NAVAL RESERVE OFFICERS TRAINING CORPS

NAVAL SHIP SYSTEMS II
WEAPONS

CNET P1550/1 (REV 11-99)

CHIEF OF NAVAL EDUCATION AND TRAINING

TABLE OF CONTENTS

TABLE OF CONTENTS i

RECORD OF CHANGES ii

LETTER OF PROMULGATION iii

DEFINITION OF MEASUREMENT OF TERMS iv

PROFESSIONAL CORE COMPETENCY OBJECTIVES v

LESSON TOPICS ix

INSTRUCTIONAL AIDS x

VIDEOTAPE LIST xi

DEFENSE CONTRACTORS AND OTHER SOURCES OF INFORMATION xvi

TRANSPARENCY SERIES xviii

BIBLIOGRAPHY xxiv

RECOMMENDATIONS FOR THE INSTRUCTOR xxvii

Lesson Guides:

1. Introduction/Weapons System Overview 1
2. Energy Fundamentals 4
3. Radar Principles and Systems 8
4. Feedback Control/Automatic Tracking Systems .. 13
5. Track-While-Scan (TWS) 16
6. Electronic Scanning and the Phased Array 19
7. Case Study: USS *Vincennes* 22
8. Electronic Warfare 39
9. C^4ISR and Information Warfare 46
10. Principles of Underwater Sound 58
11. Underwater Detection and Tracking Systems 64
12. Military Explosives/Warheads 70
13. Fuzing 75
14. Guidance and Control Principles 78
15. Weapon Propulsion and Architecture 82
16. Case Study: OOD Midwatch 89
17. Launching Systems 95
18. Fire Control 100
19. Mine Warfare 105
20. U.S. Navy and Marine Corps Platforms and Weapons 112
21. Case Study: Aircraft Mishap Incident 126

RECORD OF CHANGES

CHANGE NUMBER	DATE OF CHANGE	DATE ENTERED	BY WHOM

LETTER OF PROMULGATION

This curriculum guide was written to provide guidelines for the NROTC course of instruction in Naval Ships Systems II (Weapons). The lesson guides contain learning objectives which support the Professional Core Competencies. It is incumbent upon the instructor to ensure that all competencies are taught.

In addition, this course also focuses on the moral and ethical responsibilities of military leaders, as well as the personal qualities required for effective leadership. Although three lectures focus on these objectives, instructors should include discussions of leadership in as many lectures as possible.

Instructors are encouraged to use their own expertise to supplement the course. The course may be modified with the approval of the Professor of Naval Science, provided all professional core competencies stated in this guide are mastered by the midshipmen.

This course is approved for implementation upon receipt. Naval Ships Systems II (Weapons), CNET P1550/1 (4-96), is hereby canceled and superseded.

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Captain, U.S. Navy
NROTC Program Manager

Reviewed and approved:

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and Training

Date:

1 Nov 99

DEFINITION OF MEASUREMENT TERMS

I. Know - Recall facts, bring to mind the appropriate material; recognize knowledge.

Examples: Know the objectives of damage control aboard ship.

Know the safety procedures used to provide the fullest measure of safe small boat operations.

II. Comprehend - Interpret principles and concepts and relate them to new situations.

Examples: Comprehend the mission of the U.S. Navy and the U.S. Marine Corps.

Comprehend the concepts of internal forces (e.g., stress, strain, shear).

III. Apply - Utilize knowledge and comprehension of specific facts in new relationships with other facts, theories, and principles.

Examples: Apply correct plotting procedures when navigating in piloting waters.

Apply correct procedures to determine times of sunrise and sunset.

IV. Demonstrate - Show evidence of ability in performing a task.

Examples: Demonstrate third-class swimming skills and water survival skills.

Demonstrate the correct procedures used in radio-telephone communications.

PROFESSIONAL CORE COMPETENCY OBJECTIVES

The following professional competency objective statements for this course are taken from the Professional Core Competency Manual for Officer Accession Programs promulgated in 1996.

1. The student will comprehend the moral and ethical responsibilities of the military leader.

    a. The student will comprehend the leader's moral and ethical responsibilities to organization and society.

    b. The student will comprehend the relationship of integrity, moral courage, and ethical behavior to authority, responsibility, and accountability.

2. The student will comprehend the following personal qualities and be able to relate them to a leader's effectiveness:

    a. Loyalty

    b. Honor

    c. Integrity

    d. Courage (moral and physical)

3. The student will know the basic characteristics and capabilities of the major weapons systems and platforms of the U.S. naval forces.

    a. The student will know the designations, characteristics, capabilities, and missions of ships, aircraft, and weapon systems of the U.S. Navy and U.S. Marine Corps.

    b. The student will know the role of active and passive electronic warfare and their employment in the fleet.

    c. The student will know the significance of intelligence in the application of naval warfare.

