



**NONRESIDENT  
TRAINING  
COURSE**

December 1993



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# **Electronics Technician**

## **Volume 4—Radar Systems**

**NAVEDTRA 14089**

Although the words “he,” “him,” and “his” are used sparingly in this course to enhance communication, they are not intended to be gender driven or to affront or discriminate against anyone.

# PREFACE

By enrolling in this self-study course, you have demonstrated a desire to improve yourself and the Navy. Remember, however, this self-study course is only one part of the total Navy training program. Practical experience, schools, selected reading, and your desire to succeed are also necessary to successfully round out a fully meaningful training program.

**COURSE OVERVIEW:** In completing this nonresident training course, you will demonstrate a knowledge of the subject matter by correctly answering questions on the following subjects: **Define** the basic terms associated with radar and radar systems; **identify** the basic components of and **explain** the operation of the Navy's standard surface search radars, air search radars, three-coordinate air search radars, carrier controlled approach (CCA) and ground controlled approach (GCA) radars, and planned position indicators (PPI) and repeaters; **identify** the basic components of and **explain** the operation of identification, friend or foe (IFF) systems, direct altitude and identity readout (DAIR) systems, naval tactical data (NTDS) systems, and radar distribution switchboards; and **identify** and **explain** the safety hazards associated with radar systems.

**THE COURSE:** This self-study course is organized into subject matter areas, each containing learning objectives to help you determine what you should learn along with text and illustrations to help you understand the information. The subject matter reflects day-to-day requirements and experiences of personnel in the rating or skill area. It also reflects guidance provided by Enlisted Community Managers (ECMs) and other senior personnel, technical references, instructions, etc., and either the occupational or naval standards, which are listed in the *Manual of Navy Enlisted Manpower Personnel Classifications and Occupational Standards*, NAVPERS 18068.

**THE QUESTIONS:** The questions that appear in this course are designed to help you understand the material in the text.

**VALUE:** In completing this course, you will improve your military and professional knowledge. Importantly, it can also help you study for the Navy-wide advancement in rate examination. If you are studying and discover a reference in the text to another publication for further information, look it up.

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## **Sailor's Creed**

"I am a United States Sailor.

I will support and defend the Constitution of the United States of America and I will obey the orders of those appointed over me.

I represent the fighting spirit of the Navy and those who have gone before me to defend freedom and democracy around the world.

I proudly serve my country's Navy combat team with honor, courage and commitment.

I am committed to excellence and the fair treatment of all."

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# SUMMARY OF THE ELECTRONICS TECHNICIAN TRAINING SERIES

This series of training manuals was developed to replace the *Electronics Technician 3 & 2 TRAMAN*. The content is directed toward personnel working toward advancement to Electronics Technician Second Class.

The nine volumes in the series are based on major topic areas with which the ET2 should be familiar. Volume 1, *Safety*, provides an introduction to general safety as it relates to the ET rating. It also provides both general and specific information on electronic tag-out procedures, man-aloft procedures, hazardous materials (i.e., solvents, batteries, and vacuum tubes), and radiation hazards. Volume 2, *Administration*, discusses COSAL updates, 3-M documentation, supply paperwork, and other associated administrative topics. Volume 3, *Communications Systems*, provides a basic introduction to shipboard and shore-based communication systems. Systems covered include man-pac radios (i.e., PRC-104, PSC-3) in the hf, vhf, uhf, SATCOM, and shf ranges. Also provided is an introduction to the Communications Link Interoperability System (CLIPS). Volume 4, *Radar Systems*, is a basic introduction to air search, surface search, ground controlled approach, and carrier controlled approach radar systems. Volume 5, *Navigation Systems*, is a basic introduction to navigation systems, such as OMEGA, SATNAV, TACAN, and man-pac systems. Volume 6, *Digital Data System*, is a basic introduction to digital data systems and includes discussions about SNAP II, laptop computers, and desktop computers. Volume 7, *Antennas and Wave Propagation*, is an introduction to wave propagation, as it pertains to Electronics Technicians, and shipboard and shore-based antennas. Volume 8, *System Concepts*, discusses system interfaces, troubleshooting, sub-systems, dry air, cooling, and power systems. Volume 9, *Electro-Optics*, is an introduction to night vision equipment, lasers, thermal imaging, and fiber optics.

# INSTRUCTIONS FOR TAKING THE COURSE

## ASSIGNMENTS

The text pages that you are to study are listed at the beginning of each assignment. Study these pages carefully before attempting to answer the questions. Pay close attention to tables and illustrations and read the learning objectives. The learning objectives state what you should be able to do after studying the material. Answering the questions correctly helps you accomplish the objectives.

