NONRESIDENT TRAINING COURSE

September 1999

Utilitiesman Basic Volume 2

NAVEDTRA 14279

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:

Boilers	Galley and Laundry Equipment
Boiler Maintenance	Refrigeration
Steam Distribution Systems	Air Conditioning
Heating 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.

1999 Edition Prepared by
UTC(SCW) Dennis E. Richmond

Published by
NAVAL EDUCATION AND TRAINING
PROFESSIONAL DEVELOPMENT
AND TECHNOLOGY CENTER

NAVSUP Logistics Tracking Number
0504-LP-026-9110

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."

CONTENTS

SUMMARY OF UTILITIESMAN BASIC

VOLUME 1

Utilitiesman Basic, Volume 1, NAVEDTRA 11019, consists of chapters on Construction Plans, Specifications, Color Coding: Advanced Base Functional Components (ABFC); Plumbing; Plumbing Valves and Accessories; Plumbing Fixtures and Plumbing Repairs; Pumps and Compressors; Water Treatment; and Maintenance of Water Treatment Equipment.

VOLUME 2

Utilitiesman Basic, Volume 2, NAVEDTRA 11020, consists of chapters on Boilers; Boiler Maintenance; Steam Distribution Systems; Heating Systems; Galley and Laundry Equipment; Refrigeration; and Air Conditioning.

SAFETY PRECAUTIONS

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 5100.19 (series), *Naval Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat,* and OPNAVINST 5100.23 (series), *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 you command's *Hazardous Material Coordinator.* OPNAVINST 4110.2 (series), *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 5090.1 (series), *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.

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: 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 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 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: *Utilitiesman Basic, Volume 2*

NAVEDTRA: 14279 **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

BOILERS

Learning Objectives: Describe the principles and theory of steam generation. Identify different types of boilers and the design requirements for boilers. Describe the purpose and operation of the different types of boilers and their fittings and accessories. Describe the methods and procedures for the testing and treatment of boiler water. Describe methods and procedures involved in fireside and waterside cleaning.

A boiler is an enclosed vessel in which water is heated and circulated, either as hot water or steam, to produce a source for either heat or power. A central heating plant may have one or more boilers that use gas, oil, or coal as fuel. The steam generated is used to heat buildings, provide hot water, and provide steam for cleaning, sterilizing, cooking, and laundering operations. Small package boilers also provide steam and hot water for small buildings.

A careful study of this chapter can help you acquire useful knowledge of steam generation, types of boilers pertinent to Seabee operations, various fittings commonly found on boilers, and so on. The primary objective of this chapter is to lay the foundation for you to develop skill in the operation, maintenance, and repair of boilers.

STEAM GENERATION THEORY

Learning Objective: Describe the principles and theory of steam generation.

To acquaint you with some of the fundamentals underlying the process of steam operation, suppose that you set an open pan of water on the stove and turn on the heat. You find that the heat causes the temperature of the water to increase and, at the same time, to expand in volume. When the temperature reaches the BOILING POINT (212°F or 100°C at sea level). a physical change occurs in the water; the water starts vaporizing. When you hold the temperature at the boiling point long enough, the water continues to vaporize until the pan is dry. A point to remember is that THE TEMPERATURE OF WATER DOES NOT INCREASE BEYOND THE BOILING POINT. Even if you add more heat after the water starts to boil, the water cannot get any hotter as long as it remains at the same pressure.

Now suppose you place a tightly fitting lid on the pan of boiling water. The lid prevents the steam from escaping from the pan and this results in a buildup of pressure inside the container. However, when you make an opening in the lid, the steam escapes at the same rate it is generated. As long as water remains in the pan and as long as the pressure remains constant, the temperature of the water and steam remains constant and equal.