4. The student will know the concept of naval command and control within the armed forces.

    a. The student will know how the following doctrine contributes to the basic sea control and power-projection mission of the naval service: C^4I warfare (command, control, communications, computers, and intelligence).

    b. The student will know the basic concepts of the detect-to-engage sequence.

5. The student will be familiar with procedures for effecting communications security, including the common causes of security compromise and safeguard to prevent unauthorized disclosure.

6. The student will comprehend the basic application of electronics systems, communications theory, and electromagnetic wave theory to maritime and naval applications in radars, communications, and radio-navigation systems.

   a. The student will know the theory of operation and key components used with naval electronics and communications systems, including:

      (1) Amplifiers

      (2) Antennas

      (3) Power Amplifiers

      (4) Oscillators

      (5) Filters

      (6) Waveguides

   b. The student will know the fundamental means of imparting information to radio waves and will comprehend the uses, advantages, and disadvantages of the various means.

   c. The student will know the use of computers and digital electronics in naval and maritime communications.

   d. The student will know wave theory, including the relationship between frequency and wavelength.

   e. The student will know refraction, polarization, and propagation as related to electromagnetic waves.

   f. The student will know the definition of the effects of ground plane, free space, re-radiation, sky waves, space waves, ground waves, and tropospheric waves.

   g. The student will know the characteristics, advantages, and disadvantages of various communication frequency ranges.

   h. The student will be able to apply radar theory and comprehend basic operation, major components, and parameters.

i. The student will know radio theory, basic operation, major components, and parameters.

j. The student will know basic electromagnetic interference factors in ship and weapon design.

7. The student will comprehend the physical properties associated with sound travel in water and the application of these properties to sensing and detection systems.

a. The student will comprehend sound propagation, including Snell's Law, effects of temperature, pressure, and salinity, sound velocity profiles, sound ray traces, sound channels, and convergence zones.

b. The student will comprehend sound propagation loss, including spreading and absorption.

c. The student will comprehend the concepts of self and ambient noise.

d. The student will apply the active and passive sonar equations.

e. The student will comprehend basic transducer and hydrophone theory.

f. The student will comprehend the differences between active and passive sonar systems; contrast the advantages and disadvantages of each.

g. The student will comprehend the basic properties of ocean currents.

8. The student will comprehend the basic principles of fluid dynamics and be able to apply them in shipboard situations.

a. The student will know the concepts of lift and drag, atmospheric properties and effect, subsonic and supersonic flow characteristics and high speed aerodynamics.

b. The student will know aerodynamic and hydrodynamic controls.

9. The student will comprehend and be able to apply the basic geometry of the fire control problem and applicable principles of internal and external ballistics, propulsion, launching, and guidance.

a. The student will comprehend the basic concepts of relative motion, bearing rate, and speed across and in the line of sight.

b. The student will know the basic factors of the fire control problem.

c. The student will comprehend the factors effecting solution of the fire control problem.

10. The student will comprehend countermeasure principles, including basic principles of electronic warfare.

11. The student will comprehend the basic application of space and electronic warfare in naval operations.

a. The student will know the military space roles, including the role of space systems in strategic and tactical command and control architectures.

b. The student will know the military opportunities and applications in space.

(1) The student will know the principles of space-based communications.

(2) The student will know the basics of space-based remote sensing and applications to space-based surveillance opportunities.

c. The student will know how to utilize space assets and information for mission planning.

LESSON TOPICS

LESSON NUMBER	TITLE	HOURS
1	Introduction/Weapons System Overview	1
2	Energy Fundamentals	2
3	Radar Principles and Systems	3
4	Feedback Control/Automatic Tracking Systems	2
5	Track-While-Scan (TWS)	1
6	Electronic Scanning and the Phased Array	1
7	Case Study: USS *Vincennes*	2
8	Electronic Warfare	2
9	C^4ISR and Information Warfare	2
10	Principles of Underwater Sound	3
11	Underwater Detection and Tracking Systems	2
12	Military Explosives/Warheads	2
13	Fuzing	1
14	Guidance and Control Principles	1
15	Weapon Propulsion and Architecture	2
16	Case Study: OOD Midwatch	1
17	Launching Systems	1
18	Fire Control	2
19	Mine Warfare	2
20	U.S. Navy and Marine Corps Platforms and Weapons	4
21	Case Study: Aircraft Mishap Incident	1
	Total:	38

INSTRUCTIONAL AIDS

1. Videotapes: See Videotape List.

2. Power Point Presentations/Slides: The PowerPoint presentations for the Weapons lessons are available from the Weapons Course Coordinator. Slides can be acquired from many sources. The list of contacts below is only a partial listing.

Defense Visual Information Center
Comm: (909) 413-2522/2514/2515
DSN: 348-1522/1515/1514

The Defense Visual Information Center researchers can supply slides, photographs, transparencies, and motion videos on naval platforms.

Aegis Program Office
Public Affairs Officer
Comm: (703) 602-7249, DSN: 332-7249

The Aegis Program PAO can supply slides, viewgraphs, and videos on the Aegis weapon system. Call for details.