## SELECTING YOUR ANSWERS

Read each question carefully, then select the BEST answer. You may refer freely to the text. The answers must be the result of your own work and decisions. You are prohibited from referring to or copying the answers of others and from giving answers to anyone else taking the course.

## SUBMITTING YOUR ASSIGNMENTS

To have your assignments graded, you must be enrolled in the course with the Nonresident Training Course Administration Branch at the Naval Education and Training Professional Development and Technology Center (NETPDTC). Following enrollment, there are two ways of having your assignments graded: (1) use the Internet to submit your assignments as you complete them, or (2) send all the assignments at one time by mail to NETPDTC.

**Grading on the Internet:** Advantages to Internet grading are:

- you may submit your answers as soon as you complete an assignment, and
- you get your results faster; usually by the next working day (approximately 24 hours).

In addition to receiving grade results for each assignment, you will receive course completion confirmation once you have completed all the

assignments. To submit your assignment answers via the Internet, go to:

**<http://courses.cnet.navy.mil>**

**Grading by Mail:** When you submit answer sheets by mail, send all of your assignments at one time. Do NOT submit individual answer sheets for grading. Mail all of your assignments in an envelope, which you either provide yourself or obtain from your nearest Educational Services Officer (ESO). Submit answer sheets to:

COMMANDING OFFICER  
NETPDTC N331  
6490 SAUFLEY FIELD ROAD  
PENSACOLA FL 32559-5000

**Answer Sheets:** All courses include one “scannable” answer sheet for each assignment. These answer sheets are preprinted with your SSN, name, assignment number, and course number. Explanations for completing the answer sheets are on the answer sheet.

**Do not use answer sheet reproductions:** Use only the original answer sheets that we provide—reproductions will not work with our scanning equipment and cannot be processed.

Follow the instructions for marking your answers on the answer sheet. Be sure that blocks 1, 2, and 3 are filled in correctly. This information is necessary for your course to be properly processed and for you to receive credit for your work.

## COMPLETION TIME

Courses must be completed within 12 months from the date of enrollment. This includes time required to resubmit failed assignments.

## **PASS/FAIL ASSIGNMENT PROCEDURES**

If your overall course score is 3.2 or higher, you will pass the course and will not be required to resubmit assignments. Once your assignments have been graded you will receive course completion confirmation.

If you receive less than a 3.2 on any assignment and your overall course score is below 3.2, you will be given the opportunity to resubmit failed assignments. **You may resubmit failed assignments only once.** Internet students will receive notification when they have failed an assignment--they may then resubmit failed assignments on the web site. Internet students may view and print results for failed assignments from the web site. Students who submit by mail will receive a failing result letter and a new answer sheet for resubmission of each failed assignment.

## **COMPLETION CONFIRMATION**

After successfully completing this course, you will receive a letter of completion.

## **ERRATA**

Errata are used to correct minor errors or delete obsolete information in a course. Errata may also be used to provide instructions to the student. If a course has an errata, it will be included as the first page(s) after the front cover. Errata for all courses can be accessed and viewed/downloaded at:

**<http://www.advancement.cnet.navy.mil>**

## **STUDENT FEEDBACK QUESTIONS**

We value your suggestions, questions, and criticisms on our courses. If you would like to communicate with us regarding this course, we encourage you, if possible, to use e-mail. If you write or fax, please use a copy of the Student Comment form that follows this page.

## **For subject matter questions:**

E-mail: n315.products@cnet.navy.mil  
Phone: Comm: (850) 452-1001, Ext. 1713  
DSN: 922-1001, Ext. 1713  
FAX: (850) 452-1370  
(Do not fax answer sheets.)  
Address: COMMANDING OFFICER  
NETPDTC N315  
6490 SAUFLEY FIELD ROAD  
PENSACOLA FL 32509-5237

## **For enrollment, shipping, grading, or completion letter questions**

E-mail: fleetservices@cnet.navy.mil  
Phone: Toll Free: 877-264-8583  
Comm: (850) 452-1511/1181/1859  
DSN: 922-1511/1181/1859  
FAX: (850) 452-1370  
(Do not fax answer sheets.)  
Address: COMMANDING OFFICER  
NETPDTC N331  
6490 SAUFLEY FIELD ROAD  
PENSACOLA FL 32559-5000

## **NAVAL RESERVE RETIREMENT CREDIT**

If you are a member of the Naval Reserve, you may earn retirement points for successfully completing this course, if authorized under current directives governing retirement of Naval Reserve personnel. For Naval Reserve retirement, this course is evaluated at 5 points. (Refer to *Administrative Procedures for Naval Reservists on Inactive Duty*, BUPERSINST 1001.39, for more information about retirement points.)

