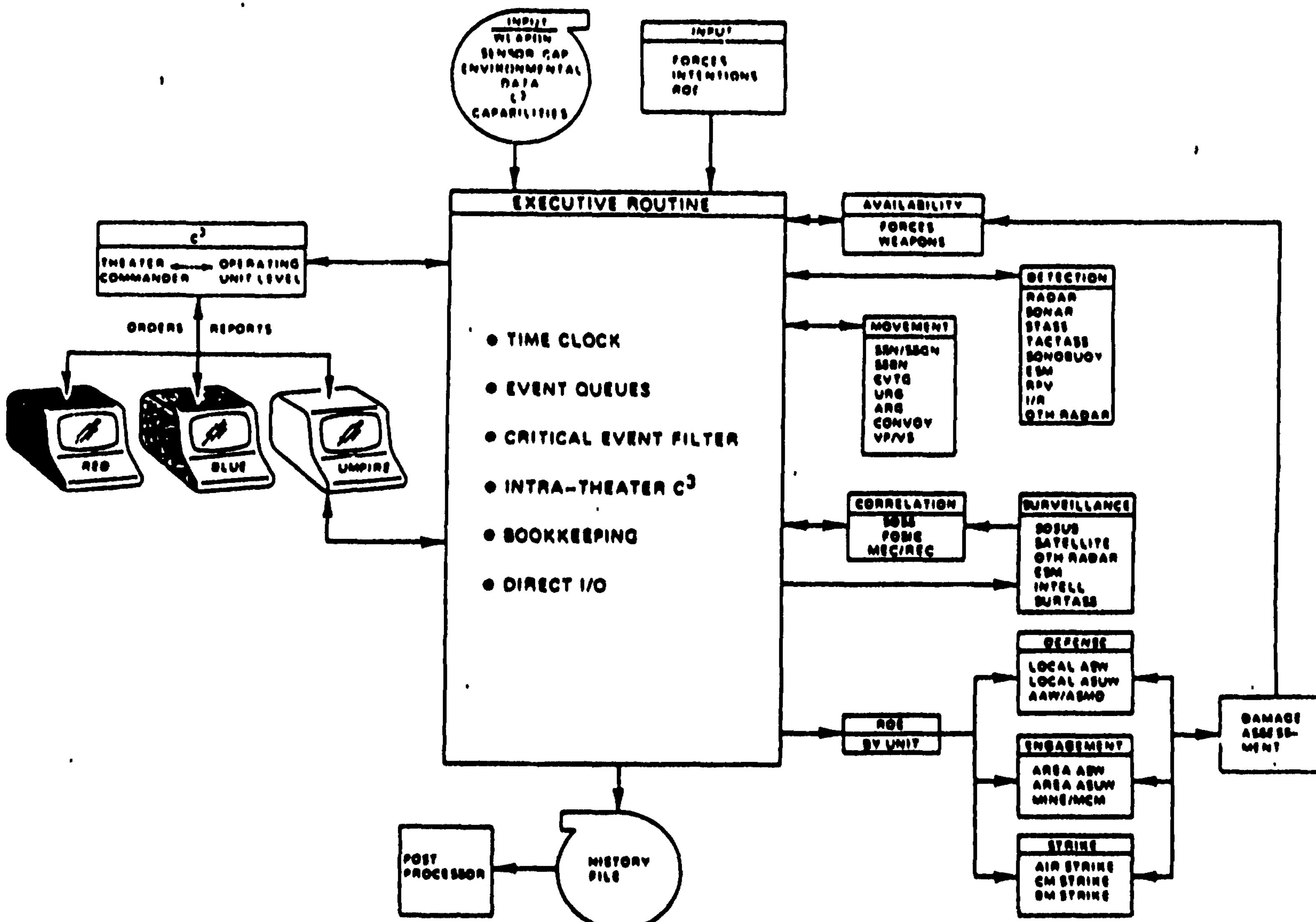

Figure 1. NNWS Model Elements

3.2 NUCDAM Module

The purpose of the NNWS Nuclear Damage Assessment Module (NUCDAM) is to determine the degree of weapon system impairment to a naval unit (submarine or surface ship) that has been subjected to the effects of a nuclear burst. Damage to naval units from a tactical engagement is determined by calculating the nuclear environment based on weapon yield and weapon-target geometry and then relating the calculated environment to damage threshold parameters associated with the target to determine the degree of impairment to the operational attributes that describe the naval unit.

Damage predictions are made for the submarine operational attributes such as seaworthiness, mobility, weapon delivery, communi- cations, sensors, and personnel and for the surface ship operational attributes such as seaworthiness, mobility, weapon delivery (includes ASW, SAM, and CM weapon systems), communications, sensors, aircraft (on carrier deck or ground), and personnel. Damage from multiple or successive bursts is accumulated by one of three methods based on the damage mechanism associated with the affected operational attribute. The availability of each operational attribute is updated based on the accumulated damage. The ability of a unit to successfully conduct a particular mission is determined by the combined availabilities of the operational attributes required for that mission. In addition to calculating damage and availability, NUCDAM contains an algorithm to calculate repair time delays to determine if and when the damage will be corrected in the affected capability area. The data flow through NUCDAM is illustrated in Figure 2.

NUCDAM consists of a main driver routine which is called from NNWS, fifteen subroutines to model the nuclear effects, associated auxiliary subroutines. NUCDAM has been coded in

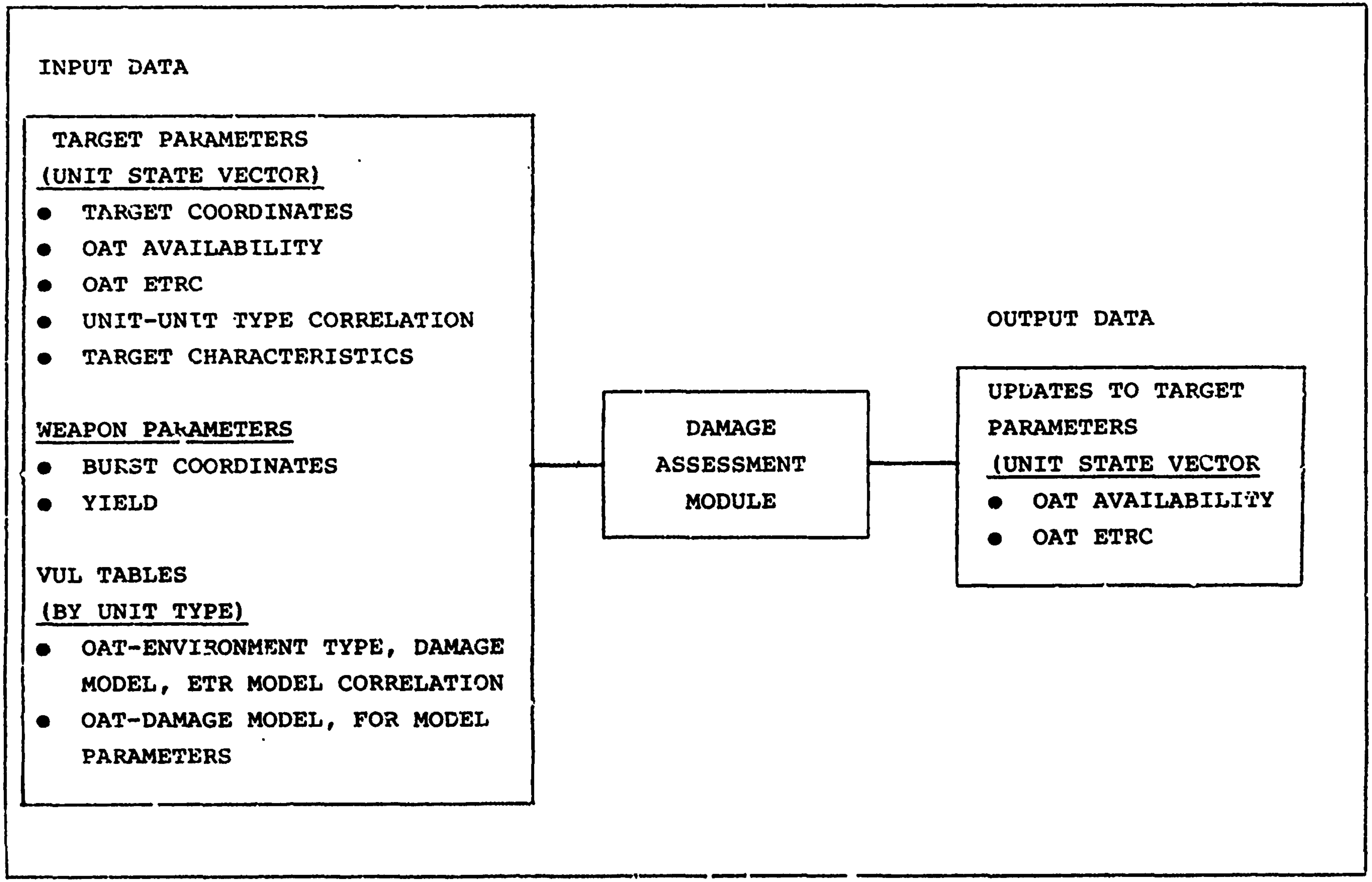

FIGURE 2. DATA FLOW THROUGH NUCDAM

FORTRAN on a CDC CYBER 720 at KSC, a CDC CYBER 730 at Headquarters DNA, a VAX at NOSC, in PL/I for use on an IBM 3033 at APL/JHU by CNO (OP-654), and in BASIC for use on a TRS-80 system at the Naval War College.

3.3 Nuclear Environments

The nuclear environments calculated by NUCDAM from atmospheric bursts include blast, thermal, EMP, neutron fluence (1 MeV Si equivalent), total ionizing dose, peak gamma dose rate, total x-ray fluence, and tissue ionizing dose. The nuclear environments from underwater bursts include peak translational velocity, excess impulse, energy flux density, and total dose and dose rate due to the base surge produced by an underwater burst.

3.4 Unit OATs

Each OAT represents a complex assembly of many component parts which has some functional capability. Seaworthiness is a measure of the ship's watertight integrity, including the ability to survive bad weather and control flooding. For submarines, seaworthiness also measures the ability to submerge, adjust depth and surface in a controlled manner. Mobility measures the ship's ability to conduct AAW, ASW, ASUW, or land attack engagements with its weapon systems. For submarines, weapon delivery measures the ability of a ship to launch missiles, torpedoes, SUBROC, or the ASW/ SOW. Communications measures the ability to transmit and receive messages from other units afloat or ashore. Sensors measures the ability to detect and track other ships or aircraft, or to direct AAW, ASW, or ASUW engagements. Aircraft measures the survivability of either carrier-based (as a weapon system on the deck) or land-based aircraft and crew. KSC is adding a module to handle aircraft in flight. Personnel refers to survivability of personnel exposed either directly or indirectly to nuclear effects.

In addition to the ASW and ASUW targets, four generic types of land targets are included in NNWS. They consist of several common OATs as well as one or more OATs specific to each target type. The four types of land targets are naval air station, naval bases, naval supply centers, and ammunition depots. The common OATs include: personnel, administration buildings, POL dumps, mechanical handling equipment, piers, and storage facilities.

OATs specific to Naval Air Stations include aircraft (also a surface ship OAT), runways, hangers, and control towers. OATs specific to naval bases include railroad yards, pumping stations, and heliports. The OATs specific to ammunition depots are bunkers and assembly buildings. Naval supply centers have no OATs specific to themselves. The operational attributes that comprise each type of target discussed are summarized in Table 3-1.

3.5 Damage Environments

Each OAT of each target is, in general, most susceptible to damage from a particular environment. With respect to underwater bursts, there is little information available for the communication and sensor OATs; therefore, these two OATs were assumed to have the same vulnerability as that for weapon delivery since the most vulnerable component for weapon delivery OAT is the electronics, either sensors or fire-control computers.

With respect to atmospheric bursts, there is considerable information available (both theoretical and empirical) on damage to surface ships and their associated OATs. As such, some of the surface ships OATs may be susceptible to more than one environment from an atmospheric nuclear burst. For instance, a fire-control radar would be included in the weapon delivery category. The radar is susceptible to mechanical damage from air blast, charring or scorching of the radome from thermal exposure, and/or damage to internal electronics from transient radiation environments.

For land targets OATs, air blast is the dominant damage environment. Structures, functional groups, aircraft, and personnel are all subject to damage from the overpressure and/or dynamic pressure associated with the blast wave from a nuclear weapon. In addition, aircraft and personnel may be damaged by the thermal pulse, and personnel are susceptible to radiation.

3.6 Damage Model

The NUCDAM damage model considers the weapon-target geometry in conjunction with specified vulnerability levels to calculate impairment to the affected OAT from intermediate environment levels. The damage model considered is illustrated in Figure 3. Given the range from the burst to the target and the weapon/target characteristics, the environment experienced by the target is calculated as shown in Figure 3a. To determine the probability of weapon system impairment, the damage or impairment curve is assumed to be linear between the vulnerability values specified for 10% and 90% impairment, which defines a model of the form:

$$I = a + bE$$

where I = impairment (0% I 10%)
a,b = constants which define intercept and slope of the impairment curve
E = relevant environment

Therefore, given the calculated environment the probability of damage (or impairment) is calculated as illustrated in Figure 3b.

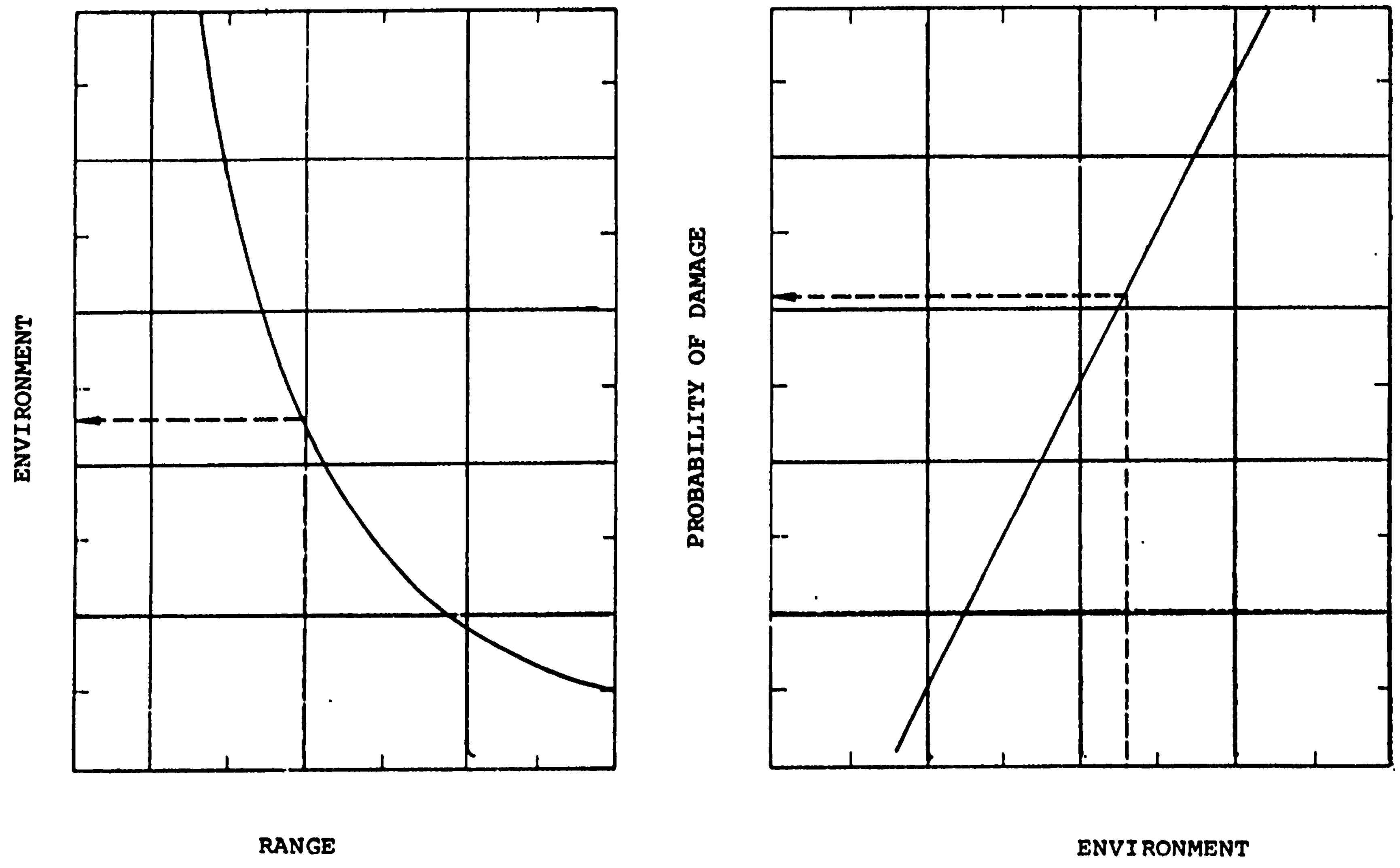

Figure 3. Damage Model

This model indicates that between the onset of damage and complete destruction, incremental increases in environment will produce corresponding incremental increases in impairment. This damage model continues to be used in NUCDAM because there is no hard evidence for employing any other model. However, there is provision in NUCDAM to include additional types of damage models as data becomes available.