3. Instructional Materials

Overhead Projector	35mm Slide Projector
Television Monitor	VHS Tape Player
LCD Projector	

4. Transparency Masters: The transparency masters, which can also be used as student handouts, are distributed by CNET. Copyright approval has been granted to utilize these masters.

5. Internet Web Sites: Numerous worldwide web network sites are available for exploration. Instructors should be aware of the following sites (at a minimum) and should encourage students to "surf the net" for additional information.

Surface Warfare Officers School Command: www.swos.navy.mil/

Navy Fact Files: www.navy.mil/navpalib/factfile/ffiletop.html

U.S.M.C. Research Center: www.usmc.mil/factfile/default.html

Weapons Department, USNA: http://wseweb.ew.usna.edu/

6. Other Aids: Other information and instructional aids may be acquired from sources listed in Defense Contractors and Other Sources of Information (page xvi). Jane's Naval Weapon Systems also lists defense contractors with addresses and phone numbers.

VIDEOTAPE LIST

1. Videotapes are extremely useful in highlighting key points and giving visual demonstrations. Instructors should not, however, rely on a video to cover a whole subject area, but rather should use them as supplemental material. It may be best to use short clips of videos instead of the entire length. Instructors have sometimes been disappointed using videos, since they may not introduce material in the desired order, may emphasize points other than those the instructor wants to emphasize, and may take too little or too much time to cover the subject. Videos do allow almost any training environment to be brought into the classroom, which is the benefit of not relying entirely on lecture or printed materials.

2. The list that follows was compiled using the Defense Automated Visual Information System (DAVIS) and the most recent electronic media product catalogues. The DAVIS gives a synopsis for each video, although it lists some obsolete and non-Navy products. The Norfolk and San Diego media center catalogs list all current Navy products held at those centers, organized by title and topic. These catalogs do not include descriptions.

3. Only those productions found in the media center catalogs or distributed by CNET are included in this list. Each production is listed within a specific lesson and includes the production identification number (PIN), year of production (year), length in minutes (time), and availability at the Norfolk (NF) and San Diego (SD) libraries (avail). The videotapes available through CNET do not have a PIN or an availability location. All videos listed are unclassified.

4. Instructors can select videos based on the Videotape List, the synopsis in the DAVIS, or the title and topic listings in the media center catalogs. The media centers can provide a synopsis for a video if the instructor cannot find this information elsewhere.

5. Ordering Instructions: Effective 1 February 1997, the Navy visual information library mail-order services were consolidated at the Navy Media Library in Norfolk. The San Diego library continues to provide over-the-counter services to the San Diego area only. The videos that can be obtained from CNET are marked accordingly on the Videotape List. The media center catalogs describe how to obtain electronic media from that center. The Norfolk center issues the Navy Media Library Catalog, and the San Diego center issues the Catalog of Navy Training Products. Ensure the following information is included in the request for electronic media:

Product Identification Number (PIN)
Title
Classification
Media format and alternate
Exhibition date(s) and alternate
Unit Identification Code (UIC)
Name, title, telephone number
Full mailing address (using zip code + 4)

6. Media Center Addresses and Phone Numbers

a. NETPDTC Norfolk Regional Electronic Media Center: Services all NROTC units. Requests for training media may be submitted by mail, fax, or electronic mail at the following addresses. Most videotapes requested by Navy commands are issued on a permanent or one-way issue. Commercial/Copyrighted videotapes, 16mm films, and sound/slide programs are provided on a two-week temporary loan. A return date will be indicated on the shipping invoice for those videotapes which must be returned.

Mailing Address

NETPDTC Norfolk Regional Electronic Media Center
448 Bullpup Street, Suite 100
Virginia Beach, VA 23461-2106

Phone: DSN 564-4011/1468 Comm (757) 444-4011/1468
Fax: DSN 492-6587 Comm (757) 492-6587

Internet E-Mail

donna.kerley@smtp.cnet.navy.mil
steve.freeman@smtp.cnet.navy.mil

b. NETPDTC San Diego Regional Electronic Media Center: (Over-the-counter service for San Diego area only)

NETPDTC San Diego Regional Electronic Media Center
921 West Broadway
San Diego, CA 92132-5105

Phone: DSN 522-1360 Comm (619) 532-1360
Fax: DSN 522-1130 Comm (619) 532-1130

7. Some Hollywood and other commercial movies contain material relevant to this course. Students often find such movies interesting and normally questions abound. Class discussions can be lively and may help to separate fact from fiction in matters surrounding naval operations and protocol. Some movies that may be suggested for viewing outside of class

include, "Top Gun," "Crimson Tide," "The Hunt for Red October," and "Courage Under Fire."

NOTE: The instructor should review the identified video tape during class preparation and decide how to best use it in class to enhance the students' overall learning experience. Because of time constraints, instructors are encouraged to use only short segments of the video material listed.

