# Equipment Operator, Basic 

| NOTICE |
| :---: |
| Pages 5-13, All-2, All-3, and All-4 |
| must be printed on a |
| COLOR printer. |

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 selfstudy course is only one part of the total Navy training program. Practical experience, schools, selected reading, and your desire to succeed are also necessaryto successfully round out a fully meaningful training program.

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."

Safety is a paramount concern for all personnel. Many of the Naval Ship's Technical Manuals, manufacturer's technical manuals, and every Planned Maintenance System (PMS) maintenance requirement card (MRC) include safety precautions. Additionally, OPNAVINST 5100. 19C, Naval Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat, and OPNAVINST 5100.23B, NAVOSH Program Manual, provide safety and occupational health information. The safety precautions are for your protection and to protect equipment.

During equipment operation and preventive or corrective maintenance, the procedures may call for personal protective equipment (PPE), such as goggles, gloves, safety shoes, hard hats, hearing protection, and respirators. When specified, your use of PPE is mandatory. You must select PPE appropriate for the job since the equipment is manufactured and approved for different levels of protection. If the procedure does not specify the PPE, and you aren't sure, ask your safety officer.

Most machinery, spaces, and tools requiring you to wear hearing protection are posted with hazardous noise signs or labels. Eye hazardous areas requiring you to wear goggles or safety glasses are also posted. In areas where corrosive chemicals are mixed or used, an emergency eyewash station must be installed.

All lubricating agents, oil, cleaning material, and chemicals used in maintenance and repair are hazardous materials. Examples of hazardous materials are gasoline, coal distillates, and asphalt. Gasoline contains a small amount of lead and other toxic compounds. Ingestion of gasoline can cause lead poisoning. Coal distillates, such as benzene or naphthalene in benzol, are suspected carcinogens. Avoid all skin contact and do not inhale the vapors and gases from these distillates. Asphalt contains components suspected of causing cancer. Anyone handling asphalt must be trained to handle it in a safe manner.

Hazardous materials require careful handling, storage, and disposal. PMS documentation provides hazard warnings or refers the maintenance man to the Hazardous Materials User's Guide. Material Safety Data Sheets (MSDS) also provide safety precautions for hazardous materials. All commands are required to have an MSDS for each hazardous material they have in their inventory. You must be familiar with the dangers associated with the hazardous materials you use in your work. Additional information is available from your command's Hazardous Material Coordinator. OPNAVINST 4110.2, Hazardous Material Control and Management, contains detailed information on the hazardous material program.

Recent legislation and updated Navy directives implemented tighter constraints on environmental pollution and hazardous waste disposal. OPNAVINST 5090.1A, Environmental and Natural Resources Program Manual, provides detailed information. Your command must comply with federal, state, and local environmental regulations during any type of construction and demolition. Your supervisor will provide training on environmental compliance.

Cautions and warnings of potentially hazardous situations or conditions are highlighted, where needed, in each chapter of this TRAMAN. Remember to be safety conscious at all times.

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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 <br> NETPDTC N331 <br> 6490 SAUFLEY FIELD ROAD <br> 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: n314.products@cnet.navy.mil
Phone: Comm: (850) 452-1001, Ext. 1826
DSN: 922-1001, Ext. 1826
FAX: (850) 452-1370
(Do not fax answer sheets.)
Address: COMMANDING OFFICER
NETPDTC (CODE N314)
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 will receive retirement points if you are authorized to receive them under current directives governing retirement of Naval Reserve personnel. For Naval Reserve retirement, this course is evaluated at 18 points. These points will be credited in units as follows:

Unit 1-12 points upon satisfactory completion of assignments 1 through 8 .

Unit 2-6 points upon satisfactory completion of assignments 9 through 12 .
(Refer to Administrative Procedures for Naval Reservists on Inactive Duty, BUPERSINST 1001.39, for more information about retirement points.)

## COURSE OBJECTIVES

This course provides the basic information required for Advanced Equipment Operators to perform the duties and responsibilities in the following positions: Transportation Supervisor; Air Detachment Equipment Supervisor; Crane Crew Supervisor; Project Supervisor; Quarry Supervisor; Crusher Supervisor; Asphalt Plant
Supervisor; Well Drilling Supervisor.

## Student Comments

Course Title: Equipment Operator, Basic
NAVEDTRA: 14081 Date:
We need some information about you
Rate/Rank and Name: $\qquad$ SSN: $\qquad$ Command/Unit $\qquad$
Street Address: $\qquad$ City: $\qquad$ State/FPO: $\qquad$ Zip $\qquad$

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 informationwill not be divulged without written authorization to anyone other than those within DOD for official use in determining performance.

## CHAPTER 1

## ENGINE SYSTEMS

To become a professional Equipment Operator, you must understand the principles of operation of automotive and construction equipment. This chapter covers the basic principles of engines, fuel systems, air induction systems, lubrication systems, and cooling systems on the equipment used by the Navy and the Naval Construction Force (NCF).

## INTERNAL COMBUSTION ENGINES

An engine is a device that converts heat energy into mechanical energy to perform work. An internal combustion engine is any engine in which fuel is burned within its body (fig. 1-1). The combustion that occurs within the cylinders produces energy. This energy moves the parts of the engine that drives the equipment.


Figure 1-1.-Basic elements of an engine.

Air and fuel are two elements needed to produce heat energy in an engine. Oxygen in the air is evenly mixed with the fuel and is vaporized. This mixture allows for quick and even burning. The chemical process that occurs when the air and fuel mixture in the cylinder is ignited is known as combustion.

An engine uses both reciprocating motion and rotary motion to transmit energy. Four parts of the engine work together to convert reciprocating motion into rotary motion. These four parts are as follows: a cylinder, a piston, a connecting rod, and a crankshaft fig. 1-2), The piston and cylinder are matched parts, fitted closely to allow the piston to glide easily with little clearance at the sides within the cylinder. The top of the cylinder is closed and has a space for the combustion chamber. The connecting rod transmits the up-and-down motion of the piston to the crankshaft. The crankshaft


Figure 1-2.-Piston and crankshaft.


Figure 1-3.-Piston to crankshaft relationship.


PISTON AT TOP


PISTON AT BOTTOM
DEAD CENTER

Figure 1-4.-Piston positions.
has a section offset from the center line of the shaft so that it "cranks" when the shaft is turned (fig. 1-3).

## ENGINE CYCLE

When the piston is at the highest point in the cylinder, it is in a position called top dead center (TDC). When the piston is at its lowest point in the cylinder, it is in a position called bottom dead center (BDC) (fig. 1-4). As the piston moves from top to bottom or from bottom to top, the crankshaft rotates exactly one half of a revolution. Each movement of the piston from top to bottom or from bottom to top is called a stroke; therefore, the piston completes two strokes for every full crankshaft revolution.

For an engine to operate, the following sequence of events must occur:

1. INTAKE: A combustible mixture is pulled into the cylinder.
2. COMPRESSION: The combustible mixture is compressed into a smaller space.
3. POWER: The compressed combustible mixture is ignited causing it to expand, producing power.
4. EXHAUST: The burnt gases are removed from the cylinder.

The engine repeats this sequence of events over and over again to produce sustained power. One complete series of these events in an engine is called a cycle. Engines have either a four-stroke cycle or a two-stroke cycle; most engines operate on the four-stroke cycle.

## Four-Stroke Cycle Gasoline Engine

In the four-stroke cycle gasoline engine, there are four strokes of the piston in each cycle: two up and two down (fiq. 1-5). The four strokes of a cycle are as


Figure 1-5.-Four-stroke cycle operation.