3.7 Damage Accumulation

The need for damage accumulation models stems from the ability of nuclear weapons to produce damaging environments at long ranges from the detonation point. If the units of a task group are spaced far enough apart, no single tactical nuclear weapon could destroy more than one ship. However, the damage producing range of such weapons is large enough that a unit may incur some collateral damage as a result of an attack on an adjacent unit in the task group. It is conceivable that a unit could be damaged to the point of combat ineffectiveness without it ever being the target of an attack:

These methods of accumulating damage have been incorporated into NUCDAM. These methods are:

- Multiplicative - The multiplicative damage model assumes that the damage levels caused by successive detonations are statistically independent. The probability of survival from each successive detonation are simply multiplied together to get the total probability of survival.

- Additive - The additive damage model, which is primarily based on structural loading, assumes that damage accumulates linearly. Total damage is the sum of impairments produced by each burst. However, based on test data, a damage increment is added to the total damage only if it exceeds 65% of the pre-existing total damage.

- o Maximum - The maximum damage model, which is based on mechanical or electrical component damage, assumes that total impairment produced by a series of bursts will be equal to the greatest impairment that exists to that point. Whenever a burst results in greater damage than already exists, the accumulated damage increases to the new level.

One or another of the damage accumulation models is assigned to each OAT based on their implied function and the nuclear environment(s) to which they are most susceptible. The damage model assignments are summarized in Table 1. The additive model applies to the seaworthiness OAT based on structural damage from blast/shock environments and to any other OAT that is vulnerable to the total gamma dose radiation environment. The maximum model applies to the mobility, weapon delivery, communication, and sensor OATs based on mechanical component damage from blast/shock environments or electrical component damage from the gamma dose rate radiation environment. The multiplicative model based on the statistical damage methodology is considered to be more applicable to personnel and aircraft OATs.

3.8 Estimated Time To Repair (ETR) Model

When a target is damaged by a nuclear burst, repair of the damaged components will immediately begin in an attempt to restore as much as possible of the target's original functional capability. Therefore, the impairment of a target OAT will be a function of time, starting at the initial level of impairment right after detonation and decreasing as time passes and repairs are made.

TABLE 1

OAT DAMAGE ACCUMULATION MODELS

OAT	ENVIRONMENT					
	UNDERWATER SHOCK		BLAST	THERMAL	RADIATION	
	SUB	SURF			RATE	TOTAL
SW	Add	Add	Add	---	---	---
MOB	Max	Max	Max	---	---	---
WD	Max	Max	Add	Add	Max	Add
COMM	Max	Max	Add	Add	Max	Add
SENS	Max	Max	Add	Add	Max	Add
PERS	Mult	Mult	Mult	Mult	Add	Add
A/C	---	Mult	Mult	Mult	Max	Add

The ETR model employed in NUCDAM is based on several assumptions. First, the ETR model ignores the fact that identical impairments may have different ETRs and indicates that for any OAT, the ETR is a direct function of impairment. Second, the model assumes that the ETR is not linear with impairment but rather exponential. This means that doubling the impairment will square the repair time, which implies that higher levels of impairment will generally involve more serious damage to components that are less easily repaired or replaced. Finally, it is assumed that above a certain level of impairment no repair will be possible unless the target returns to port in the case of a naval vessel or reconstruction begins in the case of a land target, to restore the target's functional capability.

3.9 Vulnerability Data

Vulnerability data in the literature generally consist of those environmental levels which will produce 10% to 90% impairment for the seaworthiness, mobility, and weapon delivery OAT categories. Data also are available for the severe, moderate, and light damage levels related to the aircraft and military equipment categorizations. These damage levels have been assumed to relate to 90%, 50%, and 10% impairment, respectively. Other data are given in the form of sure-safe or sure-kill levels. These levels are quantitatively defined as 0% and 100% impairment. The vulnerability data is used in the damage model to describe the shape of the impairment curve when calculating damage from some intermediate level of environment.

3.10 Vulnerability Tables

The vulnerability data used for underwater and atmospheric burst effects on submarines, surface ships, and land targets were combined with the operational attributes, nuclear environments, damage and repair models to produce a data base to be utilized by

NUCDAM. In order to determine weapon system impairment and ETR for a target subjected to a nuclear burst, NUCDAM accesses the necessary data from the vulnerability table. The vulnerability table contains the following entries:

- An index which allows access of the appropriate data for the affected OAT.
- An alphanumeric description of the OAT categories.
- An index indicating which nuclear environment subroutine to use.
- An index indicating which damage model to use (currently, only a linear model is available in the code).
- Vulnerability data corresponding to 10% and 90% impairment for calculating intermediate levels of impairment in the damage model.
- An index indicating which damage accumulation model to use (1 = multiplicative, 2 = additive, 3 = maximum).
- An index indicating which ETR model to use (currently only an exponential model is available in the code).
- The values required to calculate the ETR based on the level of impairment.

Vulnerability tables have been created for each of the submarine, surface ship, and land target categories. The vulnerability of any class of target can be completely characterized by combining the appropriate OATs for each target type with the nuclear environments and vulnerability data described earlier.

4.0 CONFIGURATION MANAGEMENT PLAN AND PROCEDURES

Configuration management for the OP-654 sponsored Nuclear Damage Assessment Module, shall involve the establishment and maintenance of a formal plan and set of procedures by which design control, development, modification scheduling, and status accounting may be accomplished under the authority of OP-654.

The Configuration Management Plan and Procedures herein specified shall be simple in concept, organization, and implementation. However, they shall also be malleable so that as a system evolves and expands, the plan and procedures shall be capable of accommodating more complexities without basic redesign. It is to be emphasized that the plan and procedures are not to impose a burden on the developers or users. Rather, they shall enhance the operating processes by keeping all interested parties up-to-date respecting the status of the system.

The Configuration Management Plan which identifies and specifies management, identification, control, and maintenance for a system under configuration control.

It is anticipated that the procedures for configuration management functions will evolve. To accommodate this dynamic environment, this document and its updates shall be controlled within the configuration management plan similar to any other software product. The initial promulgation of this document shall represent its baseline, and changes to the document will be accomplished with the procedures identified for changing any baselined item.

4.1 Objective and Scope

The objective of Configuration Management (CM) for Simulations and Management Information Systems is to establish and maintain a formal set of procedures by which a uniform system of identification, design control, and modification scheduling may be accomplished. Configuration management is concerned with the total activities of the system; the development, implementation, testing, verification, and operation of individual subsystems.

Specifically, configuration management shall aid in preserving the integrity of the system. It shall assure that replication of data, programs, and input procedures does not exist; that the interfacing routines interact in a compatible manner; that the data base structures remain stable; that adequate advance coordination is provided to all users concerned with any changes; that such changes are tested and verified prior to release; and that the structure and content of the system is protected by proper security measures.

The scope of configuration management shall be defined in terms of the following activities:

- o Configuration Identification - The configuration of the system shall be identified by and documented in a series of manuals, and computer printouts.

- o Configuration Control - In the configuration control process, changes to the established manuals shall be initiated, reviewed and evaluated, approved or rejected, implemented and verified, and released.

The purpose is to assure that the configuration used in critical phases of testing, acceptance, delivery, and operational life time is known as compatible with the specifications.

- o Configuration Maintenance - Configuration maintenance is the process by which the software and documentation are supported in order to be up to date and usable and by which end items and changes to end items are prepared for release.

- o Configuration Processing - Configuration processing is the means by which the configuration management procedures are implemented and maintained and whereby the software end items and products are stored and distributed.

Concurrent with these activities, configuration reviews and audits during the development cycle shall provide verification that the performance achieved by the end item is the performance required by the specification and that the configuration of the end item is accurately specified.

4.1.1 Document Organization

This document defines the organization and procedures for configuration management. The following paragraphs present an overview of this document.

The Configuration Management Office (CMO, OP-654), shall be responsible for establishing, organizing, and maintaining the configuration management and control operation. Section 4.2 discusses the configuration management organization, and the CMO functions.

The CMO shall be responsible for identifying the configuration which shall form the basis for change control and status accounting functions. Section 4.3 discusses configuration identification and baseline definition and requirements. Included are the forms to be used to release and to propose changes to an identified configuration.

The CMO shall form the Configuration Control Board (CCB) as a body representing the organizations and individual users of the controlled system and other technically cognizant personnel. Section 4.4 discusses the meaning of configuration control, the CCB functions as they relate to the controlled items.

The CMO shall designate the Configuration Maintenance Group (CMG) as technically qualified personnel oriented toward operating, updating, and maintaining software subsystems and associated documentation. The CMG will generally be from organizations responsible for maintenance of subsystems and from organizations developing subsystems. Section 4.5 discusses the meaning of controlled items.

The CMO shall establish the Configuration Control Center (CCC) as a body responsible for communicating and interfacing with the users, the CCB, and the CMG for maintaining a central repository of information and software products. Section 4.6 discusses the functions of CCC as they relate to the controlled items.

4.2 Configuration Management Organization

Configuration management responsibilities consist of exercising baseline and change approval authority, maintaining functions. These responsibilities shall be shared by OP-654 and designated cognizant contractors until such time as OP-654 wishes to assume full management and control functions.

The basic responsibilities of the configuration management function shall be as follows:

- Implement configuration change control procedures immediately upon establishment of the baseline.

- Insure that proposed changes to end items and/or documents are documented in detail on applicable change request forms prior to review, evaluation, and/or initiation of implementation.

- Insure that documented change requests are reviewed, evaluated and approved prior to implementation; and that rejected change requests are omitted from the implementation cycle.

- Insure effective and efficient operation of the change control cycle to the extent that no changes are implemented without prior approval, and no unnecessary delays are experienced in the processing of a change request.

- Update and release the modified system at an appropriate time and insure that updated documentation accompanies the release.

4.2.1 Configuration Management Office (CMO) Function

The Configuration Management Office (CMO) shall be responsible for establishing, organizing, and maintaining the configuration management and control operation. The CMO shall be responsible for establishing and directing the configuration management functions. It will authorize activities and have ultimate approval over the configured system, proposed modifications, and support documentation.

4.3 Configuration Identification

The configuration as identified by OP-654 shall be defined as the basis for the change control functions. The initiation point for software configuration management shall be the baseline. For developmental subsystems this is established by review and acceptance of description or specification documents. For existing subsystems the baseline may be defined as the current configuration and documents.

After a defined baseline item has been accepted, changes may be proposed using the form created for this purpose. Subsequent sections depict and describe the forms and list the items to be maintained under configuration control.

4.3.1 Baseline Definition and Requirements

Baselines are defined because they are the basis, or reference points, for subsequent development and control. Baselining a subsystem requires that the physical and functional characteristics of the controlled subsystem end items and products be defined and documented at a logical transition point in the system life cycle.

The milestone defined for configuration management initiation for systems or subsystems being developed shall be the baseline established at the Critical Design Reviews (CDRs). The subsystem design and implementation processes are illustrated in Figure 4. Certain tasks shall be performed and pertinent documentation shall be generated to reflect an accurate description of the baselined configurations. These tasks and documents are:

- The acceptance of a task order proposal (at a Proposal Review) leads to a decision to implement the subsystem. At the proposal review a unique identification is assigned to the subsystem, and this identification will accompany all software products and manuals for the lifetime of the subsystem.

- The acceptance of a Preliminary Design Description (PDD) document (following a Preliminary Design Review (PDR)) leads to a decision to develop subsystem specification. Design modifications requested at the PDR are incorporated into the PDD.

- The acceptance of a SCP following the CDR leads to a decision to develop the subsystem and establishes the SCP as the subsystem design specification document. The Subsystem Design Specification document identifies the baseline for that subsystem. Design modifications requested at the CDR are incorporated into the document.

- The Subsystem Design Specification document details the subsystem environment and design elements required for computer program and data base implementation. It includes subsystem specifications, functions, input and output requirements, flow charts, and performance requirements. It describes the program development and

DEVELOPMENT STAGE	OPNAV ACTION RECOMMENDATION AND/OR APPROVAL	CONTRACTOR ACTIVITIES	RESULTING PRODUCT(S)	OPNAV & CONTRACTOR REVIEW
1. INITIATION	ISSUE TASK DESCRIPTION	TASK ORDER PROPOSAL	PROPOSED TASK ORDER	PROPOSAL REVIEW
			TASK ORDER	
2. DESIGN	DECISION TO IMPLEMENT SUBSYSTEM AND ISSUE TASK ORDER	DETAILED REQUIREMENTS ANALYSIS-PRELIMINARY	PRELIMINARY DESIGN DESCRIPTION	PRELIMINARY DESIGN REVIEW (PDR)
			PDR MINUTES	
3. SPECIFICATION	DECISION TO DEVELOP SUBSYSTEM SPECIFICATIONS	DETAILED SUBSYSTEM DESIGN	SUBSYSTEM DESIGN SPECIFICATION (BASELINE) AND TEST PLANS	CRITICAL DESIGN REVIEW (CDR)
			CDR MINUTES	
4. IMPLEMENTATION AND INSTALLATION	DECISION TO DEVELOP SUBSYSTEM	PROGRAMMING, INSTALLING, TESTING, TRAINING, ACCEPTANCE TESTING	FINAL DESIGN DESCRIPTION OPERATING MANUAL PROGRAMMER'S MANUAL DATA ELEMENT DICT., SOFTWARE	OPERATIONAL DESIGN REVIEW (ODR)
			ODR MINUTES	
5. OPERATION	SUBSYSTEM ACCEPTANCE	OPERATIONAL SUPPORT, AS REQUIRED	OPERATIONAL SUBSYSTEM	

- - - CONFIGURATION MANAGEMENT ENVIRONMENT

Figure 4. NUCDAM Subsystem Development Process

production control. The document provides the basic design data necessary for construction of subsystem procedures, forms, files, tables, and dictionaries. It describes the storage allocation and data base organization. It includes specifications for implementation, testing, and verification criteria.

- The acceptance of the Final Design Description document at the Operational Design Review (ODR) leads to the acceptance of an operational subsystem.

  The Final Design Description document presents a description of the subsystem's logical and physical architecture including procedures, forms, programs, and data bases. It indicates what the subsystem is designed to accomplish and, in general, how the design shall be implemented. It covers operating procedures, overall subsystem methodology and related hardware configuration. It describes the subsystem for the individual interested in an overview of subsystem design and operations.

- At subsystem acceptance the Users, Programmers and Data Base Manuals, as required, become effective. An orientation for the users and programmers is conducted to acquaint them with the subsystem and the use of the manuals.

  The User's Manual describes system operation at the user level including man-system interaction, data requirements and system products. It defines alphanumeric and graphic display formats and the structure of user actions. It describes system elements and their operational attributes. The User's Manual describes the system capabilities, inputs, and outputs. It defines the input and output options, data elements, file structures. It also contains examples of deck set-ups, inputs, and outputs as required.

The Programmers Manual describes in detail all system software. It includes the current approved flow charts along with explanations and listing of the environment and impairment routines used by the NUCDAM code. It documents all physical and functional interfaces between the subsystems. It contains a catalog of all modules or subroutines with their effective date, i.e., the date of the last modification or compilation.

The Data Base Manual contains data elements information about the necessary vulnerability data used by NUCDAM. It defines each data element, identifies the sources, indicates the uses, and notes applicable security restrictions. It contains other pertinent information to be determined.

4.3.2 System Change Proposal (SCP) Form Description

This form, depicted in Figure 5, shall be used by anyone wishing to propose a change to software, documentation, or procedures because of a problem, a specification change, or an improved implementation technique.

4.3.3 Change and Release (CAR) Form Description

This form, depicted by Figure 6, shall be used by anyone wishing to release a software product or document to OP-654 and by OP-654 when an end item is to be released for use. Initially,

SYSTEM CHANGE PROPOSAL FORM (SCP)

1. SCP No. ______

2. Title ______ 3. Date ______

4. Subsystem Name ______ 5. ID ______

6. Implemented by ______ 9 App. by ______

7. Verified by ______ 10. App. Date ______

8. Released by ______ 11. Eff. Date ______

12. CAR No. References

---

13. Items Affected:

Subsystems ______

JCL ______

Program/Modules ______

Data Files ______

Documents ______

Other ______

---

14. Description of Implementation, Verification, and Release (All items affected shall be described.)

---

15. Reason for Change

---

16. Evaluation

---

17. CCB Action

---

18. CCB Attendees

Figure 5. System Change Proposal (SCP) Form

SYSTEM CHANGE PROPOSAL FORM (SCP)

	1. CAR No. ________
2. Title ________	3. Date ________
4. Subsystem Name ________	5. ID ________
6. Implemented by ________	9 App. by ________
7. Verified by ________	10. App. Date ________
8. Released by ________	11. Eff. Date ________

12. SCP No. References

13. Items Affected:

Subsystems ________ ________

JCL ________

Program/Modules ________

Data Files ________

Documents ________

Other ________

14. Description of Implementation, Verification, and Release (All items affected shall be described.)

15. Disposition of Superseded Material (All items affected shall be noted.)

Figure 6. CAR Form (Sample)

OP-654 shall use it to release a subsystem and supporting documents to the system users. After verification of subsystem modifications as developed for a SCP, the CAR shall be used to convey to OP-654 the software products, cards, tables, listings, test results, and documentation resulting from the change. When a new or revised version of a system end item is released, a CAR shall be used to document and convey this information.