PIN	TITLE	YEAR	TIME	AVAIL
Lesson Guide 7: Case Study: USS *Vincennes*				
CNET	"7 Minutes That Stunned the Navy"	1993	50	N/A
	Arts and Entertainment Network documentary regarding the USS *Vincennes* shootdown of Iran Air Lines, Flight 655.			
Lesson Guide 10: Principles of Underwater Sound				
11184DN	"Underwater Sound Raypath Theory"	1974	20	BOTH
	Despite its age, this video includes a good description of sound waves, sound propagation, and sound paths. Describes the use of sonar in detection and ASW, and the use of aircraft in ASW.			
Lesson Guide 11: Underwater Detection and Tracking Systems				
35798DN	"Tracking the Threat"	1980	23	BOTH
	Describes tracking and destroying a submarine threat using several U.S. Navy platforms and ASW techniques.			
Lesson Guide 12: Military Explosives/Warheads				
35368DN	"Development of Military Explosives"	1981	17	BOTH
Lesson Guide 14: Guidance and Control Principles				
35362DN	"Laser Weapons for the Fleet"	1979	20	BOTH
CNET	"Warship"	1991	30	N/A
	An excellent description of surface warfare electronics and weapons. Based on the capabilities of the USS *Lake Champlain*. Use the section on Tomahawk guidance systems.			

Lesson Guide 17: Launching Systems

68103DN	"Harpoon Antiship Weapon System"	1978	10	BOTH

34648DN	"Tomahawk"	1976	3	BOTH

802298DN	"Sea Warriors"	1988	15	BOTH

A description of surface warfare based on the early *Ticonderoga* class cruisers (non-VLS). Good discussion of the *Ticonderoga* as a multi-mission platform. Use the section on the transfer and launching of an SM-2MR missile.

CNET	"Warship"	1991	30	N/A

An excellent description of surface warfare electronics and weapons. Based on the capabilities of the USS *Lake Champlain*. Shows several different launchers, including those for Harpoon and Tomahawk.

Lesson Guide 20: U.S. Navy and Marine Corps Platforms and Weapons

35206DN	"Top Gun"	1984	14	BOTH

68014DN	"LHA"	1979	19	BOTH

805240DN	"Today's Submarine Force"	1992	19	BOTH

Explains the different missions and capabilities of a submarine.

804818DN	"Sea Power for the 90's"	1990	18	BOTH

Explains the use of U.S. naval forces in modern-day conflicts. Includes discussion on the new missions of the Navy.

802298DN	"Sea Warriors"	1988	15	BOTH

A description of surface warfare based on the early *Ticonderoga* class cruisers (non-VLS). Good discussion on the *Ticonderoga* as a multi-mission platform.

CNET	"Warship"	1991	30	N/A

An excellent description of surface warfare electronics and weapons. Based on the capabilities of the USS *Lake Champlain*.

CNET	"Storm from the Sea"	1991	67	N/A

The U.S. Naval Institute video of the Navy and Marine Corps operations in the Gulf War. Includes interviews and combat action footage.

DEFENSE CONTRACTORS AND OTHER SOURCES OF INFORMATION

The following defense contractors' public relations offices and U.S. Navy commands can answer questions instructors may have on specific weapons or platforms. They also may be able to supply videos, posters, or brochures. Jane's Naval Weapon Systems also lists defense contractors with addresses and phone numbers.

1. AEGIS PROGRAM OFFICE
   Public Affairs Officer
   Arlington, Virginia
   (703) 602-7249 extension 421
   Aegis weapon system

2. BATH IRON WORKS
   Public Relations Department
   Bath, Maine
   Susan Pierter
   (207) 442-2914
   FFG-7, CG-47, DDG-51 class ships

3. HUGHES MISSILE SYSTEMS COMPANY
   Marketing and Communications
   Tucson, AZ
   Gary James, Customer Marketing Representative
   (520) 794-2966
   GDJames@CCGate.HAC.com
   Hughes Missile Systems Company products

4. INGALLS SHIP BUILDING
   Pascagoula, MS
   (601) 935-3355/3971
   Put all questions in writing and fax to:
   Jim McIngvale
   FAX (601) 935-5766
   DD-963, CG-47, DDG-51, LHA-1, LHD-1 class ships

5. LOCKHEED MARIETTA (Government Electronic Systems Division)
   Moorestown, NJ
   Eleanor Goodman
   (609) 722-3454
   Aegis weapon system

6. LOCKHEED MARTIN CORPORATION
   Charles Manor, Vice President of Public Relations
   6801 Rockledge Drive
   Bethesda, MD 20817
   (301) 897-6258 Phone
   (301) 897-6552 Fax
   Lockheed aircraft, weapons, EW equipment and radar

7. MCDONNELL-DOUGLAS CORPORATION
St. Louis, MO
(314) 947-6722 (Harpoon missile)
(314) 232-8203 (F/A-18)
McDonnell-Douglas missiles and aircraft

