



**NONRESIDENT
TRAINING
COURSE**



November 1996

Steelworker, Volume 1

NAVEDTRA 14250

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.

COMMANDING OFFICER
NETPDTC
6490 SAUFLEY FIELD RD
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ERRATA #1

29 May 2001

Specific Instructions and Errata for
Nonresident Training Course

STEELWORKER, VOLUME 1, NAVEDTRA 14250

1. This errata supersedes all previous errata. No attempt has been made to issue corrections for errors in typing, punctuation, etc., that do not affect your ability to answer the question or questions.
2. To receive credit for deleted questions, show this errata to your local course administrator (ESO/scorer). The local course administrator is directed to correct the course and the answer key by indicating the questions deleted.
3. Assignment Booklet

Delete the following questions, and leave the corresponding spaces blank on the answer sheets:

Questions

1-60
2-13
3-16
3-17
3-18
3-47
3-48
3-50
3-52
5-2

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:

- Properties and Uses of Metals
- Basic Heat Treatment
- Introduction to Welding
- Gas Cutting
- Gas Welding
- Soldering, Brazing, Braze Welding, and Wearfacing
- Shielded Metal-Arc Welding and Wearfacing
- Gas Shielded-Arc Welding

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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Published by
NAVAL EDUCATION AND TRAINING
PROFESSIONAL DEVELOPMENT
AND TECHNOLOGY CENTER

**NAVSUP Logistics Tracking Number
0504-LP-026-8840**

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

CHAPTER	PAGE
1. Properties and Uses of Metal	1-1
2. Basic Heat Treatment	2-1
3. Introduction to Welding	3-1
4. Gas Cutting	4-1
5. Gas Welding	5-1
6. Soldering, Brazing, Braze Welding, and Wearfacing	6-1
7. Shielded Metal-Arc Welding and Wearfacing	7-1
8. Gas Shielded-Arc Welding	8-1
APPENDIX	
I. Glossary	AI-1
II. References Used to Develop the TRAMAN	AII-1
INDEX	INDEX-1

SUMMARY OF STEELWORKER, VOLUME I TRAINING MANUALS

VOLUME 1

Steelworker, Volume 1, NAVEDTRA 14250, consists of chapters on the following subjects: Properties and Uses of Metal; Basic Heat Treatment; Introduction to Welding; Gas Cutting; Gas Welding; Soldering, Brazing, Braze Welding, and Wearfacing; Shielded Metal-Arc Welding and Wearfacing; and Gas Shielded-Arc Welding.

VOLUME 2

Steelworker, Volume 2, NAVEDTRA 14251, consists of chapters on the following subjects: Construction Administration and Support; Sheet Metal and Fiber Glass Duct Layout and Fabrication; Structural Steel and Pipe Layout and Fabrication; Fiber Line; Wire Rope; Rigging and Hoisting; Concrete Construction (Reinforcing Steel); Pre-engineered Buildings, Towers, and Antennas; Pre-engineered Storage Tanks; Pontoons; and SATS matting.

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
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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 9 points. (Refer to *Administrative Procedures for Naval Reservists on Inactive Duty*, BUPERSINST 1001.39, for more information about retirement points.)

Student Comments

Course Title: Steelworker, Volume 1

NAVEDTRA: 14250 **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>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.</p>
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NETPDTC 1550/41 (Rev 4-00)

CHAPTER 1

PROPERTIES AND USES OF METAL

In the seabees, Steelworkers are the resident experts on the properties and uses of metal. We lay airfields, erect towers and storage tanks, assemble pontoon causeways, and construct buildings. We use our expertise to repair metal items, resurface worn machinery parts, and fabricate all types of metal objects. To accomplish these tasks proficiently, one must possess a sound working knowledge of various metals and their properties. As we learn their different properties and characteristics, we can then select the right type of metal and use the proper method to complete the job. Steelworkers primarily work with iron and steel; however, we also must become familiar with the nonferrous metals coming into use more and more each day. As Steelworkers, we must be able to identify various metals and to associate their individual properties with their proper application or use.

The primary objective of this chapter is to present a detailed explanation of some of the properties of different metals and to provide instruction on using simple tests in establishing their identity.

METAL PROPERTIES

There is no simple definition of metal; however, any chemical element having "metallic properties" is classed as a metal. "Metallic properties" are defined as luster, good thermal and electrical conductivity, and the capability of being permanently shaped or deformed at room temperature. Chemical elements lacking these properties are classed as nonmetals. A few elements, known as metalloids, sometimes behave like a metal and at other times like a nonmetal. Some examples of metalloids are as follows: carbon, phosphorus, silicon, and sulfur.

Although Steelworkers seldom work with pure metals, we must be knowledgeable of their properties because the alloys we work with are combinations of pure metals. Some of the pure metals discussed in this chapter are the base metals in these alloys. This is true of iron, aluminum, and magnesium. Other metals discussed are the alloying elements present in small quantities but important in their effect. Among these are chromium, molybdenum, titanium, and manganese.