4.3.4 Controlled Items

As a minimum, the following items shall be placed under configuration control after baselining has occurred.

- Subsystem Software Products - Each subsystem shall be controlled. The software products accompanying the release shall include the original source deck; the modification deck unless a new source is produced; the disk files - source, object, and load; the tape files - source, object, and load; and the program listings.

- Subsystem Design Specification Document - Upon subsystem baseline, this document shall be released for control.

- Final Design Description Document - Upon acceptance of the operational subsystem, this document shall be released for control.

- Programmers Manual - Upon acceptance of the operational subsystem, this document shall accompany the system release. It shall be updated with each system update. The modified pages shall be distributed. At selected times the entire document shall be reissued.

- User Manual - Upon acceptance of the operational subsystem, this document shall accompany the system release. It shall be updated with each system update. The modified pages shall be distributed. At selected times, the entire document shall be reissued.

- Data Base Manual - Upon acceptance of the operational subsystem, this file and associated document shall accompany the system release. They shall be updated with each subsequent applicable system release.

- Access Control Document - This document shall be maintained by OP-654. It includes the subsystem(s) account number, user initials, keywords, and other means of access to the subsystem(s) files with the list of personnel who have access and/or update privileges. The CMO shall determine this personnel list.

4.4 Configuration Control

Configuration control is defined as the process by which changes to end items and documents are initiated, reviewed and evaluated, approved or rejected, implemented and verified, and released. When an end item or document master is released to the CMO, it shall not be changed until the requested change has been approved by the Configuration Control Board (CCB).

The Configuration Control Board (CCB) shall be established by OP-654 to assume these responsibilities.

4.4.1 Configuration Control Board (CCB) Function

The function of the CCB is to represent and be technically cognizant of the requirements of the organizations and individual users of the system, to assist in baselining an end item, to evaluate and approve change requests, and to monitor the configuration.

The CCB functions shall include the following:

- Represent the various organizations and individual users of the system and be technically cognizant of their requirements so that by representing a system point of view, it may minimize duplication of effort among subsystems, insure subsystem compatibility, and assure that subsystem development, documentation, testing, verification, and operation follow a consistent set of standards.

- Assist in baseline identification by reviewing the Subsystem Design Specification and Final Design Description documents to familiarize themselves with the subsystem being developed; to participa.. in the design reviews, (at a minimum the Critical and Operation Design Reviews) to insure that the subsystem meets its design specifications; and to review the User, Programmers and Data Base Manuals to insure that the baseline configuration is adequately and appropriately documented.

- Review, evaluate, approve or reject proposed changes to the subsystem and/or its documentation. Consideration shall be given to the desirability of the change and benefits to the current subsystem; its impact on current and potential users and on other subsystems, on current implementation, schedules, and cost; its administrative or technical necessity; and feasible alternatives such as adopting a workaround procedure if the change were not approved. The CCB shall recommend to OP-654 the approval, rejection, or alternate approach to the proposed changes.

- o Monitor the configuration by coordination with the CMG (Configuration Maintenance Group) to insure that the changes are designed, implemented, tested, and verified as specified and that the updated subsystems are released according to schedule.

The CCB shall schedule periodic reviews as required to examine the design and implementation methods during the development of modification period. Upon approval, the CMG will proceed; otherwise, redesign and rework shall ensue. After completion and verification of the change, the CCB may review the final implementation and make recommendations to the CMO (OP-654).

4.5 Configuration Maintenance

Configuration maintenance is the process by which the software and documentation are supported in order to be up-to-date and usable and by which end items and changes to end items are prepared for release. This process begins after the CMO and CCB have approved a baseline or a change and continues for the lifetime of the subsystem. The preparation for release will be initiated with OP-654 approval and will cause the released software to become available as of the date specified.

The responsibilities of the configuration maintenance function to be undertaken by the Configuration Maintenance Group (CMG) are as follows:

- o Maintain the configuration within the current operating system so that it is accessible for use only by select users and that it is accessible for modification only by authorized personnel with approval.

- Update the configuration as specified by the SCPs which are approved by OP-654.

- Support backup capabilities as defined by OP-654.

4.5.1 Configuration Maintenance Groups (CMG) Function

The function of a CMG is to implement and verify the software end item as approved and released by CMO and to coordinate documentation updates with subsystem configuration updates.

The CMG functions include the following:

- Accomplish, verify, and implement the changes and modifications as documented by approved SCPs. The documentation such as the Subsystem Design Specification and Final Description documents, the Users, Programmers, and Data Base Manuals, shall be updated to reflect the modifications. All changes shall be conveyed to the CCC via the CARs.

- If after subsystem delivery another CMG is responsible for subsystem operation, verification of operation may be deemed desirable. This may be achieved by rerunning the test cases and verifying the test results or it may require the development of new or additional test cases and criteria. After verification and acceptance, the CMG shall update the subsystem programs, JCL, and data files to become effective release data established by the CMO.

- Execute production programs as may be requested by the CMO and other organizations.

- o Maintain the operating procedures, and other system maintenance functions. This function entails insuring that backup cards and/or tapes exist, are current, and be made available to CCC for safe storage.

4.6 Configuration Processing

Configuration processing is the means by which the configuration management procedures are implemented and maintained and whereby the software end items and products are stored and distributed. The basic responsibilities include communicating and interfacing with the users, and the CMGs; the storage and distribution of software products and information; and the status accounting of the configurations under control.

The Configuration Control Center (CCC) will accomplish these responsibilities.

4.6.1 Configuration Control Center (CCC) Function

The function of the CCC is to implement and maintain the configuration control procedures and act as a central repository of information and central communications facility.

- o Act as the central contact point for procedural activities related to managing the configurations assisting the CMO in arranging meetings for the CCB, CMG, users, and other auxilliary personnel to review the proposed changes. The CCC shall prepare a review package and be prepared to discuss the status of current implementations.

The CCC will provide update release information, software products, and documents as required to interested authorized recipients; prepare and distribute minutes of configuration review meetings; and handle and process the CARs and SCPs.

- Assure the configuration identification of the subsystem immediately upon the initiation of the baseline and assign identification numbers to the software documents and products.

  The identification number assigned to a subsystem is that agreed to at the proposal review. It shall be unique in that it does not duplicate the identification assigned to any other subsystem.

- Accept responsibility for storage and distribution of software documents and products. This entails being the central repository for up-to-date software documents and products and insuring that duplicate masters of computer programs and documentation are maintained in a remote location.

  The Data Base Manual for data element definitions used in the controlled systems will be maintained by the CCC.

- Accomplish status accounting. This requires maintaining a log of all change requests and the status of their processing, and preparing, maintaining, and distributing status reports as required to provide adequate visibility of the configurations and configuration management activities in process.

5.0 VERSION IDENTIFICATION AND CONTROL

For the purpose of control and identification each implementation of NUCDAM will be identified as a version. All of the versions use the same models but are different in their implementation.

NUCDAM VERSION #1

Developed From:	PHASE III
Computer:	IBM 3033
Language:	PL1
Current Distribution:	NNWS (OP-654), APL, Johns-Hopkins Univ.

Notes:

NUCDAM was developed by Kaman Sciences Corporation for OP-654, to be used in NNWS for calculating damage to naval units involved in tactical nuclear engagements at sea. Each time a nuclear burst occurs in a naval warfare engagement, NUCDAM is called by the NNWS Executive Routine with sufficient input data to perform the damage assessment function. The inputs to NUCDAM consist of target parameters carried in the unit state vector, weapon parameters which are passed from the Executive Routine, and the environment vulnerability data for the particular unit type from the vulnerability tables contained in the data base. These data describe the target operational attributes, the current operational attribute availability and repair completion time status, and the damage and repair time model threshold parameters. The impairment and repair time calculations are then made in NUCDAM for each of the operational attributes that describe the unit being evaluated. The output from NUCDAM consists of updates to the availability and repair completion time parameters for each operational attribute carried in the unit state vector. After the damage calculations and parameter updates are completed for this particular engagement, control is passed back to the Executive Routine to determine the unit's capability to perform its mission.

NUCDAM VERSION #2

Developed From:	PHASE II
Computer:	Radio Shack TRS-80 Model 1 Microcomputer
Language:	FORTRAN
Current Distribution:	Naval War College
	DNA, LASL (CDC CYBER)
	Kaman Sciences Corporation

Notes:

Kaman Sciences Corporation has implemented the Phase II NUCDAM program on a Radio Shack TRS-80 microcomputer using the TRS-80 Fortran Package by Microsoft Consumer Products. The implementation includes a single interactive driver program which replaces the NNWS Executive Routine. This allows the user to specify the inputs to subroutine NUCDAM. Provisions have been made to allow inputs from the keyboard or from the disk. Outputs from NUCDAM are sent to the line printer by the driver routine. This version of NUCDAM provides the user with a simple means of examining the effects of nuclear weapons on a ship.

In order to implement NUCDAM on a microcomputer, the data structure has been reduced. The TRS-80 implementation processes one unit at a time, with that unit defined by up to ten operational attributes. TRS-80 NUCDAM occupies about 32K bytes out of a maximum of 48K bytes available. Execution time requires only a few seconds for a unit with 10 OATs.

The delivered TRS-80 NUCDAM includes the unclassified version of subroutine RADENV, with dummy values for certain coefficients. Prompt radiation environments are therefore meaningless until required changes are applied to produce the classified version of RADENV. In addition, this version of NUCDAM does not include the additional nuclear weapon effects incorporated under Phase III. These additional nuclear weapon effects from underwater bursts included the blast overpressure along the surface of the water (psi), the peak dose rate from the base surge (Rads/Hr), the total dose from the base surge (Rads), and the peak translational velocity (ft/sec) which include the effects of bottom reflection.

NUCDAM VERSION #3

Developed From:	PHASE II
Computer:	WANG 2200 T/VP
Language:	BASIC
Current Distribution:	Naval Weapons Training Group (LANT&PAC)
	Naval Tactical Support Activity (FMPL)
	Commander Second Fleet
	Kaman Sciences Corporation

Notes:

NUCDAM has been implemented on the WANG 2200 T&VP microcomputers. The WANG implementation of NUCDAM is a translation into BASIC of the TRS-80 microcomputer version of NUCDAM, which was written in FORTRAN. The TRS-80 version is in turn based upon the NNWS Phase II NUCDAM code. The NUCDAM Version #3 code is written in WANG BASIC 2.0. The program is supplied on a single-sided, single-density eight inch disk. NUCDAM and associated data files occupy 122 out of 1023 sectors. Execution is performed by resetting the computer, inserting the NUCDAM disk in the proper drive, and entering the appropriate commands.

The WANG/NUCDAM includes the unclassified version of subroutine RADENV, with dummy values for certain coefficients. Prompt radiation environments are therefore meaningless until required changes are applied to produce the classified version of RADENV. In addition, this version of NUCDAM does not include the additional nuclear weapon effects incorporated under Phase III. These additional nuclear weapon effects from underwater bursts included the blast overpressure along the surface of the water (psi), the peak dose rate from the base surge (Rad/Hr), the total dose from the base surge (Rads), and the peak translational velocity (ft/sec) which included the effects of bottom reflection.

NUCDAM VERSION #4

Developed From:	PHASE II
Computer:	HP9845
Language:	BASIC
Current Distribution:	Tactical Training Group (LANT&PAC) Commander Second Fleet Kaman Sciences Corporation

Notes:

Kaman Sciences Corporation has implemented the Phase II NUCDAM on the HP9845 microcomputer. Two versions of NUCDAM have been developed for the HP9845 microcomputer, called the Fleet Model and the Analytic Model.

The Fleet Model is designed for maximum efficiency and ease of operation. Demands for user selection of variable inputs have been minimized. Target data are taken from input files which have been pre-loaded into the memory along with the main program for U.S. and Soviet surface ships, carrier, and submarines. Nevertheless, provisions exist for the user to override these data and furnish his own, should this become necessary. Technical data have been cut to a minimum to avoid distracting or confusing the users interested only in the bottom line. Thus, the output of this model contains verbal descriptions of platform damage rather than tables of data.

The Analytical Model presents all of the input and output data available in NUCDAM and allows the user complete freedom to modify them as necessary. The user has the option to employ existing data files or to generate his own. Standard output procedures have been streamlined so that only half the normal number of entries is required. This is accomplished by pre-selection of damage accumulation and repair-time parameters. Again, this pre-selection may be overridden by the user should he so desire.

The Version #4 of NUCDAM includes the unclassified version of subroutine RADENV, with dummy values for certain coefficients. Prompt radiation environments are therefore meaningless until required changes are applied to produce the classified version of RADENV. In addition, this version of NUCDAM does not include the additional nuclear weapon effects incorporated under Phase II[7]. These additional nuclear weapon effects from underwater bursts included the blast overpressure along the surface of the water (psi), the peak dose rate from the base surge (Rad/Hr), the total dose from the base surge (Rads), and the peak translational velocity (ft/sec) which included the effects of bottom reflection.

NUCDAM VERSION #5

Developed From:	PHASE III
Computer:	VAX 11/780
Language:	FORTRAN
Current Distribution:	Naval Ocean Systems Center (NOSC)
	Boeing Aerospace Company
	Titan Systems, Inc.
	Kaman Sciences Corporation
	CNO (OP-654) (PDP 11/34)

Notes:

NUCDAM Version #5 (NWISS NUCDAM SYSTEM) was developed by Kaman Sciences Corporation to work in conjunction with the Battle Group Training Computer Support Facility (GBTCSD) as a stand along tactical decision aid on a VAX 11/780. The BGTCSF offers the opportunity for tactical engagement raining through the computerized wargame simulation. The initial BGTCSF simulation had no nuclear engagement capability. The NUCDAM Version #5 code will give the users of BGTCSF the option of having some tactical nuclear capability through the stand alone simulation designed to operate within the BGTCSF framework.

The NWISS NUCDAM SYSTEM will provide the player participating in the tactical engagement training wargame the opportunity to examine the possible effects of the use of tactical nuclear weapons by either of the forces. The NWISS control function will also be able to utilize the information from the NWISS NUCDAM SYSTEM to make decisions as to the effects of nuclear weapons if it is decided that their use is to be employed. Since the NWISS NUCDAM SYSTEM will not have access to the data base of the wargame simulation, there will be a compatible data base designed to allow stand along analysis in real time during the wargame. The data base is designed by the wargame systems analyst.

The NWISS NUCDAM SYSTEM is designed with four operating functions: HELP, BUILD, TACAID, and NUCDAM. Each of the functions are described below.

The HELP function will provide interactive user documentation on the use of NUCDAM. The HELP function is self-prompting and self-directing. The HELP function can be called at any time during a NWISS NUCDAM SYSTEM session. The return of HELP to any prompt will place the user in the HELP mode. An END will terminate the HELP session and return to the prompt from which HELP was called.

The BUILD function will allow the game analyst to prepare a data file of the platforms (units involved in the wargame) and the OATs (operational attributes of the platforms) which will be used in the wargame. There are two types of entries in the BUILD function: OATs and platforms. The BUILD function will open and close the data files as requested.

The TACAID function is a tactical decision aid to the player during a BGTCSF wargame. This function allows the player to see the nuclear environment contours (which are in tabular form in this version) for environments of interest around a potential nuclear burst. This will allow the player to determine the effects which will be experienced by nearby friendly, neutral, or enemy forces. The output of the TACAID function will be plot data in tabular form which can eventually be plotted when appropriate hardware is available.

The NUCDAM function provides specific environment and damage level data for a given platform and nuclear detonation combination. The information may be of value to the NWISS control function for determining the damage to a platform if a nuclear weapon is fired during a game. It also will be of value to a player considering the use of a nuclear weapon. This function can project possible environment levels and damage experienced by a specific enemy, neutral, or friendly platform.

NUCDAM VERSION #6

Developed From:	PHASE III
Computer:	CYBER
Language:	FORTRAN
Current Distribution:	HQ, DNA Washington
	McDonnell Douglas Corporation
	Kaman Sciences Corporation
	McLean Research Center

Notes:

This is the implementation of Version #5 on the CDC CYBER. The Version #5 users guide will apply.