8. SANDERS, A LOCKHEED MARTIN COMPANY
Nashua, NH
Joseph Wagovich
(603) 885-2816/2817
Sanders radar and surveillance systems, integrated defense countermeasure systems, ASW systems

9. SURFACE WARFARE OFFICERS SCHOOL COMMAND
Combat Systems Department
Naval Education and Training Center
Newport, RI 02841
(401) 841-4962/4963/4964/4965 DSN: 948-4962/3/4/5

Division Officer's School
Naval Education and Training Center
Newport, RI 02841
(401) 841-2509 DSN: 948-3055

10. UNITED DEFENSE (formerly FMC Corporation)
Armament Systems Division
Marketing Communications
Minneapolis, MN 55421
Rick Snider, Manager of Marketing Communications
(612) 572-7947 FAX: (612) 574-0114
Shipboard main armament, 5-inch/54-caliber gun system, guided-missile launching systems

11. UNITED STATES NAVAL ACADEMY
Weapons and Systems Engineering Department
105 Maryland Ave
Annapolis, MD 21402-5025
(410) 293-6101
DSN: 281-6101

12. WESTINGHOUSE ELECTRIC CORPORATION
Naval Systems Division
Public Relations
Cleveland, OH
(216) 692-5112
Torpedoes (Mk-48, Mk-48 ADCAP)

TRANSPARENCY SERIES

For transparencies, use the NROTC Naval Ships Systems II (Weapons), CNET P1550/11 (Rev. 6-94), Transparency Masters. These transparencies are numbered based on the 6-94 revision of this course. The list below indicates which lesson these transparencies support in this revision. There are some transparencies that have been eliminated as they no longer apply to the lessons in this course.

Lesson Guide 1: Introduction/Weapons System Overview

1-2	Weapons system concept
1-3	Block diagram of a simplified missile control system
1-5	Defense in depth for ASW operations
1-6	Area defense and point defense

Lesson Guide 2: Energy Fundamentals

2-1	Characteristics of a radio wave assuming a frequency of 3 hertz
2-2	Methods of plotting wave characteristics
2-3	The electromagnetic frequency spectrum
2-4	Generation of electromagnetic radiation
2-5	Formation of electric and magnetic fields around an antenna
2-7	Reflection
2-8	Trapping/Ducting, diffraction, attenuation
2-9	Relationship between skip zone, skip distance, and ground waves
2-10	Earth's atmosphere

Lesson Guide 3: Radar Principles and Systems

3-1	Pulse transmission
3-2	Pulse width and pulse repetition rate
3-3	Range parameters verses range
3-4	Formation of a time base
3-5	Pulsed echo radar block diagram
3-6	Doppler Theory
3-7	CW radar block diagram
3-8	Electromagnetic energy modulation techniques
3-9	Half-wave dipole antenna
3-10	Broadside array
3-11	Radiation patterns with and without parasitic reflector
3-12	Beam width and target position accuracy
3-13	Adjusting vertical beam and horizontal beam for accuracy
3-19	Summary of radar performance factors
3-20	Radar indicator displays

Lesson Guide 4: Feedback Control/Automatic Tracking Systems

4-1 Control system elements
4-2 Digital computer organization
4-4 Negative feedback control system
4-6 Relationship between the line-of-sight and the tracking line
4-7 Block diagram of a typical automatic tracking system employing a radar sensor system
4-8 Shorted delay-line range error detector
4-9 Conical scanning
4-10 Conical scanning with target on tracking line
4-11 Conical scanning with target displaced from the tracking line
4-12 Monopulse radar system: Amplitude changes

Lesson Guide 5: Track-While-Scan (TWS)

5-1 Track-while-scan volumetric windows
5-2 Track-while-scan processing
5-3 Simplified computer target track file
5-4 Simplified track-while-scan algorithm flow diagram

Lesson Guide 6: Electronic Scanning and the Phased Array

6-1 Beam positioning along, above, below the boresight axis
6-2 Time delay scanning
6-3 Frequency scanning
6-4 Phase scanning

Lesson Guide 8: Electronic Warfare

7-2 Functional relationships of electronic support measures
7-3 Functional relations of electronic countermeasures
7-4 Effective and ineffective jamming
7-5 Spot, barrage, and sweep jamming
7-6 The effect of bandwidth on jammer spectral power density
7-7 Jamming tactics
7-8 Range deception as it would appear on an air surveillance radar scope
7-9 System degradation with ECM
7-10 Functional relations of electronic counter-countermeasures

Lesson Guide 9: C^4ISR

17-1 Nominal weapon range and defensive reaction time
17-2 Frequency spectrum: Typical uses
17-3 Frequency spectrum: Propagation on characteristics and typical uses
17-4 Navy tactical data system
17-5 Display consoles