The steam boiler operates on the same basic principle as a closed container of boiling water. By way of comparison, it is as true with the boiler as with the closed container that steam formed during boiling tends to push against the water and sides of the vessel. Because of this downward pressure on the surface of the water, a temperature in excess of 212°F is required for boiling. The higher temperature is obtained simply by increasing the supply of heat; therefore, the rules you should remember are as follows:

1. All of the water in a vessel, when held at the boiling point long enough, will change into steam. AS LONG AS THE PRESSURE IS HELD CONSTANT, THE TEMPERATURE OF THE STEAM AND BOILING WATER REMAINS THE SAME.

2. AN INCREASE IN PRESSURE RESULTS IN AN INCREASE IN THE BOILING POINT TEMPERATURE OF WATER.

A handy formula with a couple of fixed factors will prove this theory. The square root of steam pressure multiplied by 14 plus 198 will give you the steam temperature. When you have 1 psig of steam pressure, the square root is one times 14 plus 198 which equals 212°F which is the temperature that the water will boil at 1 psig.

There are a number of technical terms used in connection with steam generation. Some of these commonly used terms you should know are as follows:

- "Degree" is defined as a measure of heat intensity.
- "Temperature" is defined as a measure in degrees of sensible heat. The term *sensible heat* refers to heat that can be measured with a thermometer.
- "HEAT" is a form of energy measured in British thermal units (Btu). One Btu is the amount of heat required to raise 1 pound of water 1 degree Fahrenheit at sea level.
- "Steam" means water in a vapor state. DRY SATURATED STEAM is steam at the saturation temperature corresponding to pressure, and it contains no water in suspension. WET SATURATED STEAM is steam at the saturation temperature corresponding to pressure, and it contains water particles in suspension.
- The "QUALITY" of steam is expressed in terms of percent. For instance, if a quantity of wet steam consists of 90 percent steam and 10 percent moisture, the quality of the mixture is 90 percent.
- "SUPERHEATED STEAM" is steam at a temperature higher than the saturation temperature corresponding to pressure. For example, a boiler may operate at 415 psig (pounds per square inch gauge). The corresponding saturation temperature for this pressure is 483°F, and this will be the temperature of the water in the boiler and the steam in the drum. (Charts and graphs are available for computing this pressure-temperature relationship.) This steam can be passed through a superheater where the pressure remains about the same, but the temperature will be increased to some higher figure.

Q1. When heat is applied to water, what physical change occurs?

Q2. How is a "degree" of heat defined?

Q3. As long as the pressure in a boiler is held constant, what factor remains the same in the boiler?

BOILER DESIGN REQUIREMENTS

Learning Objective: Describe the design requirements for boilers.

A boiler must meet certain requirements before it is considered satisfactory for operation. Three important requirements for a boiler are as follows:

1. The boiler must be safe to operate.
2. The boiler must be able to generate steam at the desired rate and pressure.
3. The boiler must be economical to operate.

NOTE

Make it a point to familiarize yourself with the boiler code and other requirements applicable to the area in which you are located.

Design rules for boilers are established by the ASME (American Society of Mechanical Engineers). These rules are general guidelines used by engineers when designing boilers. These rules require that for economy of operation and to generate steam at the desired rate and pressure, a boiler must have the following attributes:

- Adequate water and steam capacity
- Rapid and positive water circulation
- A large steam generating surface
- Heating surfaces that are easy to clean on both water and gas sides
- Parts accessible for inspection
- A correct amount and proper arrangement of heating surface
- A firebox for efficient combustion of fuel

Q4. What three requirements must a boiler meet before being considered satisfactory for operation?

Q5. What organization has established guidelines for designing boilers?

TYPES OF BOILERS

Learning Objective: Identify the different types of boilers and describe the operation of each.

The Utilitiesman is concerned primarily with the FIRE-TUBE type of boiler, since it is the type generally used in Seabee operations. However, the WATER-TUBE type of boiler may occasionally be used at some activities. The information in this chapter primarily concerns the different designs and construction feature: of fire-tube boilers.