NUCDAM Version #5 (NWISS NUCDAM SYSTEM) was developed by Kaman Sciences Corporation to work in conjunction with the Battle Group Training Computer Support Facility (BGTCSF) as a stand along tactical decision aid on a CYBER 170/730. The BGTCSF offers the opportunity for tactical engagement raining through the computerized wargame simulation. The initial BGTCSF simulation had no nuclear engagement capability. The NUCDAM Version #5 code will give the users of BGTCSF the option of having some tactical nuclear capability through the stand alone simulation designed to operate within the BGTCSF framework.

The NWISS NUCDAM SYSTEM will provide the player participating in the tactical engagement training wargame the opportunity to examine the possible effects of the use of tactical nuclear weapons by either of the forces. The NWISS control function will also be able to utilize the information from the NWISS NUCDAM SYSTEM to make decisions as to the effects of nuclear weapons if it is decided that their use is to be employed. Since the NWISS NUCDAM SYSTEM will not have access to the data base of the wargame simulation, there will be a compatible data base designed to allow stand along analysis in real time during the wargame. The data base is designed by the wargame systems analyst.

The NWISS NUCDAM SYSTEM is designed with four operating functions: HELP, BUILD, TACAID, and NUCDAM. Each of the functions are described below.

The HELP function will provide interactive user documentation on the use of NUCDAM. The HELP function is self-prompting and self-directing. The HELP function can be called at any time during a NWISS NUCDAM SYSTEM session. The return of HELP to any prompt will place the user in the HELP mode. An END will terminate the HELP session and return to the prompt from which HELP was called.

The BUILD function will allow the game analyst to prepare a data file of the platforms (units involved in the wargame) and the OATs (operational attributes of the platforms) which will be used in the wargame. There are two types of entries in the BUILD function: OATs and platforms. The BUILD function will open and close the data files as requested.

The TACAID function is a tactical decision aid to the player during a BGTCSF wargame. This function allows the player to see the nuclear environment contours (which are in tabular form in this version) for environments of interest around a potential nuclear burst. This will allow the player to determine the effects which will be experienced by nearby friendly, neutral, or enemy forces. The output of the TACAID function will be plot data in tabular form which can eventually be plotted when appropriate hardware is available.

The NUCDAM function provides specific environment and damage level data for a given platform and nuclear detonation combination. The information may be of value to the NWISS control function for determining the damage to a platform if a nuclear weapon is fired during a game. It also will be of value to a player considering the use of a nuclear weapon. This function can project possible environment levles and damage experienced by a specific enemy, neutral, or friendly platform.

NUCDAM VERSION #7

Developed From:	PHASE III
Computer:	WICAT 150 WS
Language:	FORTRAN 77
Current Distribution:	Naval Training Center, Orlando, Florida

Notes:

The NAVTAG Companion is a self-teaching study aid designed to run on a WICAT 150 as an adjunct to the NAVTAG wargame system. The Companion contains a nuclear weapons primer and an interactive version of NUCDAM.

The nuclear weapons primer contains textual material and is a self-prompting study guide to nuclear weapons effects. The primer is divided into three sections:

- o Tutorial - each nuclear weapon environment is described.
- o Operational Impact - each environment's impact on a naval units operations is discussed.
- o Tactical Significance - the significance of th nuclear environment to the tactical siutation is discussed.

The NUCDAM portion of the NAVTAG Companion is a self-prompting simulation which allows the user to experiment with nuclear weapons and their damage on tactical targets. The NUCDAM portion is divided into two sections:

- TACAID - In this module weapon parameters may be specified and the levels of nuclear environment examined.

- FREE PLAY - In this module the user may specify a tactical deployment and examine the operational impairment to each unit from a nuclear attack.

This version of NUCDAM is made up of the Phase III routines with the bottom reflection routine, BOTREF, deleted.

REFERENCES

1. Young, W.J., et al, "Phase I Damage Assessment Module for the Naval Nuclear Warfare Simulation (NNWS) (U)," K-79-224(R), Kaman Sciences Corporation, 30 June 1979. SECRET FORMERLY RESTRICTED DATA

2. Young, W.J., et al, "Naval Nuclear Warfare Simulation (NNWS) Phase II Damage Assessment Module (U)," K-80-392(R), Kaman Sciences Corporation, 30 September 1980. SECRET RESTRICTED DATA/CNWDI

3. Young, W.J., et al, "Naval Nuclear Warfare Damage Assessment Module (NUCDAM) (U)," K-82-67(R), Kaman Sciences Corporation, 31 December 1981. SECRET RESTRICTED DATA

APPENDIX A

VERSION #2 USERS GUIDE (TRS-80)

TRS-80 NUCDAM

INTRODUCTION

Kaman Sciences Corporation (KSC) has implemented the Phase II NUCDAM damage assessment module of the Naval Nuclear Warfare Simulation (NNWS)[1] on a Radio Shack TRS-80 Model I microcomputer. The implementation includes a simple interactive driver program to allow the TRS-80 user to specify the inputs to subroutine NUCDAM. Provision has been made to allow inputs from the keyboard or from disk. Outputs from NUCDAM are sent to the line printer by the driver routine. The TRS-80 code has been verified with the check cases used for the PL/I version.

In order to implement NUCDAM on a microcomputer, the data structure has been reduced. The TRS-80 implementation processes one unit at a time, with that unit defined by up to 10 Operational Attributes (OAT). Additional programming changes of a minor nature were also necessary to conform to Microsoft TRS-80 FORTRAN[2] restrictions. TRS-80 NUCDAM occupies about 32K bytes out of a maximum of 48K bytes available. Execution time is quite fast, requiring only a few seconds for a unit with 10 OATs. Minimum system requirements are a TRS-80 Model I Microcomputer with 48K RAM (Random Access Memory) and one disk drive. For code modifications using the FORTRAN compiler, it is recommended that two disk drives be available.

---

[1] Griffin, D., et al., Naval Nuclear Warfare Simulation (NNWS) Phase I: Damage Assessment Module (U), Kaman Sciences Corporation, K-80-392(R Colorado Springs, Colorado. 30 September 1980. SECRET RESTRICTED DATA/CNWDI.

[2] TRS-80 FORTRAN Package, Microsoft Consumer Products, Bellvue, Washington. 19 February 1979. UNCLASSIFIED.

The delivered TRS-80 NUCDAM includes the unclassified version of subroutine RADENV, with dummy values for certain coefficients. Prompt radiation environments are therefore meaningless until required changes, from Reference 1, are applied to produce the classified version of RADENV.

This report documents the above NNWS NUCDAM modifications and provides operational information for the TRS-80 NUCDAM implementation. It is intended to be a supplement to existing NNWS NUCDAM documentation (Reference 1). The reader is assumed to be familiar with the NNWS NUCDAM documentation and with TRS-80 operation.

DATA STRUCTURE

To reduce the size of NNWS NUCDAM to be compatible with the TRS-80 microcomputer, it was necessary to revise the data structure. Most of the changes involve subroutine NUCDAM, primarily input/output and the COMMON blocks. The NUCDAM data differences are summarized in Table 1.

The NUCDAM calling sequence was altered to pass all inputs and outputs through COMMON blocks STVEC and VULTAB. Because only one unit is being processed for each call to subroutine NUCDAM, the variable K indicating the unit number, is no longer used. The variables SHIPCAT(K) and SCAT are also not used. Since OAT data are put directly into the new VDAT and KVDAT arrays, the KROSS array has been removed. The NNWS FEGSTAT array, containing availability and estimated time to repair (ETR), has been renamed FEGST and dimensioned for 10 OATs. The vulnerability table VULDATA has been reduced and split into the arrays VDAT and KVDAT for real and byte variables, respectively. Byte variables are integers that range in value from -128 to 127 and can therefore be stored in one byte. Only one environment of concern is now allowed, i.e.,

TABLE 1

NUCDAM DATA DIFFERENCES

NNWS NUCDAM	TRS-80 NUCDAM	COMMENTS
K	-	Not used.
SHIPCAT(K),SCAT	-	Not used.
KROSS(K,N)	-	Not used. OAT data put directly into VDAT and KVDAT arrays.
FEGSTAT(K,N,I)	FEGST(N,I)	OAT N. Dimensioned for 10 OATs.
VULDATA(KFEG,I,J)	VDAT(N,I) and KVDAT(N,I)	OAT N. Only 1 environment.
VULDATA(- ,1,-)	KVDAT(-,1)	
2	-	Assumed = 1.
3	VDAT (-,1)	
4	VDAT (-,2)	
5	KVDAT(-,2)	
6	-	Assumed = 1.
7	VDAT (-,3)	
8	-	Assumed = 4.6.
9	KVDAT(-,3)	
ENVLEV(J)	ENVLEV(N)	Changed to store environment for OAT N.
NUNITS,UNITNO, XUN,YUN,ZUN,NKFEG, FEGNAME	-	Not used.

the third dimension of VULDATA has been eliminated. The relationship between VULDATA items and the corresponding VDAT and KVDAT entries is indicated in the table. Note that items 2, 6, and 8 are assumed to be constants. This is consistent with the NNWS NUCDAM usage of these variables. That is, items 2 and 6 are always 1, while item 8 is always 4.6.

Since TRS-80 NUCDAM allows only one environment per OAT, the meaning of the array ENVLEV has been changed. For the TRS-80 implementation, ENVLEV is dimensioned to 10 and used to store the environment for OAT N. As shown, the NNWS NUCDAM variables NUNITS, etc., are not used.

To conserve memory and increase execution speed, BYTE variables have been used wherever possible. Also, common block /PASS/ in subroutine BVEL was removed, along with references to the variables in /PASS/. This was possible since the original purpose of these variables was to aid in debugging and the variables are no longer used.

In examining subroutine RADENV, it was noted that there was duplication in the environments coefficients data in arrays CFN1, CGTOT, etc. The coefficients that apply to weapon yields between 1 and 10 kt and between 10 and 40 kt are identical. Thus, these data were reduced from three tables to two and the environments calculations changed to reflect this.

PROGRAMMING CHANGES

In addition to the above changes to reduce the size of NUCDAM, all comment cards were removed from the NNWS routines to keep the size of the source code to a manageable level. Comments for these subroutines can, of course, be found in the NNWS NUCDAM listings. Because the driver TRSDAM and its subroutines CLEAR, OPTHOB and

XREAD are not documented elsewhere, comment cards were left in these listings.

Several programming changes were required because of Microsoft FORTRAN restrictions. Variable names of more than six characters are not allowed. The PRINT XX statements were changed to WRITE (2,XX) and asterisks (*) in FORMAT statements replaced with single quote marks (') around Hollerith fields. Multiple statements per line, with $ characters as separators, have been broken up into multiple lines. The TYPE portion of the declaration statements has also been removed. Input is now from the keyboard (unit 5) or disk (unit 6). Output is directed to the video (unit 5) or lineprinter (unit 2).

Microsoft FORTRAN does not allow multiple entry points for subroutines, defined with the ENTRY statement. Consequently, the calls in NUCDAM to various RADENV entry points, such as FN1MEV, GTOT, etc., were changed to CALL RADENV with the flag IP in the calling sequence set to the appropriate value. KDM, which was not used in the NNWS RADENV subroutine, has been removed from the calling sequence.

VERIFICATION

In order to ensure that the TRS-80 NUCDAM implementation is consistent with the NNWS NUCDAM code, an extensive matrix of cases was crosschecked. These cases included the entire set of computer runs used to verify the PL/I version of NUCDAM[3]. Table 2 shows a sample run for TRS-80 NUCDAM verification. Table 3 compares the TRS-80 NUCDAM results to the NNWS NUCDAM for the same OATs and

---

[3] Verification of PL/I Version of NUCDAM, Kaman Sciences Corporation, K-80-24U(M), Colorado Springs, Colorado Springs, Colorado. 4 March 1980. UNCLASSIFIED.

TABLE 2

SAMPLE VERIFICATION RUN

HEIGHT OF TARGET(FT)	0.	COLLAPSE DEPTH(FT)	2000.
HULL RADIUS(FT)	16.	HULL DEPTH(FT)	30.

OAT	OAT NAME	ENVIR MODEL	ENVIR	I10	I90	DAMAGE ACC MOD	A	IMAX	AVAIL	ETR
1	WD1	4	OVPRES	5.00E-01	5.00E+00	1	.40	90	100.	0.
2	COM1	5	EMPFLD	2.70E+03	3.40E+04	1	.40	50	100.	0.
3	WD2	6	N1MEV	6.00E+09	5.40E+10	1	2.40	85	100.	0.
4	COM2	7	GTOT	1.60E+02	1.50E+03	1	.90	55	100.	0.
5	COM3	8	GDOT	5.00E+07	5.00E+08	1	1.20	80	100.	0.
6	COM4	9	XRAY	2.70E+00	2.50E+01	1	.40	60	100.	0.
7	WD3	10	GP	1.00E+03	1.00E+04	1	.40	75	100.	0.
8	COM5	11	TISSUE	1.40E+07	1.50E+07	1	2.40	65	100.	0.
9	PER1	12	THERML	1.00E+02	1.00E+03	1	.90	70	100.	0.

YIELD(KT)	130.
HOB(FT)	2000.
GR(FT)	7500.

OAT	OAT NAME	ENVIR	ENVIRONMENT LEVEL	AVAIL	ETR
1	WD1	OVPRES	7.33E+00	0.	999903.
2	COM1	EMPFLD	6.05E+03	94.	27.
3	WD2	N1MEV	6.40E+09	89.	91.
4	COM2	GTOT	5.32E+01	36.	30.
5	COM3	GDOT	1.30E+07	96.	13.
6	COM4	XRAY	0.00E+00	100.	0.
7	WD3	GP	2.17E+00	99.	1.
8	COM5	TISSUE	2.36E+02	100.	0.
9	PER1	THERML	5.40E+01	94.	17.

TABLE 3

TRS-80/NNWS NUCDAM COMPARISON

Ground Range = 2500 ft

OAT	Environment TRS-80	Environment NNWS	Availability (%) TRS-80	Availability (%) NNWS	ETR TRS-80	ETR NNWS
1	4.91(1)	4.91(1)	0	0	*	*
2	1.63(5)	1.63(5)	0	0	*	*
3	1.77(13)	1.77(13)	0	0	*	*
4	1.61(4)	1.61(4)	0	0	*	*
5	2.60(10)	2.60(10)	0	0	*	*
6	5.87(-18)	5.87(-18)	100	100	0	0
7	3.43(3)	3.43(3)	68	68	79	79
8	6.71(5)	6.71(5)	100	100	0	0
9	3.55(2)	3.55(2)	67	67	189	189

Ground Range = 5000 ft

OAT	Environment TRS-80	Environment NNWS	Availability (%) TRS-80	Availability (%) NNWS	ETR TRS-80	ETR NNWS
1	1.55(1)	1.55(1)	0	0	*	*
2	3.23(4)	3.23(4)	15	15	*	*
3	3.30(11)	3.30(11)	0	0	*	*
4	8.32(2)	8.32(2)	50	50	489	489
5	5.77(8)	5.77(8)	0	0	*	*
6	1.63(-30)	1.63(-30)	100	100	0	0
7	8.31(1)	8.32(1)	98	98	2	2
8	1.23(4)	1.23(4)	100	100	0	0
9	1.19(2)	1.19(2)	88	88	38	38

Ground Range = 7500 ft

OAT	Environment TRS-80	Environment NNWS	Availability (%) TRS-80	Availability (%) NNWS	ETR TRS-80	ETR NNWS
1	7.33(0)	7.33(0)	0	0	*	*
2	6.05(3)	6.05(3)	84	84	27	27
3	6.40(9)	6.40(9)	89	89	91	91
4	5.32(1)	5.32(1)	96	96	10	10
5	1.38(7)	1.38(7)	96	96	13	13
6	0	5.23(-44)	100	100	0	0
7	2.17(0)	2.17(0)	99	99	1	1
8	2.36(2)	2.36(2)	100	100	0	0
9	5.40(1)	5.40(1)	94	94	17	17

other inputs; only ground range is varied. The comparison is obviously favorable. Similar results were obtained for the other test cases.

OPERATIONAL INFORMATION

Execution

The TRS-80 NUCDAM code, including the driver routine, is a command file on the TRS-80 disk labeled "EXECUTION". The TRS-80 file name of the executable code is NUCDAM/CMD. To execute the code, insert the EXECUTION disk into drive 0 and press the reset button. At DOS READY, key in NUCDAM, followed by <enter> and the program will begin execution. Inputs are entered by following the prompts displayed on the video. Output is to the line printer. Damage calculations are performed for one unit at a time, with up to 10 OATs. The user is given the option of repeating the calculation for other units.

Input/Output

Table 4 describes the input required for TRS-80 NUCDAM. The first input is whether or not analysis is to be on an existing unit, i.e., one that is already stored on disk. If answered N for no, the user is prompted to enter values for the target parameters shown in Table 4.