Lesson Guide 10: Principles of Underwater Sound

8-1 The three elements of sound
8-2 Longitudinal waves
8-3 Simple longitudinal wave
8-5 Bottom loss
8-6 Patterns of flow noise
8-7 Cavitation
8-8 Ambient noise levels (modified Wenz curves)
8-9 Diagrammatic view of active sonar equations
8-10 Diagrammatic view of passive sonar equations
8-11 Graphical relationship of sound speed to pressure, salinity, and temperature
8-12 Expendable bathythermograph
8-13 Typical deep-sea speed profile divided into layers
8-14 Sound travel in isothermal water
8-15 Sound travel in water of decreasing temperature
8-16 Sound travel in water of increasing temperature
8-17 Layer depth phenomenon
8-18 Sound channel
8-19 Convergence zone
8-20 Bottom bounce
8-21 Possible propagation paths

Lesson Guide 11: Underwater Detection and Tracking Systems

9-1 Simplified passive and active sonar operation
9-2 Basic sonar system
9-3 Sonar system block diagram
9-4 Searchlight magnetostrictive transducer
9-5 Main components of scanning sonar
9-6 Scanning sonar
9-7 Passive sonar functional diagram
9-8 Summary of factors affecting sonar tactical performance
9-9 Tactical towed array sonar (TACTAS)
9-10 Finding submarines in shadow zones
9-11 Doppler degree
9-12 Defense in depth in ASW operations

Lesson Guide 12: Military Explosives/Warheads

10-1 Nuclear bursts: Surface burst, deep underwater burst, air burst
10-2 Typical energy distribution for a low altitude air burst
10-3 Three stages in the development of a 100-kiloton shallow underwater nuclear burst
10-4 Classification of nuclear bursts according to location
10-5 High explosive train
10-6 Isotropic and non-isotropic propagation
10-7 Effects of a blast wave at a given distance from blast center

10-8 Pressure vs. time relationship of a blast wave at a given distance from blast center
10-9 Direct and reflected shock waves for an underwater burst
10-10 Formation of mach wave and triple point
10-11 Three stages in the development of a 1-megaton air burst at 6500 feet height
10-12 Basic construction of a fragmentation warhead
10-13 Effect of a fragmentation warhead on a target at sea
10-14 Effect of a fragmentation warhead on a target on land
10-15 Shaped charge sequence
10-16 Expansion of a continuous rod warhead

Lesson Guide 13: Fuzing

11-1 Basic fuze system
11-2 Progression of a detonation wave
11-3 Actuation of an impact fuze
11-4 Mechanical time fuze action
11-5 Fuze classification by mode of operation
11-6 Example demonstrating the principle of an acceleration-integration safety and arming device
11-7 Projectile forces
11-8 Fuze system redundancy

Lesson Guide 14: Guidance and Control Principles

12-1 Guidance phases of missile flight
12-2 Command guidance system
12-3 Simple beam-rider guidance system
12-4 Homing guidance
12-5 Torpedo programmed path
12-6 Cruise missile programmed path
12-7 Accelerometers in guided missiles
12-8 Terrestrial guidance
12-9 Current guidance system examples
12-10 Air-to-air missile guidance phases
12-11 Pursuit path
12-12 Constant bearing path
12-13 Proportional navigation flight path

Lesson Guide 15: Weapon Propulsion and Architecture

13-1 Explosive propellant train
13-2 Impulse propulsion principles
13-3 Pressure-travel curve
13-4 Pressure-travel and velocity-travel curves
13-5 Degressive burning grains
13-6 Neutral burning grains
13-7 Progressive burning grains
13-8 Solid propellant configurations
13-9 Development of thrust in a rocket motor
13-10 Elements of a solid rocket motor

13-11 Axial flow turbojet
13-12 The turbojet engine
13-13 Low-supersonic ramjet
13-14 Hypersonic ramjet
13-15 Reaction motor advantages
13-16 Reaction motor disadvantages
13-17 Forces on a missile in flight
13-18 Functional systems of a guided missile
13-19 Location of components in guided missiles
13-20 Guided missile definitions
13-21 Control surfaces
13-22 Architecture of a bullet
13-23 Gun barrel rifling
13-26 Special purpose projectiles: Illumination, white phosphorus
13-27 Penetrating projectiles

Lesson Guide 17: Launching Systems
14-13 Mk-32 torpedo tubes
14-14 Guided missile launch system Mk-26
14-15 Vertical launch system

Lesson Guide 18: Fire Control

15-1 How own ship motion affects range and deflection
15-2 Miss-producing effects
15-3 Iterative procedure employed in a fire control solution
15-4 Flow diagram for ballistic procedure considering only gravity
15-5 Effects of transverse wind
15-6 The way to compensate for air resistance
15-7 Drift
15-8 Summary of the solution to the fire control problem
15-9 Close-in weapon system (Phalanx) closed-loop gunfire control