An "alloy" is defined as a substance having metallic properties that is composed of two or more elements. The elements used as alloying substances are usually metals or metalloids. The properties of an alloy differ from the properties of the pure metals or metalloids that make up the alloy and this difference is what creates the usefulness of alloys. By combining metals and metalloids, manufacturers can develop alloys that have the particular properties required for a given use.

Table 1-1 is a list of various elements and their symbols that compose metallic materials.

Table 1-1.—Symbols of Base Metals and Alloying Elements

Element	Symbol
Aluminum	Al
Antimony	Sb
Cadmium	Cd
Carbon	C
Chromium	Cr
Cobalt	Co
Copper	Cu
Iron	Fe
Lead	Pb
Magnesium	Mg
Manganese	Mn
Molybdenum	Mo
Nickel	Ni
Phosphorus	P
Silicon	Si
Sulfur	S
Tin	Sn
Tungsten	W
Vanadium	V
Zinc	Zn

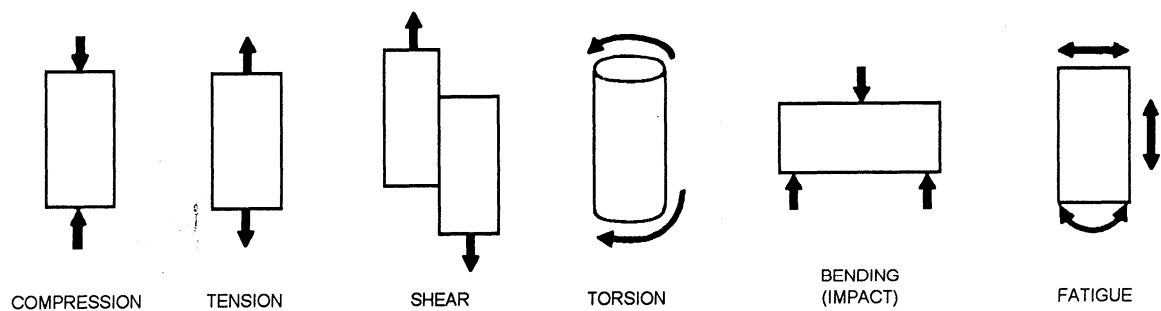


Figure 1-1.—Stress applied to a material.

Very rarely do Steelworkers work with elements in their pure state. We primarily work with alloys and have to understand their characteristics. The characteristics of elements and alloys are explained in terms of physical, chemical, electrical, and mechanical properties. Physical properties relate to color, density, weight, and heat conductivity. Chemical properties involve the behavior of the metal when placed in contact with the atmosphere, salt water, or other substances. Electrical properties encompass the electrical conductivity, resistance, and magnetic qualities of the metal. The mechanical properties relate to load-carrying ability, wear resistance, hardness, and elasticity.

When selecting stock for a job, your main concern is the mechanical properties of the metal. The various properties of metals and alloys were determined in the laboratories of manufacturers and by various societies interested in metallurgical development. Charts presenting the properties of a particular metal or alloy are available in many commercially published reference books. The charts provide information on the melting point, tensile strength, electrical conductivity, magnetic properties, and other properties of a particular metal or alloy. Simple tests can be conducted to determine some of the properties of a metal; however, we normally use a metal test only as an aid for identifying a piece of stock. Some of these methods of testing are discussed later in this chapter.

MECHANICAL PROPERTIES

Strength, hardness, toughness, elasticity, plasticity, brittleness, and ductility and malleability are mechanical properties used as measurements of how metals behave under a load. These properties are described in terms of the types of force or stress that the metal must withstand and how these are resisted.

Common types of stress are compression, tension, shear, torsion, impact, 1-2 or a combination of these stresses, such as fatigue. (See fig. 1-1.)

Compression stresses develop within a material when forces compress or crush the material. A column that supports an overhead beam is in compression, and the internal stresses that develop within the column are compression.

Tension (or tensile) stresses develop when a material is subject to a pulling load; for example, when using a wire rope to lift a load or when using it as a guy to anchor an antenna. "Tensile strength" is defined as resistance to longitudinal stress or pull and can be measured in pounds per square inch of cross section. Shearing stresses occur within a material when external forces are applied along parallel lines in opposite directions. Shearing forces can separate material by sliding part of it in one direction and the rest in the opposite direction.

Some materials are equally strong in compression, tension, and shear. However, many materials show marked differences; for example, cured concrete has a maximum strength of 2,000 psi in compression, but only 400 psi in tension. Carbon steel has a maximum strength of 56,000 psi in tension and compression but a maximum shear strength of only 42,000 psi; therefore, when dealing with maximum strength, you should always state the type of loading.

A material that is stressed repeatedly usually fails at a point considerably below its maximum strength in tension, compression, or shear. For example, a thin steel rod can be broken by hand by bending it back and forth several times in the same place; however, if the same force is applied in a steady motion (not bent back and forth), the rod cannot be broken. The tendency of a material to fail after repeated bending at the same point is known as fatigue.