Numeric values should be entered as either integer or real variables, with the appropriate decimal point, and may be in the FORTRAN scientific notation E-format, if desired. Values input are followed by <enter>. For up to 10 OATs, inputs as indicated are entered. Each OAT is identified by a user-input name. This name is an alphanumeric label used only in the printout and is 8 characters in length. If fewer than 8 characters are used, it is recommended that trailing blanks be added. The three OAT

TABLE 4

INPUTS

EXISTING UNIT (Y/N) - Y if unit is stored on disk
N if input is from keyboard

*TARGET HEIGHT (FT) - use <Ø if underwater

*HULL RADIUS (FT)

*COLLAPSE DEPTH (FT)

*HULL DEPTH (FT)

FOR EACH OAT:

- *OAT NAME - used as identifier
- *ENVIRONMENT MODEL
  (DAMAGE MODEL - assumed to be 1)
- *I10 - Environment level for 10% impairment
- *I90 - Environment level for 90% impairment
- *DAMAGE ACCUMULATION MODEL
  (ETR MODEL INDEX - assumed to be 1)
- *A - ETR model linear multiplier
  (B - ETR model exponential coefficient, assumed to be 4.6)
- *IMAX - Impairment level at which ETR is infinite
- *AVAILABILITY - initialized by program to 100% when OAT defined
- *EXPECTED TIME TO REPAIR (MIN) - initialized to Ø when OAT defined

YIELD (KT)

HEIGHT OF BURST (FT) - use <Ø if underwater
If "999." entered for Height of Burst, optimum height of burst selected for input psi level

GROUND RANGE (FT)

TIME (MIN)

FILESPEC - up to 24 character TRS-8Ø file specification in format name/extension.password:drive number

*Saved on disk

items in parenthesis are not explicitly entered, but are assumed to be the values shown in the table. These values are consistent with the NNWS NUCDAM vulnerability tables. That is, the damage model and ETR model index in every case are both 1, and the ETR model exponential coefficient b is always 4.6 in NNWS NUCDAM. The OAT availability and expected time to repair (ETR) also are not explicitly input, but are initialized by the program to 100% availability and zero ETR at the time the OAT is defined. For further definition of these OAT parameters, see the NNWS NUCDAM documentation in Reference 1.

Following the OAT data input, the user is asked if the unit should be saved on disk. If answered Y for yes, the user inputs the unit filespec in the standard TRS-80 format of name [/extension] [.password] [:drive number], where the bracketed portions are optional. The stored inputs in Table 4 are then written to disk. The disk files created in this manner may be loaded by reference to the filename in subsequent NUCDAM runs.

The nuclear burst parameters of yield, height of burst and ground range are next entered. If the height of burst is entered as "999.", the program will compute the height of burst required to optimize the blast radius to a given overpressure level, from 1 to 100 psi. The user is then given the option of using the computed burst height or entering another value. The input variable TIME is the current NNWS simulation time, used to update the expected time to repair for each OAT.

Output data is printed on the line printer. A sample output is shown in Table 5. The first item is a table of labeled input data. This table should be carefully examined to ensure that the desired inputs have been correctly entered. As NUCDAM progresses, the various subroutines check to see if the target

TABLE 5

SAMPLE OUTPUT

```
HEIGHT OF TARGET(FT)        1000.     COLLAPSE DEPTH(FT)       2000.
HULL RADIUS(FT)               16.     HULL DEPTH(FT)             30.
```

OAT	OAT NAME	ENVIR MODEL	ENVIR	I10	I90	DAMAGE ACC MOD	A	IMAX	AVAIL	ETR
1	WD1	4	OVPRES	5.00E-01	5.00E+00	1	.40	90	100.	0.
2	COM1	5	EMPFLD	3.70E+03	3.40E+04	1	.40	50	100.	0.
3	WD2	6	N1MEV	6.00E+09	5.40E+10	1	2.40	85	100.	0.
4	COM2	7	GTOT	1.60E+02	1.50E+03	1	.90	55	100.	0.

```
YIELD(KT)       100.
HOB(FT)        2000.
GR(FT)         6000.
+++++ S/R OVFRES IS NOT APPLICABLE FOR HOB =     2000.00       AND HTARG =     1000.
00
```

OAT	OAT NAME	ENVIR	ENVIRONMENT LEVEL	AVAIL	ETR
1	WD1	OVPRES	0.00E+00	100.	0.
2	COM1	EMPFLD	1.72E+04	54.	173.
3	WD2	N1MEV	8.75E+10	0.	999999.
4	COM2	GTOT	2.98E+02	82.	71.

and burst altitudes (or depths) are appropriate. In the example, a warning is printed that subroutine OVPRES is not applicable for the non-zero target altitude. The calculated environment levels, availability in percent and expected time to repair (ETR) in minutes are then printed for each OAT.

At this point, the unit data may be saved on disk, as before. The saved availability and ETR for each OAT are the calculated values, such as those at the bottom of the sample output in Table 5.

<u>Code Modifications</u>

In the event that code modifications to TRS-80 NUCDAM are necessary, the FORTRAN compiler must be used together with the SOURCE disk. Table 6 illustrates one way to modify the NUCDAM source code. For further clarification and explanation of other user options, please see the Microsoft FORTRAN manual.

The FORTRAN and SOURCE disks are placed into drives 0 and 1, respectively, and the system reset. At the DOS READY prompt, the user enters EDIT followed by <enter> to load the FORTRAN text editor. The editor will request a FILE:, which should be answered NUCDAM/FOR:1 <enter>. This will cause the NUCDAM source code to be loaded from disk 1. This file can be modified as desired. Because of the wide variety of possibilities, the editing procedure is not described here. It is suggested that the EDIT-80 portion of the FORTRAN manual be consulted. When code modifications are complete, the edited file can be written to the SOURCE disk (or a formatted scratch disk in drive 1) by keying in E NUCDAMB/FOR:1 followed by <enter>. Note that the revised file does not have the same name as the initial source file. The same name NUCDAM/FOR is not permitted by the editor; it is necessary to create a backup file NUCDAMB/FOR.

TABLE 6

CODE MODIFICATIONS

(1) Insert FORTRAN disk into drive Ø and press reset

(2) Insert SOURCE disk into drive 1

(3) EDIT <enter> - Loads text editor

(4) FILE: NUCDAM/FOR:1 <enter> - Loads NUCDAM text

(5) Make changes as desired

(6) Insert SCRATCH disk into drive 1 if desired

(7) *E NUCDAMB/FOR:1 <enter> - Writes edited file to drive 1

(8) F8Ø =NUCDAMB <enter> - performs syntax check

(9) Repeat steps (2) to (8) as necessary

(10) KILL NUCDAM/FOR if desired - lose backup file of NUCDAM

(11) RENAME NUCDAMB/FOR TO NUCDAM/FOR <enter>

NOTE: User inputs are underlined

If the file is successfully written, the editor exits to DOS READY. At this point, a syntax check may be made by entering F80 =NUCDAMB <enter>. The FORTRAN compiler F80 will process the revised source code and syntax errors will be displayed on the video. If errors exist, the source code must again be edited as outlined above. It should be noted that the exit from the editor must be made with an unassigned file name, i.e., NUCDAM/FOR may not be used in the second pass. When syntax errors have been eliminated, the original NUCDAM/FOR file may be killed if desired. This will, of course result in the loss of the NUCDAM backup file, which is not necessary if a scratch disk has been used. The NUCDAMB/FOR file can then be renamed NUCDAM/FOR.

Compilation

A representative procedure for compilation is shown in Table 7. After loading the appropriate disks as shown, and resetting the system, the user can key in F80 <enter> to load the FORTRAN compiler, which will display an asterisk prompt. The command NUCDAM:1=NUCDAM:1 <enter> will create the relocatable object file NUCDAM/REL on drive 1. The <break> key may be used to exit the compiler. An alternate command ,NUCDAM:1=NUCDAM:1-N <enter> will create a listing file NUCDAM/LST on drive 1 that can be listed by the DOS PRINT or LIST commands. Unfortunately, the NUCDAM code is too large to permit both the relocatable object code and listing files to be generated simultaneously on one disk.

When the object code is stored on disk, the linking loader may be loaded by L80 <enter>. The input NUCDAM,FORLIB <enter> will cause the loader to load the NUCDAM code and search the FORTRAN library FORLIB for necessary subroutines. The EXECUTION disk or a formatted scratch disk should be inserted into drive 1.

TABLE 7

COMPILATION

(1)	Insert FORTRAN disk into drive Ø and press reset
(2)	Insert SOURCE or scratch disk into drive 1
(3)	F8Ø <enter> - Loads the compiler
(4)	*NUCDAM:1=NUCDAM:1 <enter> - Creates object file on drive 1
(5)	Use <break> to exit compiler
(6)	L8Ø <enter> - Loads linking loader
(7)	*NUCDAM,FORLIB <enter> - Searches NUCDAM and FORLIB libraries
(8)	Insert EXECUTION or scratch disk into drive 1
(9)	*NUCDAM:1-N-E <enter> - Saves object code on drive 1
(10)	NUCDAM <enter> - Executes NUCDAM

NOTE: User inputs are underlined

The command NUCDAM:1-N-E to the linking loader will then create an execution file NUCDAM/CMD on drive 1. This file will replace the existing NUCDAM/CMD file if the EXECUTION disk has been used. Execution then begins with NUCDAM <enter> in response to DOS READY.

APPENDIX B

VERSION #3 USERS GUIDE (WANG 2200)

A. Program Overview

NUCDAM is the Nuclear Damage Assessment Module of the Navy Nuclear Warfare Simulation (NNWS), which was developed under CNO (OP-654) sponsorship. The Phase 2 version of NUCDAM has been implemented on the Wang 2200 T/VP computers. NUCDAM models damage to submarines, surface ships and land targets occuring during a tactical nuclear engagement. Targets are represented by a group of operational attributes (OATs) describing the vulenerability of certain shipboard systems to the appropriate nuclear environments. Representative OATs have been pre-defined for several generic target types, and the user may define specific targets as desired.

The operation of the Wang 2200T/VP version of NUCDAM is illustrated here with step-by-step instructions showing the flow of NUCDAM input and output, with a specific example included. More detailed definition of the inputs and outputs is then given.

B. Operating Instructions

STEP	INSTRUCTION	DISPLAY	EXAMPLE INPUT
1	To load program, place disk in the left slot of the disk drive and input the following:		CLEAR LOAD DC F "NUCDAMT" RUN
	The screen will be cleared and the following will appear on the screen	NUCDAM KAMAN SCIENCES CORPORATION INITIALIZING	
2.	The screen will be cleared and TARGET OPTIONS will be presented for selection	AVAILABLE TARGET PLATFORMS (1) BLUE CRUISER/DESTROYER (2) BLUE CARRIER (3) BLUE AMPHIBIOUS (4) BLUE SUBMARINE (5) ORANGE CRUISER/DESTROYER (6) ORANGE CARRIER (7) ORANGE AMPHIBIOUS (8) ORANGE SUBMARINE (9) EXISTING USER DEFINED (10) NEW USER DEFINED SELECTION	10

STEP	INSTRUCTION	DISPLAY	EXAMPLE INPUT
3.	If the selection is a value of 1 through 8, the user will choose a file of a generic ship described by a group of OATS for that particular ship type., e.g., (7) will use as an input the orange amphibious ship type. Skip to Step 8.		
4.	If selection 9 is input the user will be asked to input a filename of a ship described earlier. Skip to Step 8.	FILENAME	TEST1

STEP	INSTRUCTION	DISPLAY	EXAMPLE INPUT
5.	If selection 10 is input the user will then be asked to input the target data one-by-one	IS TARGET A SUBMARINE (Y/N)	Y
		OPERATING DEPTH (FT)	200
		HULL RADIUS	30
		COLLAPSE DEPTH (FT)	800
		(If target is not a submarine -- input N then skip to these data elements	
		HULL DEPTH (FT)	30
		HULL RADIUS (FT)	15
		IS TARGET DATA CORRECT (Y/N)	Y - if N then step 5 will be repeated
6.	Clear the screen the requests for operational attributes will appear one-by-one	DATA FOR OAT #	1
		OAT NAME (8CHAR)	WD1
		ENVIRONMENT MODEL	4
		I10	3.7E2
		I90	4.6E3
		DAMAGE ACCUMULATION MODEL	2
		A	.4
		IMAX	55
		DATA FOR THIS OAT OK (Y/N)	Y
		(Y allows user to continue, N repeats OAT menu)	
		MORE OATS (Y/N)	N
		(Y allows user to repeat OAT menu for additional attributes, N allows user to continue)	

STEP	INSTRUCTION	DISPLAY	EXAMPLE INPUT
7.	Clear the screen requests to save the input data	SAVE TO DISK (Y/N)	Y
		(Y saves data, N continues to the input of weapon information - Step 8)	
		FILENAME	TEST2
		MORE CASES (Y/N)	N
		(if Y go back to Step 1 and continue, N finishes program)	
		PROGRAM FINISHED	
8.	If the save to disk answer was N or selection was 1 through 9, user continues. Clear the screen. Request weapon data one-by-one	YIELD (KT)	130
		HEIGHT OF BURST (FT)	2000
		(if height of burst = 999 then	
		PSI LEVEL TO OPTIMIZE	20
		HOB (FT) 999	
		ACCEPTABLE (Y/N)	Y
		[N will return user to height of burst (FT)])	
		GROUND RANGE (FT)	5000
		TIME (MIN)	0
		THREAT DATA CORRECT (Y/N)	Y
		(N repeats Step 8)	

STEP	INSTRUCTION	DISPLAY	EXAMPLE INPUT
9.	Select means of output	OUTPUT TO VIDEO (V) OR PRINTER (P)	P
10.	Display will be as shown (a repeat of input data):		

HEIGHT OF TARGET (FT) 0 — COLLAPSE DEPTH (FT) 0

HULL RADIUS (FT) 15 — HULL DEPTH (FT) 30

OAT	OAT NAME	ENVIR MODEL	ENVIR	I10	I90	DAMAGE ACC MOD	A	IMAX	AVAIL	ETR
1	WD1	4	OVPRES	5.00E-01	5.00E+00	1	.4	90	100	0
2	COM1	5	EMPFLD	3.70E+03	3.40E+04	1	.4	50	100	0
3	WD2	6	N1MEV	6.00E+09	5.40E+10	1	2.4	85	100	0
4	COM2	7	GTOT	1.60E+02	1.50E+03	1	.9	55	100	0
5	COM3	8	GDOT	5.00E+07	5.00E+08	1	1.2	80	100	0
6	COM4	9	XRAY	2.78E+00	2.50E+01	1	.4	60	100	0
7	WD3	10	GP	1.00E+03	1.00E+04	1	.4	75	100	0
8	COM5	11	TISSUE	1.40E+07	1.50E+07	1	2.4	65	100	0
9	PER1	12	THERML	1.00E+-2	1.00E+03	1	.9	70	100	0

(if V was selected instead of P, the last two columns (AVAIL and ETR) would not be shown)

(If Video (V) selected PRESS RETURN TO CONTINUE CR)

STEP	INSTRUCTION	DISPLAY	EXAMPLE INPUT
11.	Display will be as shown (a repeat of weapon data)	YIELD (KT) 130 HOB (FT) 2000 GR (FT) 5000	
	(If Video (V) selected	PRESS RETURN TO CONTINUE	CR)
12.	The program performs the appropriate calculations and the display will be as shown:		

OAT	OAT NAME	ENVIR	ENVIRONMENT LEVEL	AVAIL	ETR
1	WD1	OVPRES	1.54E+01	0	999999
2	COM1	EMPFLD	3.22E+04	14	999999
3	WD2	N1MEV	3.29E+11	0	999999
4	COM2	GTOT	8.31E+02	49	488
5	COM3	GDOT	5.76E+08	0	999999
6	COM4	XRAY	1.63E-30	100	0
7	WD3	GP	8.31E+-1	98	2
8	COM5	TISSUE	1.23E+04	100	0
9	PERT	THERML	1.18E+02	88	38

(if Video (V) selected PRESS RETURN TO CONTINUE CR)

STEP	INSTRUCTION	DISPLAY	EXAMPLE INPUT
13.	Clear the screen request to save degraded OATS data	SAVE DEGRADED OATS TO DISK (Y/N) FILENAME	Y TEST3
	(if input N to question "SAVE DEGRADED OATS TO DISK" go to Step 14)		
14.	Asks if more cases are to be run	MORE CASES (Y/N) PROGRAM FINISHED	N
	(if input Y to question "MORE CASES" go to Step 1)		

C. Specific Information

1. The input data required for this program for selection of target vulnerability data are:

SELECTION	chooses means of entering target data:
1 through 10	if limits are exceeded asks user to select again
1 through 8	uses predefined files of generic ship types
9	uses a file predefined by the user
10	user defines ships Operational Attributes (OAT)

This data is entered based on the means selected to enter target data.