Lesson Guide 19: Mine Warfare

22-1 Bottom mine (typical) and moored mine (typical)
22-2 Mines Mk-25 and Mk-52 (typical)
22-3 Mines Mk-55 (typical), Mk-56, and Mk-57
22-4 Mine Mk-60
22-5 Mines Mk-62, Mk-63, Mk-64, and Mk-65
22-6 Mine Mk-67

Lesson Guide 20: U.S. Navy and Marine Corps Platforms and Weapons

18-1 *Ticonderoga* class cruiser diagram and information
18-2 *Aegis* weapon system displays
18-3 *Aegis* ASW detection systems
19-1 *Spruance* class destroyer diagram and information
19-2 *Spruance* class destroyer diagram
19-4 ASW detection system

20-1 *Los Angeles*-class submarine diagram and information
20-2 Major components of a typical submarine combat system
21-1 F/A-18 *Hornet* diagram and information
21-2 F-14 *Tomcat* diagram and information
21-4 F-14 *Tomcat* weapons options

BIBLIOGRAPHY

1. Texts (1 per student, 1 per instructor)

Frieden, David R., LCDR, USN, ed. Principles of Naval Weapons Systems. Annapolis, MD: Naval Institute Press, 1985.

Harrel, Gary, LT, USN, ed. NROTC Supplement to *Principles of Naval Weapons Systems Workbook*. Annapolis, MD: Naval Institute Press, 1985.

Naval Doctrine Command. Naval Intelligence. Naval Doctrine Publication 2. Washington, D.C.: GPO, 1995.

2. References (1 per instructor)

** Indicates essential references which are provided by CNET. The other references are not essential to the teaching of the course but can provide clarifying or amplifying information. The individual unit should take measures to obtain copies of references, if their use is desired.

NOTE: Instructors should incorporate current and past articles from magazines such as Surface Warfare, Proceedings, and Aviation Week and Space Technology, as they apply to the various subjects. Although some particular articles may be listed in the bibliography and the lesson guides, it should not be assumed to be an exhaustive listing of applicable articles.

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** Department of the Navy. ...From the Sea, Preparing the Naval Service for the 21st Century. Washington, D.C.: GPO, September 1992.

** Department of the Navy. Forward...From the Sea. Washington, D.C.: GPO, 1994.

** Friedman, Norman. The Naval Institute Guide to World Naval Weapons Systems, current edition. Annapolis, MD: Naval Institute Press.

** Hall, Joseph, CDR, USN, ed. Principles of Naval Weapons Systems, preliminary edition. Dubuque, IA: Kendall/Hunt Publishing Co., 1999.

** Hartmann, Gregory K. and Truver, Scott C. Weapons That Wait: Mine Warfare in the U.S. Navy. Annapolis, MD: Naval Institute Press, 1991.

** Lambert, Mark, ed. Jane's All the World's Aircraft 1994-95. Alexandria, VA: Jane's Information Group Inc., 1994.

** Libicki, Martin, C. What Is Information Warfare? Washington, D.C.: National Defense University Press, 1995.

MacDonald, Scot. "Slick Warriors and the '32'." Surface Warfare, January/February 1990: pp. 14-17.

McClane, Joseph L. Jr., CAPT, USN (Retired) and McClane, James L., CDR, USN. "The *Ticonderoga* Story: Aegis Works." Proceedings/Naval Review, 1985. Annapolis, MD: Naval Institute Press, 1985, pp. 118-129.

** Naval Doctrine Command. Naval Command and Control. Naval Doctrine Publication 6. Washington, D.C.: GPO, 1995.

** Naval Doctrine Command. Naval Warfare. Naval Doctrine Publication 1. Washington, D.C.: GPO, 1994.

Naval Education and Training Command. Damage Controlman 3&2. NAVEDTRA 10572. Washington, D.C.: GPO, 1986.

** Naval Education and Training Activity. Mine Warfare Supplementary Text. SAUF 32537 (8-91).

Naval Mine Warfare Engineering Activity. NAVSEA Mine Familiarizer. Yorktown, VA: Naval Mine Warfare Engineering Activity, April 1985.

Naval Mine Warfare Engineering Activity. U.S. Navy Mine Countermeasures Familiarizer. Yorktown, VA: Naval Mine Warfare Engineering Activity, October 1991.

Sabalos, Nicholas Jr., ed. "C^4I for the Warrior." Surface Warfare, July/August 1995: pp. 2-27.

Sabalos, Nicholas Jr., ed. "...Now Build the Best." Surface Warfare, September/October 1996: pp 11-35.

** Sharpe, Richard, CAPT, RN, ed. Jane's Fighting Ships, 1994-95. Alexandria, VA: Jane's Information Group Inc., 1994.

** Sharpe, Richard, CAPT, RN, ed. Jane's Naval Weapon Systems. Alexandria, VA: Jane's Information Group Inc., 1993-1995.

** Skolnik, Merrill I. Introduction to Radar Systems. New York, NY: McGraw-Hill, Inc., 1962.

** Thomas, Vincent C., ed. The Almanac of Sea Power, current edition. Arlington, VA: Navy League of the United States.

Truver, Scott C. "Weapons That Wait ... and Wait..." Proceedings, February 1988: pp. 31-40.

