



**NONRESIDENT  
TRAINING  
COURSE**



May 2002

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# **Gunner's Mate**

**NAVEDTRA 14324**

**DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.**

**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.**

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# 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: Explosive and Pyrotechnics; Ammunition, Magazines, and Missile Handling; Small Arms; Basic mechanisms; Electrical and Electronic Circuit Analysis; Gun Mounts; GMLS: Primary Functions and Descriptions and Secondary and Auxiliary Functions; SMS Guided Missiles, Aerodynamics, and Flight Principals; Target detection and Weapon Control; Alignment; Maintenance; and Administration and Training.

**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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# 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. 1808  
DSN: 922-1001, Ext. 1808  
FAX: (850) 452-1370  
(Do not fax answer sheets.)  
Address: COMMANDING OFFICER  
NETPDTC N3443  
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 CODE 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 12 points. (Refer to *Administrative Procedures for Naval Reservists on Inactive Duty*, BUPERSINST 1001.39, for more information about retirement points.)

## Student Comments

Course Title: Gunner's Mate

NAVEDTRA: 14324 Date: \_\_\_\_\_

**We need some information about you:**

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

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

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

**Privacy Act Statement:** 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.

NETPDTC 1550/41 (Rev 4-00)

## CHAPTER 1

# EXPLOSIVES AND PYROTECHNICS

As you begin the study of the Gunner's Mate rating, you are taking the first step in joining a proud tradition of over 200 years of service. As a Gunner's Mate, you and your equipment represent the offensive power of the U.S. Navy's surface fleet. As you move into the petty officer ranks, you will wear the title of "Gunner" to all those who know and respect the responsibilities of your profession. This training manual provides a condensed version of the responsibilities and basic knowledge required of your specialty. Throughout the text, you will find references to other manuals for further study. These references are crucial to your success both on the deck plates and in competition for advancement in rate. Seek them out and become familiar with their contents.

One very important development in the history of ordnance was the discovery of explosives. In this chapter, we will discuss the fundamental characteristics of explosives and how they are classified according to their use. Then we will go into some details of various explosives and pyrotechnics used in Navy ammunition. We will conclude this chapter with a discussion of some general explosive safety requirements.

### WARNING

**DO NOT** attempt to operate any explosive or pyrotechnic device until you are thoroughly trained and certified on that device. The information contained in this training manual should not be used to replace source publications or prescribed training procedures.

### EXPLOSIVES

**LEARNING OBJECTIVE:** Describe the characteristics and classification of explosives and propellants of naval ordnance.

To understand the composition and function of a complete round of ammunition, you need a basic knowledge of the characteristics and uses of military explosives. The demands for ammunition capable of fulfilling the many requirements of the Navy necessitates the employment of several classes of

explosives. Each explosive performs in a specific manner and is used for a specific purpose. Therefore, explosives used to burst a forged steel projectile would be unsuitable as a propelling charge for ejecting and propelling projectiles. Similarly, the explosives used in initiators, such as in primers and fuzes, are so sensitive to shock that only small quantities can be used safely.

NAVSEA OP-4, *Ammunition Afloat*, defines the word *explosives* without further qualification as those substances or mixtures of substances that when suitably initiated by flame, spark, heat, electricity, friction, impact, or similar means, undergo rapid chemical reactions resulting in the rapid release of energy. The release of energy is almost invariably accompanied by a rapid and pronounced rise in pressure and temperature. The rise in pressure usually, but not necessarily, is a consequence of the rapid generation of gas in a much larger volume than that originally occupied by the explosive.

An "explosion" is defined as a practically instantaneous and violent release of energy. It results from the sudden chemical change of a solid or liquid substance into gases. These gases, expanded by the heat of the chemical change, exert tremendous pressure on their containers and the surrounding atmosphere.

### HIGH AND LOW EXPLOSIVES

Military explosives are divided into two general classes, high explosives and low explosives, according to their rate of decomposition.