FILENAME	appropriate file name
OPERATING DEPTH	
feet	submarine
HULL RADIUS	
feet	submarine or surface ship
COLLAPSE DEPTH	
feet	submarine

HULL DEPTH	
feet	surface ship
OAT #	only 25 OATS/TARGET
OAT NAME	
8 characters	used only as an identifier in output
ENVIRONMENT MODEL	
1	translational body velocity, ft/sec
2	excessive impulse, ft-psi
3	energy flux density, ft-psi
4	overpressure, psi
5	electromagnetic pulse, v/m
6	neutron fluence form 1 MeV equivalent, n/cm^2
7	total ionizing dose, rads (SI)
8	peak gamma dose rate, rads (SI)/sec
9	total x-ray fluence, cal/cm^2
10	prompt gamma dose (direct and scattered), rads (SI)
11	tissue ionizing dose, rems
12	thermal exposure, cal/cm^2
I10	environment level for 10% impairment
I90	environment level for 90% impairment

DAMAGE ACCUMULATION MODEL	
1	Multiplicative - personnel and aircraft
2	Additive - seaworthiness from blast structural damage or damage from total gamma dose
3	Maximum - mobility, weapon delivery, communication and sensor from blast mechanical damage or electrical damage from gamma dose rate
A	expected time to repair linear multiplier, $ETR = Ae^{4.605I}$ (if unknown use zero and disregard ETR output)
IMAX	maximum impairment for repair at sea $ETR = \infty$ for $I > IMAX$

This information must be entered for every case.

YIELD (KT)	Kilotons	
HEIGHT OF BURST (FT)	Feet	negative number indicates an underwater burst. If 999 entered for HOB, optimum is selected for input psi level

PSI LEVEL TO OPTIMIZE	PSI	if less than 1 or greater than 100 will ask for level again
GROUND RANGE (FT)	Feet	distance from target to burst ground zero
TIME (MIN)	Minutes	current simulation time used to update ETR (use zero if no ETR data)

2. Output data consists of:

- o A repeated display of input target data
- o A repeated display of input weapon data
- o A listing of:

OAT #	identifier
OAT NAME	identifier
ENVIRONMENT	environment for which this OAT is tested
ENVIRONMENT LEVEL	actual level of environment the OAT experiences
AVAILABILITY	availability of this OAT remaining (in percent)
ETR	estimated time to repair this damage infinity = 999999

APPENDIX C

VERSION #4 USERS GUIDE (HP 9845)

I. INTRODUCTION

A. Purpose

The purpose of this Section is to describe two versions of NUCDAM which have been implemented on the Hewlett Packard HP9845 computer; to provide complete instructions to the user for operation of both versions of the code, including sample dialogues; and, finally, to establish a baseline configuration for control purposes.

B. Definitions

Two versions of NUCDAM have been developed for the HP9845, called the Fleet Model and the Analytical Model. Fully described below, the Fleet Model is designed for efficient use in a tactical environment, while the Analytical Model is intended to be employed as a development tool.

C. Design Philosophy

1. Fleet Model

This model is designed for maximum efficiency and ease of operation. Demands for user selection of variable inputs have been minimized. Target data are taken from input files which have been pre-loaded into the memory along with the main program for U.S. and Soviet surface ships, carriers and submarines. Nevertheless, provisions exist for the user to override these data and furnish his own, should this become necessary. Technical data have been cut to a minimum to avoid distracting or confusing users interested only in the bottom line. Thus, the output of this model contains verbal descriptions of platform damage rather than tables of data.

2. Analytical Model

This model presents all of the input and output data available in NUCDAM and allows the user complete freedom to modify them as necessary. The user has the option to employ existing data files or to generate his own. Standard input procedures have been streamlined so that only half the normal number of entries is required. This is accomplished by pre-selection of damage accumulation and repair-time parameters. Again, this pre-selection may be overridden by the user should he so desire.

D. Limitations

Several functions could be added to this version of NUCDAM but do not reside in it at present. It is important to recognize that these features are not presently available:

- o Bottom-reflection of underwater shock
- o Underwater shock from a surface burst
- o Electromagnetic pulse from a high-altitude burst
- o Fireball blackout
- o Acoustic reverberation (BLUEOUT) from underwater or surface bursts
- o Residual radiation from base surge and pool.

II. FUNCTIONAL DESCRIPTION OF THE FLEET MODEL OF HP9845 NUCDAM

This model is intended to be used for rapid estimates of damage to fleet units subjected to nuclear detonations. To maximize simplicity of input procedures, the following data have been pre-loaded on the tape cassette:

> Vulnerability and repair time data for U.S. and Soviet cruisers (destroyers, carriers, submarines,and auxiliary ships). The data actually used are published in a separate document.
>
> Yields and burst heights/depths of U.S. and Soviet weapons. These are tabulated as UNCLASSIFIED examples which can, on request, be changed to actual data on a SECRET, RESTRICTED DATA tape cassette.

By use of preloaded data, the user need only enter the target type (OAT file name), weapon selection, horizontal range, and submarine keel depth.

Despite the high degree of pre-loading of data, the user, nevertheless, retains flexibility to vary all of the input data if he is willing to take the time. Vulnerability levels can be changed in NUCDAM Command Option 2. An entire new file can be created by running the NUCDAM Analytical Model, which is described below, recording the file on tape, then reloading the NUCDAM Fleet Model and running it with the newly created file.

Upon initial start-up (press RUN) or restart (press STOP, then RUN) five NUCDAM command options are presented:

NUCDAM Command Options
1. Directory of target files
2. Change or add data in target file
3. Assess attack on target from file
4. Calculate nuclear environments
5. Quit NUCDAM

OPTION 1 informs the user of existing target OAT files.

OPTION 2 allows the user to change any data in a target OAT file, or to add data (provided the file is not full).

OPTION 3 is the main operational damage assessment mode of Fleet NUCDAM. Given the yield, burst height and horizontal range, the program calculates and describes the damage suffered by the platform represented in the target OAT file.

OPTION 4 allows use of the code to calculate nuclear environments.

OPTION 5 terminates the code and rewinds the tape. Provided the computer has not been turned off, NUCDAM can be restarted by pressing RUN.

As with other versions of NUCDAM, the program calculates degradation of five different combat capabilities, known as operational attributes (or OATs) using standard algorithms.* The resulting degradation is then converted to a time-to-repair, which is used to generate a verbal damage description.

* See Reference 1.

NUCDAM impacts 5 OATs with selected items from a list of 12 environments, depending on applicability. X-rays are not included in any atmospheric explosion environment. The remaining 11 apply to the various OATs as follows:

	Weapon Delivery	Comm. & Sensors	Mobility	Seawor-thiness	Personnel
Body Velocity	X	X	X		
Excess Impulse				X*	
Energy Flux				X**	
Air Blast	X	X	X	X	X
EMP	X	X			
Neutrons	X	X			
Total Gamma	X	X			
Gamma Dot	X	X			
Total Prompt	X	X			
Tissue Dose					X
Thermal	X	X			X

* Submarines only

** Surface ships only.

NOTE: Submarine OATs are Weapon Delivery, Mobility and Seaworthiness only.

TABLE 1. Permitted Environments for Target OATs

If the target is a submarine, personnel and communications are omitted and only the three remaining OATs are addressed in the damage calculation.

Degradation of each OAT is calculated for each applicable nuclear environment. The program then selects the largest degradation of each OAT, calculates the associated repair time, and releases a statement to be printed out, which describes the damage and extent of non-availability of the OAT. For example, if weapon delivery were degraded 35% by air blast, 10% by gamma dot and 20% by thermal radiation, only the blast damage is reflected in the printed statement.

Each OAT has preloaded repair time parameters (A and IMAX) as in standard NUCDAM.* If degradation is less than 10%, the OAT is treated as undamaged, and no statement regarding the OAT will appear in the output. If all OATs are undamaged, the words "NO DAMAGE SUSTAINED" will be printed. If degradation is greater than IMAX, the words "OUTSIDE HELP REQUIRED" are printed, except in the case of seaworthiness and personnel. If degradation is between 10% and IMAX, the statement "UNAVAILABLE FOR (ETR) HOURS" will be printed, but only once for each OAT, corresponding to maximum degradation from all applicable environments. Repair times are rounded to the nearest half hour. The level of the environment responsible for the maximum degradation of each OAT is also printed out.

The program contains provisions to tailor damage descriptions and limitations as to OAT types for different targets. Thus, the weapon delivery capability of an aircraft carrier is described in terms of its ability to operate aircraft, and communications/sensors and personnel OATs are not included in the OAT files of submarines.

---

* See Reference 1.

III. FUNCTIONAL DESCRIPTION OF THE ANALYTICAL MODEL OF HP9845 NUCDAM

This model is intended for a wide variety of calculations, and is capable of being further modified to suit the needs of users. At present it carries out the basic function of finding the degradation of the combat capabilities or OATs (operational attributes) of targets as described in target OAT files. Inputs and displays show all relevant data, and changes can be made with ease.

This version of NUCDAM differs from its predecessors in that input procedures have been simplified. Depths have replaced negative heights; submarine keel depth is a part of the dialogue, rather than embedded in a file which must be changed; a separate routine to edit a target OAT file has been added; permitted environments have been defined in accordance with Table 1, above; and the amount of required input data for each OAT has been halved.

Review of Reference 1 indicates that repair time parameters and damage accumulation models are target-specific. They are considered to be the best available and unlikely to be soon replaced. Thus it seems unreasonable to require the user-analyst to select values for A, IMAX, and the damage accumulation model each time an OAT entry is made. Hence the data and guidance contained in Reference 1 have been transformed into a set of selection rules and added to the input logic of the Analytical Model. These parameters are selected automatically by the program, leaving the user to input only the damage model, I10 and I90, thus appreciably simplifying the task of creating target OAT files. Should the user wish to alter the program-selected values of these parameters, this is still possible by changing the data in the file after initial file creation (see *7 in Users Guide below).

Upon initial startup (press RUN) or restart (press STOP, then RUN) four NUCDAM command options are presented:

```
        NUCDAM Command Options
1.  Directory of OAT files
2.  Enter OAT data or file and run
3.  Purge existing OAT file
4.  Quit NUCDAM
```

OPTION 1 informs the user of existing target OAT files.

OPTION 2 is for performing actual damage assessment calculations, changing data in existing files or creating new files.

OPTION 3 allows the user to delete unwanted target OAT files.

OPTION 4 terminates the code and rewinds the tape. Provided the computer has not been turned off, NUCDAM can be restarted by pressing RUN.

After selection/creation of the target OAT file, the program takes the user through a brief interactive dialogue in which the weapon parameters are selected. The program then calculates the degradation of every OAT for every environment specified, and prints the results.

IV. USER'S GUIDE AND SAMPLE DIALOGUE FOR THE FLEET MODEL OF NUCDAM

NOTE: All computer-generated printouts are preceded by C:. All typing by the user is preceded by ":. Quotation marks, where shown, must be typed. Statements in parentheses are not typed. RUN, EXECUTE and CONT are keys on the HP9845 keyboard.

U: (insert tape cassette in right hand (T15) drive)

U: GET "NUC--F" EXECUTE (wait for square to disappear on screen)

U: RUN

*1 C:

```
 NUCDAM Command Options
1.  Directory of target files
2.  Change or add data in target file
3.  Assess attack on target from file
4.  Calculate nuclear environments
5.  Quit NUCDAM
```

U: 1 CONT

C:

```
BLAX        BLCD        BLSS        BLCV
OROS        ORCV        ORCD        ORSS

File names are as follows:

BL      BLUE/friendly
OR      ORANGE/enemy
CV      Carrier
CD      Cruiser/destroyer
SS      Submarine
AX      Auxiliary
OS      OSCAR class
```

C: Press CONT to continue

U: CONT

C:

NUCDAM Command Options

1. Directory of target files
2. Change or add data in target file
3. Assess attack on target from file
4. Calculate nuclear environments
5. Quit NUCDAM

U: 2 CONT (if 3 see *2 below)

C: Target OAT file name (4 characters maximum; press CONT to exit, D for directory assistance)

U: (Enter file name) CONT

C: Displays the target OAT file just selected

C: OAT you wish to change/add (up to 20 total) (type 0 to exit)

U: (Enter OAT number) CONT

C:

CHANGE/ADD OPTIONS

1. OAT Name
2. Environment Model
3. I10
4. I90
5. All OAT Data
6. Exit Change Mode

C: Enter menu option (1 to 6)

U: 1 CONT

C: Enter OAT name:

U: (Enter OAT name) CONT

U: 2 CONT

C:

Environments	
1. Peak body velocity	7. Total gamma dose
2. Excess impulse	8. Peak gamme dose rate
3. Energy flux	10. Prompt gamma dose
4. Peak air overpressure	11. Tissue dose
5. Electromagnetic pulse (EMP)	12. Thermal fluence
6. Neutron fluence	

C: Enter environment model (1 to 12)

U: (Enter environment model number) CONT

U: 3 CONT

C: Enter I10

U: (Enter I10) CONT

U: 4 CONT

C: Enter I90

U: (Enter I90) CONT

U: 5 CONT

(Follow the same dialogue as in Options 1-4 above)

C: OAT you wish to change/add (type 0 to exit)

U: (Continue until all required changes have been made)

U: 0

C: Save to tape (Y/N)?

U: Y (if N skip to *3 below)

C: New target OAT file name (4 characters maximum; press CONT to exit)

U: (Enter new file name)

(skip to *2 below)

U: 3 CONT (assess attack on target from file)

*2 C: Target OAT file name (4 characters maximum; press CONT to exit, D for directory assistance)

U: (Enter file name) CONT

C: (If target is a submarine) Enter keel depth (0 to (collapse depth -1), ft.

U: (Enter keel depth) CONT

C:

Weapon Selection

1. Known BLUE
2. Estimated RED
3. Arbitrary

C: Enter weapon selection (1 to 3)

U: 1 (or 2) CONT (if 3 see *4 below)

C: (1) (2)

Weapon		Yield	HOB
1.	Illus-1	10	0
2.	Illus-2	10	-500
3.	Illus-3	100	0
4.	Illus-4	100	500
5.	Illus-5	100	-500
6.	Illus-6	500	0
7.	Illus-7	500	1000
8.	Illus-8	500	-1000
9.	Illus-9	1000	0
10.	Illus-10	1000	2000

Weapon		Yield	HOB
1.	Gener-1	10	0
2.	Gener-2	10	-1000
3.	Gener-3	10	1000
4.	Gener-4	200	0
5.	Gener-5	200	-1000
6.	Gener-6	200	2000
7.	Gener-7	1000	0
8.	Gener-7	1000	1000
9.	Gener-8	1000	5300
10.	Gener-19	1500	5000

C: Enter weapon number (1 to 10)

U: (Enter weapon number) CONT

----

*4 U: 3 CONT

C: Enter yield (1 to 10,000 kt)

U: (Enter yield) CONT

C: Enter height of burst (-30,000 to 200,000 ft)

U: (Enter height of burst) CONT

C: Enter ground range (1 to 50,000 yd)

U: (Enter ground range) CONT

C: Current time (in 24-hr format)?

U: (Enter time) CONT

C: Display to CRT or printer (C/P)?

U: (Enter C or P) CONT

C: (Sample printout)

```
Target:        BLCD
Yield:       200 kt
HOB:           0 ft
GR:         3000 yd
```

Environment Level	Operational Impairment
4.66E+00 psi	Unable to fire weapons for 6 hours
4.66E+00 psi	Radar/Comm not available for 9 hours
3.55E+01 cal/sq cm	Exposed topside pers suffering serious 3rd degree burns

C: Display all environment levels (Y/N)?

U: Y (or N) CONT

C:

Environment	Level
Overpressure	4.66 psi
EMP	2917 volts/m
Neutrons	9.66E+08 n/sq cm
Tot gamma	17.44 rad(Si)
Gamma-dot	2.38E+06 rad(Si)/sec
Tissue dose	35.38 rem
Thermal	35.49 cal/sq cm

C: Another run with the same target (Y/N)?

U: N CONT (if Y reenter dialogue at *3 above)

C: More cases (Y/N)?