## **Student Comments**

**Course Title:** Electronics Technician, Volume 4—Radar Systems

**NAVEDTRA:** 14089 **Date:** \_\_\_\_\_

**We need some information about you:**

Rate/Rank and Name: \_\_\_\_\_ SSN: \_\_\_\_\_ Command/Unit \_\_\_\_\_

Street Address: \_\_\_\_\_ City: \_\_\_\_\_ State/FPO: \_\_\_\_\_ Zip \_\_\_\_\_

**Your comments, suggestions, etc.:**

|                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Privacy Act Statement:</b> Under authority of Title 5, USC 301, information regarding your military status is requested in processing your comments and in preparing a reply. This information will not be divulged without written authorization to anyone other than those within DOD for official use in determining performance.</p> |
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NETPDTC 1550/41 (Rev 4-00)

## CHAPTER 1

# INTRODUCTION TO BASIC RADAR

The Navy Electricity and Electronics Training Series (NEETS) modules, especially module 18, *Radar Principles*, provide information that is basic to your understanding of this volume. This volume will discuss radar and radar systems as you may encounter them as an Electronics Technician at your command. You should refer to NEETS module 18 and Electronics Installation and Maintenance Book (EIMB), *Radar and Electronic Circuits*, on a regular basis to ensure that you have a complete understanding of the subject matter covered in this volume.

As an Electronics Technician, Second Class, and possible work center supervisor, you must understand the basic radar principles and safety requirements for radar maintenance. However, due to luck of the draw, your first assignment may not afford you exposure to radar systems. Our intention with this volume is NOT to teach you every radar system the Navy uses, but simply to familiarize you with the radars and their general maintenance principles.

You will be able to identify the equipment requirements and general operation of the three basic radar systems covered in chapter 1. You'll become familiar with the nomenclature of specific radars used in the Navy today as we discuss them in chapter 2. Then, armed with all that knowledge you will easily grasp the system concepts addressed in chapter 3. And before you go out to tackle the radar world, chapter 4 will give you necessary safety information specific to radar maintenance.

When you arrive at your next command as a second class with work center responsibilities for a radar maintenance shop, you will be ready.

### BASIC RADAR CONCEPTS

The term *radar* is an acronym made up of the words *radio*, *detection*, and *ranging*. It refers to electronic equipment that detects the presence, direction, height, and distance of objects by using reflected electromagnetic energy. The frequency of electromagnetic energy used for radar is unaffected by darkness and also penetrates weather. This permits radar systems to determine the position of ships, planes,

and land masses that are invisible to the naked eye because of distance, darkness, or weather.

Radar systems provide only a limited field of view and require reference coordinate systems to define the positions of the detected objects. Radar surface angular measurements are normally made in a clockwise direction from **TRUE NORTH**, as shown in figure 1-1, or from the heading line of a ship or aircraft. The actual radar location is the center of this coordinate system.

Figure 1-1 contains the basic terms that you need to know to understand the coordinate system. Those terms are defined in the following paragraph.

The surface of the earth is represented by an imaginary flat plane, known as the **HORIZONTAL PLANE**, which is tangent (or parallel) to the earth's surface at that location. All angles in the up direction are measured in a secondary imaginary plane, known as the **VERTICAL PLANE**, which is perpendicular to the horizontal plane. The line from the radar set directly to the object is referred to as the **LINE OF SIGHT (LOS)**. The length of this line is called **RANGE**. The angle

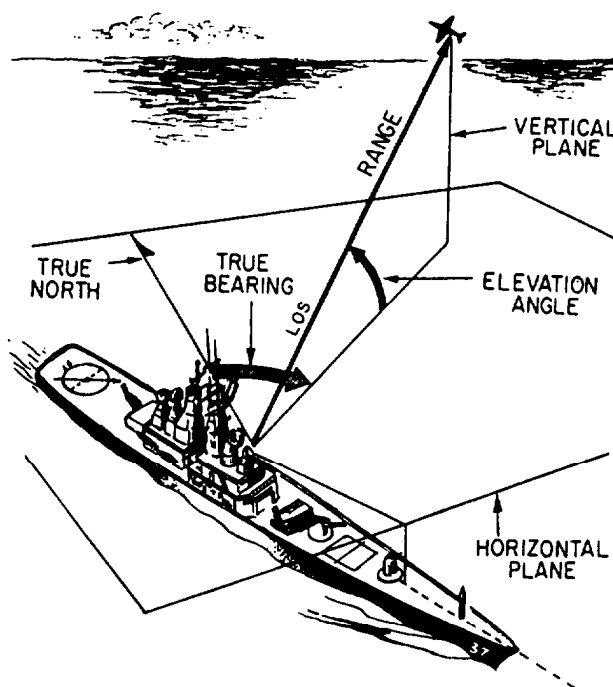


Figure 1-1.—Radar reference coordinates.