#### High Explosives

High explosives are usually nitration products of organic substances, such as toluene, phenol, pentaerythritol, amines, glycerin, and starch, and may be nitrogen-containing inorganic substances or mixtures of both. TNT is an example of a high explosive. A high explosive may be a pure compound or a mixture of several compounds with additives, such as powdered metals (aluminum), plasticizing oils, or waxes, that impart desired stability and performance characteristics. A high explosive is characterized by the extreme rapidity with which its decomposition occurs; this action is known as "detonation." When initiated by

a blow or shock, it will decompose almost instantaneously in a manner similar to an extremely rapid combustion or with rupture and rearrangement of the molecules themselves. In either case, gaseous and solid products of reaction are produced. The disruptive effect of the reaction makes these explosives valuable as a bursting charge but precludes their use as a low-explosive propellant.

### **Low Explosives**

Low explosives are mostly solid combustible materials that decompose rapidly but do not normally detonate. This action is known as "deflagration." Upon ignition and decomposition, low explosives develop a large volume of gases that produce enough pressure to propel a projectile in a definite direction. The rate of burning is an important characteristic that depends upon such factors as combustion gas pressure, grain size and form, and composition. Under certain conditions, low explosives may be made to detonate in the same manner as high explosives.

### **CHARACTERISTICS OF EXPLOSIVE REACTIONS**

The most important characteristics of explosive reactions are as follows:

1. **VELOCITY:** An explosive reaction differs from ordinary combustion in the velocity of the reaction. The velocity of combustion of explosives may vary within rather wide limits, depending upon the kind of explosive substance and upon its physical state. For high explosives the velocity, or time of reaction, is high (usually in feet per second), as opposed to low explosives, where the velocity is low (usually in seconds per foot).

2. **HEAT:** An explosive reaction of a high explosive is always accompanied by the rapid liberation of heat. The amount of heat represents the energy of the explosive and its potential for doing work.

3. **GASES:** The principal gaseous products of the more common explosives are carbon dioxide, carbon monoxide, water vapor, nitrogen, nitrogen oxides, hydrogen, methane, and hydrogen cyanide. Some of these gases are suffocating, some are actively poisonous, and some are combustible. For example, the flame at the muzzle of a gun when it is fired results from the burning of these gases in air. Similarly, solid residues of the explosives remaining in the gun have been known to ignite when brought into contact with air as the breech is opened. The ignition may come from

high temperature of the gas or from the burning residue in the gun bore. The resulting explosion may transmit flame to the rear of the gun, producing what is called a "flareback." This danger has led to the adoption of gas-expelling devices on guns installed in enclosed compartments or mounts.

4. **PRESSURE:** The high pressure accompanying an explosive reaction is due to the formation of gases that are expanded by the heat liberated in the reaction. The work that the reaction is capable of performing depends upon the volume of the gases and the amount of heat liberated. The maximum pressure developed and the way in which the energy of the explosion is applied depend further upon the velocity of the reaction. When the reaction proceeds at a low velocity, the gases receive heat while being evolved, and the maximum pressure is attained comparatively late in the reaction. If in the explosion of another substance the same volume of gas is produced and the same amount of heat is liberated but at a greater velocity, the maximum pressure will be reached sooner and will be quantitatively greater. However, disregarding heat losses, the work done will be equal. The rapidity with which an explosive develops its maximum pressure is a measure of the quality known as "brisance." A brisant explosive is one in which the maximum pressure is attained so rapidly that a shock wave is formed, and the net effect is to shatter material surrounding or in contact with it. Thus brisance is a measure of the shattering ability of an explosive.

5. **STABILITY:** The stability of an explosive is important in determining the length of time it can be kept under normal stowage conditions without deterioration and its adaptability to various military uses. A good, general explosive should stand a reasonable exposure to such extremes as high humidity in a hot climate or cold temperatures of arctic conditions.

6. **IGNITION TEMPERATURES:** There is no one temperature of ignition or detonation in an explosive for its behavior when heated depends on two factors: the manner of confinement and the rate and manner of heating. It is usually possible, however, to find a small range of temperatures within which a given explosive will ignite or detonate. These so-called ignition temperatures, or explosion temperatures, are useful in setting limits near which it is certainly unsafe to heat an explosive. When an unconfined explosive is heated sufficiently, it may detonate or simply catch fire and burn. Detonation can occur either immediately or after an interval of burning. In general, the likelihood of