U: Y (or N) CONT

(If Y reenter dialogue at *2 above)

(If N reenter dialogue at *1 above)

V. USER'S GUIDE AND SAMPLE DIALOGUE FOR THE ANALYTICAL MODEL OF HP9845 NUCDAM

NOTE: All computer-generated statements are preceded by C:. All typing by the user is preceded by U:. Quotation marks, where shown, must be typed. Statements in parentheses are not typed. RUN, EXECUTE and CONT are keys on the HP9845 keyboard.

```
     U:   (Load cassette in right hand tape drive (T15))
     U:   GET "NUCDAM" EXECUTE
          (Wait for square to disappear on screen)
     U:   RUN
*1   C:
                    NUCDAM Command Options
              1.  Directory of OAT files
              2.  Enter OAT data or file and run
              3.  Purge existing OAT file
              4.  Quit NUCDAM

     U:   1 CONT
     C:

     BLAX            BLCD            BLSS            BLCV
     OROS            ORCV            ORCD            ORSS

     File names are as follows:

     BLAX   BLUE Auxiliary
     BLCD   BLUE Cruiser/Destroyer
     BLCV   BLUE Carrier
     BLSS   BLUE Submarine
     ORCD   ORANGE Cruiser/Destroyer
     ORCV   ORANGE Carrier
     OROS   ORANGE Submarine, OSCAR Class
     ORSS   ORANGE Submarine
```

	U:	2 CONT
	C:	Existing unit (Y/N)?
*2	U:	Y CONT (If N see *9 below)
	C:	Target OAT file name (6 characters maximum; press CONT to exit)?
	U:	(Enter file name) CONT
	C:	(for submarine target) Enter keel depth (0 to (collapse depth -1) ft)
	U:	(Enter keel depth) CONT
	C:	Do you want to change any of the prestored data (Y/N)?
*3	U:	N CONT (If Y see *7 below)
*3.1	C:	Enter yield (1 to 10,000 kt)
	U:	(Enter yield) CONT
	C:	Enter height of burst (-30,000 to 200,000 ft); (if submarine target) Enter depth of burst (0 to 30,000 ft)
	U:	(Enter height/depth of burst) CONT
	C:	Current time (in 24-hr format)?
	U:	(Enter time) CONT
	C:	Display to CRT or printer (C/P)?
	U:	C (or P) CONT
	C:	(Prints output)
	C:	Save output data on tape (Y/N)?
	U:	N CONT (if Y see *8 below)
	C:	Another run with the same target OAT file (Y/N)?
*4	U:	Y CONT (if N see *5)
	C:	Do you want to change any of the prestored data (Y/N)?
	U:	N CONT (reenter dialogue at *3) (if Y see *7 below)

----

*5	U:	N CONT (no more runs with the current target OAT file)
	C:	More cases (Y/N)?
	U:	Y CONT (if N see *6)
	C:	Existing unit (Y/N)?
	U:	(Reenter dialogue at *2)

----

*6 U: N CONT (no more cases to run)

C:

NUCDAM Command Options	
1.	Directory of OAT files
2.	Enter OAT data or file and run
3.	Purge existing OAT file
4.	Quit NUCDAM

U: (Reenter dialogue at *1)

----

*7 U: Y CONT (exercise option to change prestored target OAT data)

C: Display to CRT or printer (C/P)?

U: C (or P) CONT

C: Prints out prestored OAT data for selected file

C: Press CONT to continue

U: CONT

C: OAT you wish to change/add (1 to maximum number OATs but not more than 20. If more than 20 OATs are required a new OAT file (see *9 below) must be created)

U: (Enter OAT number; CONT

C:

CHANGE/ADD OPTIONS	
1.	OAT Name
2.	Environment Model
3.	I10
4.	I90
5.	Damage Accumulation Model
6.	A (repair time parameter)
7.	IMAX
8.	All OAT data
9.	Exit change mode

U: (Enter option as follows:

<u>1</u> (self-explanatory)

<u>2</u> (environment model)

C:

Environments	
1. Peak body velocity	7. Total gamma dose
2. Excess impulse	8. Peak gamma dose rate
3. Energy flux	10. Prompt gamma dose
4. Peak air overpressure	11. Tissue dose
5. Electromagnetic pulse (EMP)	12. Thermal fluence
6. Neutron fluence	

U: 3 or 4 (I10 or I90: environmental levels corresponding to onset of damage (10% degradation) or nearly complete damage (90% degradation))

6 or 7 (A or IMAX: repair time for 50% degradation, or maximum degradation repairable on-board)

8, 9 (self-explanatory)

C: Save to tape-file (Y/N)?

U: Y CONT (Skip to *8.1) (if N reenter dialogue at *3.1)

----

*8 U: Y CONT (save target OAT file to tape)

*8.1 C: Output file name (6 characters maximum; press CONT to exit)?

U: (Appropriate file name) CONT

C: Another run with the same target OAT file (Y/N)?

U: (Reenter dialogue at *4)

----

*9 U: N CONT (user will create a new target OAT file)

C: Is this unit a ship or a submarine (SHIP/SUB)?

U: SHIP (if SUB see *11 below) CONT

C: Enter hull radius (1 to 100 ft)

U: (Enter one half the beam) CONT

C: Enter draft (0 to 200 ft)

U: (Enter draft) CONT

C: Enter number of weapon delivery OATs (0 to 8)

U: (Enter number of OATs desired to describe surface ship weapon delivery vulnerability to environments selected from the following: peak body velocity, air blast, electromagnetic pulse, neutron fluence, total gamma dose, peak gamma dose rate, prompt gamma dose, and thermal fluence) CONT

*10 C: Data for OAT #1, WD1

C: Environments for WD OATs (prints list of permitted environments; e.g., excess impulse is not applicable to surface ships; TREE effects are not applicable to submarines; tissue dose is not applicable to any OATs except personnel, etc.)

C: Enter environment number

U: (Enter number from list of permitted environments) CONT

C: Enter I10 (in appropriate units)

U: (Enter environment corresponding to onset of damage) CONT

C: Enter I90 (in appropriate units)

U: (Enter environment corresponding to nearly complete damage) CONT

C: Prints complete line of data just entered by user, plus computer-selected data on repair times and damage accumulation. Should the user desire to vary any of these parameters, he can do so by typing Y at *3 above after this OAT file is complete. It will then be possible to change any (or all) of the program-selected elements in the target OAT data file.

C: Are the data for this OAT correct (Y/N)?

U: Y CONT (if N return to *10)

C: Data for OAT #2, WD2, etc. (through WD8 in this case)

C: Enter number of mobility OATs (0 to 2)

U: (Enter number of OATs desired, up to 2, to describe surface ship mobility vulnerability to peak body velocity and air blast) CONT (Reenter dialogue at *10)

C: Enter number of seaworthiness OATs (0 to 3)

U: (Enter number of OATs desired, up to 3, to describe surface ship seaworthiness vulnerability to peak body velocity, energy flux, and air blast) (Reenter dialogue at *10)

C: Enter number of personnel OATs (0 to 3)

U: (Enter number of OATs desired, up to 3, to describe personnel vulnerability to air blast, tissue dose (initial nuclear radiation), and thermal radiation) (Reenter dialogue at *10)

C: Enter number of communications/sensors OATs (0 to 8)

U: (Enter number of OATs desired, up to 8, to describe surface ship communications/sensors vulnerability to peak body velocity, air blast, electromagnetic pulse, neutron fluence, total gamma dose, peak gamma dose rate, prompt gamma dose , and thermal fluence) (Reenter dialogue at *10)

C: Save to tape (Y/N)?

U: Y CONT (if N reenter dialogue at *3.1)

C: Output file name (6 characters maximum; press CONT to exit)?

U: (Enter name of new target OAT file just created). (NOTE: It is possible to specify an existing file name and write the new data over the existing data, if desired) CONT (Reenter dialogue at *3.1)

---

*11 U: SUB CONT (user desires to create a submarine target OAT file)

C: Enter hull radius (1 to 100 ft)

U: (Enter hull radius (half the beam)) CONT

C: Enter collapse depth (100 to 10,000 ft)

U: (Enter collapse depth) CONT

C: Enter keel depth (0 to (collapse depth -1))

U: (Enter keel depth) CONT

(Reenter dialogue at *10. Note that there is only one permitted environment for each of three OATs for submarines, as follows:

OAT	ENVIRONMENT
Weapon Delivery	Body velocity
Mobility	Body velocity
Seaworthiness	Excess impulse)

APPENDIX D

VERSION #5 USERS GUIDE (VAX 11/780)

NWISS NUCDAM SYSTEM USERS MANUAL

CHAPTER 1

OVERVIEW

1.1 INTRODUCTION

The NWISS NUCDAM SYSTEM was developed to work in conjunction with the Battle Group Training Computer Support Facility (BGTCSF) as a stand alone tactical decision aid. The BGTCSF offers the opportunity for tactical engagement training through a computerized warfare simulation. The initial BGTCSF simulation will have no nuclear engagement capability. The NWISS NUCDAM SYSTEM will give the users of BGTCSF the option of having some tactical nuclear capability through a stand alone simulation designed to operate within the BGTCSF framework.

The purpose of this report is to document the activities associated with the design and development of the NWISS NUCDAM SYSTEM performed by KSC under Contract DNA001-82-C-0288 during the period 1 July 1982 through 15 November 1982. These activities involve the incorporation of the NUCDAM model developed for the Naval Nuclear Warfare Simulation (NNWS) into a user friendly system designed to be compatible with the BGTCSF.

The remainder of this chapter provides an overview of both the NWISS NUCDAM SYSTEM and NUCDAM. Chapter 2 documents the NWISS NUCDAM SYSTEM which was developed under this contractual effort. Chapter 3 describes the use of the data BUILD function to create the data files to be used in a wargame exercise which will be compatible to the BGTCSF data. Chapter 4 is a student users manual which describes the use of the system once a data file is available and the BGTCSF exercise has begun. Appendix A contains a brief description of the routines developed for the NWISS NUCDAM SYSTEM. Appendix B contains FORTRAN listings of those routines. The NUCDAM routines have been thoroughly documented in References 1, 2 and 3. This information has not been repeated in this document and the interested reader is directed to those references. For completeness the FORTRAN listings of the NUCDAM subprograms have been put in Appendix C.

1.2 NWISS NUCDAM SYSTEM DESCRIPTION

The NWISS NUCDAM SYSTEM is designed to provide a stand alone nuclear capability to the BGTCSF tactical engagement training simulation. The initial BGTCSF computerized warfare simulation offers no nuclear capability. The NWISS NUCDAM SYSTEM will provide the player participating in the tactical engagement training wargame the opportunity to examine the possible effects of the use of tactical nuclear weapons by either of the forces. The NWISS control function will also be able to utilize the information from the NWISS NUCDAM SYSTEM to make decisions as to the effects of the use of nuclear weapons if it is decided that their use is to be employed. Since the NWISS NUCDAM SYSTEM will not have access to the data base of the wargame simulation, there will be a compatible data base designed to allow stand alone analysis in real time during the wargame. The data base will be designed by the wargame systems analyst. That function will decide what data will be in the data file available to the BLUE and ORANGE views. It may be that both views would use the same data base and thus know everything about both forces or each force may only have nuclear damage data concerning its own units or each force might have accurate data concerning its own units and questionable intelligence data about the opposition vulnerability. Real-time data is entered from the keyboard during the wargame based on the view that the user has.

The NWISS NUCDAM SYSTEM is designed with four operating functions: HELP, BUILD, TACAID, NUCDAM. Each of the functions will be described separately in the following paragraphs.

The HELP function will provide interactive user documentation on the use of NUCDAM. The HELP function is self prompting and self directing. The HELP function can be called at any time during a NWISS NUCDAM SYSTEM session. The return of HELP to any prompt will place the user in the HELP mode. An END will terminate the HELP session and return to the prompt from which HELP was called.

The BUILD function will allow the game analyst to prepare a data file of the platforms (units involved in the wargame) and the OATs (operational attributes of the platforms) which will be used in the wargame. There are two types of entries in the BUILD function: OATs and platforms. The BUILD function will open and close the data files as requested.

The TACAID function is a tactical decision aid to the players during a BGTCSF wargame. This function allows the player to see the nuclear environment contours (which are in tabular form in this version) for environments of interest around a potential nuclear burst. This will allow the player to determine the effects which will be experienced by nearby friendly, neutral or enemy forces. The output of the TACAID function will be plot data in tabular form which can eventually be plotted when appropriate hardware is available.

The NUCDAM function provides specific environment and damage level data for a given platform and nuclear detonation combination. The information may be of value to the NWISS control function for determining the damage to a platform if a nuclear weapon is fired during a game. It also will be of value to a player considering the use of a nuclear weapon. This function can project possible environment levels and damage experienced by a specific enemy, neutral or friendly platform.

1.3 NUCDAM DESCRIPTION

The Nuclear Damage Assessment Module (NUCDAM) was developed by Kaman Sciences Corporation to be used in the Naval Nuclear Warfare Simulation (NNWS) for calculating damage to naval units involved in tactical nuclear engagements at sea. The purpose of NUCDAM is to determine the degree of OAT impairment to a naval unit that has been subjected to the effects of a nuclear burst. Damage to naval units from a tactical engagement is determined by calculating the nuclear environment based on the weapon yield and weapon-target geometry, and then relating the calculated environment to damage threshold parameters associated with the target to determine the degree of impairment to the operational attributes that describe the naval unit.

The nuclear environments which have been incorporated into the model are underwater shock (including bottom reflection), air blast and atmospheric radiation from underwater bursts, and atmospheric blast, thermal, initial radiation and low altitude EMP from air or surface bursts. Damage predictions are made based on admittedly subjective data which is described in Chapter 3 where the use of the BUILD function to create the data file to be used in a wargame exercise is described.

The nuclear environment models in NUCDAM have been thoroughly documented in References 1, 2 and 3 and will not be repeated in this report. The interested reader is directed to these references for a complete technical discussion of the models used and their implementation.

CHAPTER 2

NWISS NUCDAM SYSTEM

2.1 INTRODUCTION

The purpose of this chapter is to describe the NWISS NUCDAM SYSTEM which has been developed for use with the BGTCSF tactical engagement simulation. This is a fully interactive user friendly system designed to run in conjunction with BGTCSF as a stand alone tactical decision aid. The basic purpose of this system is to provide nuclear environment and damage data to the commander that finds himself in a tactical nuclear warfare situation. General information concerning the environments created by a nuclear burst will be presented as well as information about specific units in the nuclear vicinity. This system is designed with four operating functions: HELP, BUILD, TACAID and NUCDAM. A request for a keyboard entry will always be prompted by >. During any function a prompt answered by a ? will result in a message explaining what is required as a response followed by a repeat of the prompt. Also any prompt may be answered by a HELP or a HELP (qualifier) which will result in the activation of the HELP function which may then be terminated by END resulting in a repeat of the original prompt. QUIT as a response to any prompt will cause the termination of the current operating function. A detected erroneous response to a prompt will result in the prompt being repeated or the function being recycled to a logical position in the processing.

2.2 HELP FUNCTION

The HELP function is designed to provide interactive user documentation on the use of the NWISS NUCDAM SYSTEM. This function is activated by a series of interactive commands which will guide the user through the use of this system. These commands are:

HELP	The basic help command which will direct the user in the use of the HELP function.
HELP HELP	This HELP directive will explain the concepts, general flow and the use of the NWISS NUCDAM SYSTEM.
HELP BUILD	This directive will describe the BUILD function and give complete instructions for its use.
HELP TACAID	This instruction will explain the TACAID function and give step-by-step directions for its use.
HELP NUCDAM	This directive will outline the NUCDAM function and describe the data which is output.
HELP DATA	This option allows the user to see what CAT and platform names are currently on the data file.

The processing in the HELP function is very simple. Requests are made by the user and information is returned from predefined data. The data is designed to be self prompting and self directing. At the end of each HELP presentation directions are given to the user on how to proceed.

2.3 BUILD FUNCTION

The BUILD function allows the game analyst to prepare a data file of the platforms and OATs which will be used in a BGTCSF wargame exercise. There are two types of entries in the BUILD function: platforms and OATs. The processing during this function consists of data file creation and modification based on interactive input data. All responses are checked for possible errors such as incorrect type or out-of-range conditions. In case of a detected error the user will be notified and given a chance to correct it. The file creation process will be logical: checked during the BUILD function. Each OAT and platform name must be unique and each OAT assigned to a platform must already exist on the data file. Error conditions must be corrected or eliminated before processing can continue.

The data file created by the build function is a random access indexed file which is keyed on an OAT/platform indicator and the OAT/platform name. A sequential listing of the OAT and platform names on the file can be obtained using the HELP DATA command. The output of the BUILD function is a data file which can be used as input to the NUCDAM function. The opening and closing of data files is handled by the system.

2.4 TACAID FUNCTION

The TACAID function is a tactical decision aid to the player during a BGTCSF wargame. The intent of this function is to present environment contour plots resulting from a nuclear explosion. Due to hardware limitations, graphic plots are not available in this version. Instead the data is presented in a tabular from which may be used for plotting and eventually used for graphics presentation when appropriate hardware becomes available.

The player is able to see the nuclear environments of interest around a nuclear burst and to determine the possible environment level which will be experienced by nearby friendly, neutral or enemy forces. The nuclear environments may be examined under two options: RANGE and LEVEL. Under the RANGE option the user may specify up to 6 environments and plot parameters of maximum range and range increment. The RANGE option returns data suitable for environment level vs range plots. The LEVEL option allows the user to specify up to 6 environment levels for which radius of effects for each environment level are presented. These data are suitable for radius of effect contours on a plot board.

2.5 NUCDAM FUNCTION

The NUCDAM function provides specific environment and damage level information for a given platform and nuclear burst combination. The player is allowed to choose the appropriate data file. The NUCDAM function may then be queried about the effects of a nuclear burst on one of the defined platforms in the data file. The user has the option of specifying the relative locations of the burst and the platform as a range, or the absolute locations may be specified as latitude and longitude from which the range is calculated. This function will then report on the environment levels experienced, impairment, availability and expected time to repair (ETR) of each OAT associated with the platform.

During a session of the NUCDAM function, a scratch file of damage data is maintained. The purpose of this file is to accumulate damage data and ETR information for multiple nuclear burst environments during a NUCDAM function session. As data is requested for the nuclear bursts affecting the requested platforms, the damage data is accumulated on the scratch file for each OAT of each platform. When the NUCDAM function is terminated, the file is scratched and the damage accumulation data lost. Thus to effectively "zero out" the damage accumulation data, the user may terminate and then reenter the NUCDAM function.

CHAPTER 3

BUILD FUNCTION USERS GUIDE

3.1 INTRODUCTION

The BUILD function is a data file utility of the NWISS NUCDAM SYSTEM which creates and modifies the data files used by the NUCDAM function. This utility is not intended to be used by the student or participant in a BGTCSF wargame exercise. The integrity of the data files is protected by a BUILD authorization code which is required before the user is allowed into the BUILD function. The BUILD function is used by the BGTCSF wargame analyst to create a data file which is compatible with the BGTCSF data base and the purpose of the wargame exercise. It may be that the purpose of one exercise would be served by one data file containing all of the nuclear damage data which would then be available to both of the forces. Another wargame purpose might be best served by having a BLUE VIEW data file and an ORANGE VIEW data file designed by the wargame analyst to restrict the knowledge of each view to some realistic level. The purpose of this chapter is to guide the wargame analyst in the use of this function.

3.2 DATA FILE HANDLING

After entering the NWISS NUCDAM SYSTEM the user is asked which processing function is desired. At this point the user may request the BUILD function. Upon selection of BUILD the user will be asked for the user authorization code. This is an installation parameter which will be provided to the user that is authorized to create and modify data files for the NWISS NUCDAM SYSTEM. When the authorization has been accepted, the user will have the option to create a file or modify an existing file. At this point the user must specify the file name that will be used. The file specification has the form:

device:[directory]filename.type;version.

In general the device and directory specification will be default. If the version number is not specified the latest version will be selected by default. If a data file is already open the user has the option to use that file or open a different file. When a file has been successfully opened the user will have the option to process an OAT or to process a platform or to terminate the BUILD function with END. The interactive command structure is shown below.

```
ENTER PROCESSING OPTION (HELP,BUILD,TACAID,NUCDAM,END)
> (build)
ENTER BUILD AUTHORIZATION
> (authorization)

***** THIS IS THE BUILD FUNCTION *****

DO YOU WISH TO BUILD A NEW FILE OR MODIFY (NEW/MOD)
> (new or mod)
ENTER FILE NAME
> (filename.type;version)
FILE (filename.type;version) HAS BEEN OPENED
ENTER OAT, PLATFORM OR END
> (oat, platform or end)
```

3.3 OAT PROCESSING

An OAT represents an operational attribute of a platform. An OAT name must be unique to all others on the data file. An OAT is represented by an alphanumeric string up to 10 characters long. If an OAT record already exists on the data file the user has the option to modify, delete or retain the record. If the record exists and the user chooses to modify the record, each parameter of the OAT is presented and the user has the option to enter a new value or to leave it the same with a null return. The user is prompted through the parameters for each record which is being created or modified.

Each OAT must have 1 and may have up to 5 environments which may affect its performance. There are 6 parameters associated with each environment.

Each OAT of a platform is, in general, most susceptible to damage from one environment than from another. While the NNWS NUCDAM SYSTEM has allowed up to 5 damaging environments to be associated with each OAT, it is not expected that more than one or two will be used for most OATs. See Reference 3 for some example data. The environment is defined by a nuclear environment code shown in the following table:

1	translation body velocity, ft/sec
2	excessive impulse, psi-sec
3	energy flux density, ft-psi
4	atmospheric overpressure, psi
5	electromagnetic pulse, v/m
6	neutron fluence for 1 mev equiv, n/cm^2

7 total ionizing dose, rads(si)
8 peak gamma dose rate, rads(si)/sec
9 total x-ray fluence, cal/cm²
10 prompt gamma dose (direct/scattered), rads(si)
11 tissue ionizing dose, rems
12 thermal exposure, cal/cm²
13 surface atmos ovrprs from u/w burst, psi
14 base surge: max dose rate, rads/hour
15 base surge: total dose, rads

The NUCDAM damage model considers the weapon-target geometry in conjunction with specified vulnerability levels to calculate impairment to the affected OAT from intermediate environments. When an environment level for an OAT has been calculated, the probability of OAT impairment is determined from a damage or impairment curve which is assumed to be linear between the vulnerability values specified for 10% and 90% impairment. For this model two input values are required: an environment level associated with 10% impairment and an environment level associated with 90% impairment.

The NUCDAM damage accumulation model stems from the ability of nuclear weapons to produce damaging environments at long ranges from the detonation point. If the units of a task group are spaced far enough apart, no single tactical nuclear weapon could destroy more than one ship. However, the damage producing range of such weapons is large enough that a unit may incur some collateral damage as a result of an attack on an adjacent unit in the task group. It is conceivable that a unit could be damaged to the point of combat ineffectiveness without itself ever being the target of an attack. The damage accumulation model associated with a given OAT is specified by one of the following codes:

1 multiplicative (personnel, aircraft)
2 additive (seaworthiness)
3 maximum (mobility, weapons, communications, sensors)

When a target is damaged by a nuclear burst, repair of the damaged components will immediately begin in an attempt to restore as much as possible of the target's capability. The expected time to repair (ETR) model in NUCDAM is based on several assumptions. First, the ETR model ignores the fact that identical impairment levels may have different ETRs and assumes that for any OAT the ETR is a direct function of impairment. Second, the model assumes that ETR is not linear with impairment but rather exponential. This means that doubling the impairment will square the repair time, which implies that higher levels of impairment will generally involve more serious damage to components that are less easily repaired or replaced. Finally, it is assumed that above a certain level of impairment no repair will be possible unless the unit returns to port to restore its functional capability. Thus, for the ETR model two input parameters are required: the ETR linear multiplier and the maximum impairment for which repair can be made at sea. If ETR data is not available, a null return will disable the ETR model.

When the user has finished entering the parameters for the OAT being processed, the data will be displayed and the user given the choice of saving it onto the data file or scratching it. The interactive input prompts are shown below.

```
ENTER OAT, PLATFORM OR END
> (oat)
ENTER OAT NAME
> (oat name)
```

```
ENTER NUMBER OF ENVIRONMENTS
> (number of environments)
ENTER DATA FOR ENVIRONMENT NUMBER 1
ENTER ENVIRONMENT CODE
> (code number)
ENTER LEVEL FOR 10% IMPAIRMENT
> (environment level)
ENTER LEVEL FOR 90% IMPAIRMENT
> (environment level)
ENTER DAMAGE ACCUMULATION CODE
> (code number)
ENTER EXPECTED TIME TO REPAIR CONSTANT
> (etr constant)
ENTER THE MAXIMUM IMPAIRMENT PERCENTAGE
> (maximum impairment)
        .
        .   (repeated for each environment)
        .
(oat name) HAS (number) ENVIRONMENTS
ENVIRONMENT NUMBER 1 CODE IS (number) - (name)
 10% IMPAIRMENT LEVEL IS (environment level)
 90% IMPAIRMENT LEVEL IS (environment level)
 DAMAGE ACCUMULATION CODE IS (number) - (type)
 REPAIR TIME CONSTANT IS (repair constant)
 MAXIMUM IMPAIRMENT PERCENTAGE IS (maximum impairment)
        .
        .   (repeated for each environment)
        .
SAVE THIS DATA ? (YES OR NO)
> (yes or no)
ENTER OAT, PLATFORM OR END
>
```

3.4 PLATFORM PROCESSING

A platform represents a unit in a task group or a target unit which consists of a set of OATs. A unique alphanumeric name up to 10 characters is assigned to each platform on a data file. The platform is associated with a set of OATs each of which must exist on the data file. Each platform may be associated with from 1 to 50 OATs. Each platform is classified as one of four generic types: surface ship, submarine, aircraft or land target. A surface ship will have associated with it the hull radius and the hull depth. A submarine will have associated with it the hull radius and the collapse depth. The hull radius is the hull cross section radius in feet. The hull depth is the depth of the hull of a surface ship. The collapse depth is the depth in feet at which the structural integrity of a submarine is in danger.

When the user completes the platform entries, the parameters are displayed. The user then has the option to save the data on the data file or to discard those entries. The processing sequence is shown below.

```
ENTER OAT, PLATFORM OR END
> (platform)
ENTER PLATFORM NAME (ALPHANUMERIC)
> (name)
ENTER PLATFORM TYPE
> (sur, sub, air or lan)
ENTER HULL RADIUS (if type sur or sub)
≥ (hull radius in feet)
ENTER HULL DEPTH (COLLAPSE DEPTH if type sub)
ENTER NUMBER OF OATS
> (number)
```

```
OAT 1 FOR PLATFORM (name)
ENTER OAT NAME (ALPHANUMERIC)
> (oat name)
      .
      .   (repeated for each oat)
      .
PLATFORM (name) IS TYPE (target type)
 HULL RADIUS IS (radius) FEET
 HULL DEPTH IS (depth) FEET
 HAS (number) OATS
 OAT 1 IS (oat name)
      .
      .   (repeated for each oat)
      .
SAVE THIS DATA? (YES OR NO)
> (yes or no)
ENTER OAT, PLATFORM OR END
> (END will terminate the BUILD function)
```

CHAPTER 4

STUDENT USERS GUIDE

4.1 INTRODUCTION

The NWISS NUCDAM SYSTEM was designed to be a tactical decision aid to the BGTCSF student. The player participating in a tactical engagement training wargame will have the opportunity to examine the possible effects of the use of tactical nuclear weapons by either of the forces. This system operates as stand alone real-time support to the student involved in a BGTCSF training. This system has two functions which are available to the player: TACAID and NUCDAM.

4.2 TACAID FUNCTION

The TACAID function is a tactical decision aid to the player during a BGTCSF training exercise. The original intent of TACAID was to provide graphics plots of nuclear environments but current hardware limitations have forced the use of tabulated data which can be used for hand plots or used for graphics plots when the hardware becomes available. The player is allowed to specify the nuclear detonation and determine the effects which would be experienced by nearby friendly, neutral and enemy forces. This will aid in determining the aimpoint if multiple kills are possible or to ensure that there is no damage to friendly units.

The user will specify the nuclear burst yield and height of burst and the height of target at which environment levels are desired. At that point the user may choose one of two options: RANGE or LEVEL. The RANGE option will present data representing an environment level vs range plot. The user will specify a maximum range which represents the length of the range axis, the range increment which represents the range axis tic marks, and the environment codes of interest. The LEVEL option will present radius of effects contours for the specified environment levels. The user will specify the environment codes and the levels of interest. After the data has been presented the user may choose to continue the TACAID function and whether the same weapon and target parameters are to be used.

The following is a sample sequence of the TACAID function prompts.

```
ENTER PROCESSING OPTION (HELP,BUILD,TACAID,NUCDAM,END)
> TACAID

***** THIS IS THE TACAID FUNCTION *****

ENTER YIELD OF THE WEAPON IN KILOTONS(KT)
> 1000
ENTER HEIGHT OF BURST IN FEET(NEG FOR UNDERWATER)
>1000
ENTER HEIGHT OF TARGET IN FT(NEG FOR UNDERWATER)
>0
ENTER RANGE OR LEVEL
> RANGE
ENTER MAXIMUM RANGE IN FEET
>10000
```

```
ENTER RANGE INCREMENT IN FEET
> 1000
ENTER THE NUMBER OF ENVIRONMENTS
> 2
ENTER ENVIRONMENT CODE NUMBER 1
> 4
ENTER ENVIRONMENT CODE NUMBER 2
> 5

YIELD= 1000.0    HOB=  1000.0    HTARG=   0.0
     RANGE OVERPRESSR   E M P
      FEET     P S I    V / M
     1000.  4366.    0.3805E+06
     2000.  459.2    0.3084E+06
     3000.  149.8    0.2271E+06
     4000.  74.21    0.1428E+06
     5000.  44.46    0.7457E+05
     6000.  30.13    0.4138E+05
     7000.  22.02    0.2293E+05
     8000.  16.92    0.1269E+05
     9000.  13.49     7022.
    10000.  11.07     3883.
DO YOU WISH TO CONTINUE TACAID?  (YES OR NO)
> yes
DO YOU WANT A NEW WEAPON OR TARGET?  (YES OR NO)
> no
ENTER RANGE OR LEVEL
> level
ENTER THE NUMBER OF ENVIRONMENTS
> 2
ENTER ENVIRONMENT CODE NUMBER 1
> 4
```

```
ENTER ENVIRONMENT LEVEL
> 22.02
ENTER ENVIRONMENT CODE NUMBER 2
> 5
ENTER ENVIRONMENT LEVEL
> 7022.

YIELD=  1000.0   HOB=  1000.0   HOT=   0.0
ENVIRONMENT LEVEL          UNITS      RANGE(FT)
OVERPRESSR  22.02          P S I        7001.
   E M P    7022.          V / M        9000.
DO YOU WISH TO CONTINUE TACAID?  (YES OR NO)
> no
ENTER PROCESSING OPTION (HELP,BUILD,TACAID,NUCDAM,END)
>
```

4.3 NUCDAM FUNCTION

The BGTCSF trainee will be able to utilize the assigned data file and the real-time wargame information in order to operate the NUCDAM function. The NUCDAM function provides specific environment and damage level data for a given platform and nuclear detonation combination. Depending on the data which is available in the assigned data file, the student will be able to examine the possible environment levels and damage which would be experienced by a specific enemy, neutral or friendly platform.

The user will provide the nuclear weapon parameters, the platform name, and the spacial relationship between the nuclear burst and the target platform. The user will have the option to enter the spacial relationship either as the range in feet between them or to provide the latitude and longitude locations from which the NUCDAM function will calculate the range.

When the input parameters have been accepted, the data concerning the target platform is retrieved from the data file. The nuclear environments, impairment and, if available, the damage and ETR data is calculated and presented for each OAT of the platform. Damage is accumulated on a scratch file during a NUCDAM session. If a target platform is attacked by more than one nuclear weapon, the damage is accumulated and the current status of the unit is presented. When a NUCDAM function session is terminated, the scratch file is deleted and the data is lost. To zero out the damage accumulation file, the user can terminate the NUCDAM function session and then reenter it.

An example of a NUCDAM function prompt sequence is shown below.

```
ENTER PROCESSING OPTION (HELP,BUILD,TACAID,NUCDAM,END)
> NUCDAM

***** THIS IS THE NUCDAM FUNCTION *****

ENTER FILE NAME
> (filename.type;version)
FILE (filename,type;version) HAS BEEN OPENED
ENTER THE TARGET PLATFORM NAME
> DESTROYER
ENTER HEIGHT OF BURST IN FEET(NEG FOR UNDERWATER)
> 1000.
ENTER YIELD OF WEAPON IN KILOTONS(KT)
> 1000.
ENTER RANGE OR LOCATION (OPTION)
> RANGE
```

```
ENTER THE RANGE IN FEET FROM THE TARGET TO THE BURST PT
> 10000.
```

PLATFORM DESTROYER

YIELD= 1000.0 HOB= 1000.0 HOT= 0.0 RANGE= 10000.

OAT	ENVIRONMNT	ENVIRONMNT LEVEL	ENVIRONMNT UNITS	IMPAIRMENT	AVAILABILITY	ETR HOURS
SEAWORTHY	OVERPRESSR	11.07	P S I	0.4275E-01	95.73	31.33
MOBILITY	OVERPRESSR	11.07	P S I	0.7139	28.61	0.1000E7
WPNDLVRY	OVERPRESSR	11.07	P S I	1.0000	0.0000E+00	0.1000E7
	THERMAL	181.2	CAL/CM**2	1.0000	0.0000E+00	0.1000E7
PERSONNEL	OVERPRESSR	11.07	P S I	0.0000E+00	99.74	105.3
	TISSUE ION	39.82	REMS	0.2632E-02	99.74	105.3

```
DO YOU WANT TO CONTINUE NUCDAM?  (YES OR NO)
> no
ENTER PROCESSING OPTION (HELP,BUILD,TACAID, NUCDAM,END)
>
```

When the user has finished with the NUCDAM function, it may be terminated and then the user may choose another function or terminate the NWISS NUCDAM SYSTEM session.