** Urick, Robert J. Principles of Underwater Sound, 3rd ed. New York, NY: McGraw-Hill, Inc., 1983.

Walsh, Edward J. "USN Seeks 'Technology Roadmap' for Next DDG." Sea Power, February, 1993: pp. 39-45.

RECOMMENDATIONS FOR THE INSTRUCTOR

1. Instructor References: The references listed in this curriculum guide are possible resources for the instructor. The reference information is abbreviated in the lesson guides; full bibliographical information can be found in the bibliography. It is imperative to keep the lessons and examples current by also reading periodicals such as Surface Warfare, Proceedings, and Aviation Week and Space Technology. References to current world events, weapon deployment in recent conflicts, and popular movies and books add much to this course and lead to better student understanding and increased interest.

2. Teaching Techniques: This course lends itself to a variety of teaching methods. Experiment with different interactive learning techniques, which are far more effective than the standard lecture format. Many instructors have found student presentations and guest lecturers (even other instructors from the unit or recent graduates) to be effective methods of keeping the students interested. Use multimedia demonstrations as often as possible without becoming dependent upon them to do the teaching.

3. Student Assignments: Instructors should be thoroughly familiar with the textbook and the supplement before assigning homework or reading.

4. LTG Guide Organization: Lesson topics are grouped in the same general order as the textbook. Instructors may shift the sequence to derive maximum benefit from guest speakers, field trips, or other unit education and training activities.

5. Professional Core Competencies: The instructor should be thoroughly familiar with the Professional Core Competencies (PCCs). It is incumbent upon the instructor to ensure all PCCs are mastered by the midshipmen. With the permission of the Professor of Naval Science, the instructor may modify the course if the PCCs are met. Instructors should ensure they are not focusing the course only upon the warfare areas or platforms with which they are familiar. The midshipmen should leave this course with an equal understanding of the platforms and weapons used by all four U.S. Navy warfare areas and by the U.S. Marine Corps.

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 1 **HOURS: 1**

TITLE: Introduction/Weapons Systems Overview

I. Learning Objectives

A. The student will know the course structure and the topics to be presented.

B. The student will know the course policies, requirements, and the purpose of the course.

C. The student will comprehend the concept, requirements, and components of naval weapons systems.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, appendices A, B, C

2. NROTC Supplement to *Principles of Naval Weapons Systems Workbook*, Chap. 1

B. Student texts

1. Principles of Naval Weapons Systems, appendices A, B, C

2. NROTC Supplement to *Principles of Naval Weapons Systems Workbook*, Chap. 1

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts/syllabus/transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

IV. Suggested Methods and Procedures

A. Method options

1. Discuss the course objectives and student evaluation.

2. Present an overview of the sections of the course with the logical progression toward an overall integrated combat system.

B. Procedural and student activity options: Distribute copies of student text and course syllabus.

V. Presentation

A. Introduction of instructor, including a short auto-biography of naval assignments.

B. Discuss course policies, requirements, and grading procedures.

C. Discuss the purpose of the course and relate course structure with naval assignments for junior officers.

D. Have students with previous experience discuss weapons systems encountered.

E. Present an overview of the course.

1. Professional core competency objectives for the course

2. Lesson topics

3. Basic definitions: Weapons, weapon system, ordnance

4. System of classification and nomenclature of naval weapons and platforms

F. Introduce and explain the concept of a weapon system.

1. Purpose of weapon systems

2. Single or multiple weapons

3. Components of a weapon system

a. Units that detect, locate, and identify the target (example: radar)

b. Units that direct or aim a delivery unit (example: computer and tracking system)

c. Units that deliver or initiate delivery of the weapon to the target (example: launching system)

d. Units that destroy the target when in contact with it or near it (example: missile)

G. Explain weapon systems requirements.

1. Military requirements

2. General characteristics

   a. Reliability

   b. Flexibility

   c. Safety

   d. Simplicity of operation

   e. Maintainability

H. Introduce appendices in basic text for student familiarization of weapons systems terminology.

I. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 2 **HOURS: 2**

TITLE: Energy Fundamentals

I. Learning Objectives

A. The student will comprehend the basic application of electronics systems, communications theory, and electromagnetic wave theory to maritime and naval applications in radars, communications, and radio-navigation systems.

B. The student will comprehend radar and radio wave parameters, including frequency, period, wavelength, coherency, velocity, and amplitude.

C. The student will know and be able to apply radar and radio wave theory, including:

1. Maxwell's Theory

2. Relationship between wavelength and frequency

3. Relationship between wavelength and velocity

4. Relationship between frequency and wave propagation paths

5. Relationship between frequency and period

D. The student will comprehend the basic operation of a simple radar/radio system, including:

1. The concept of the generation of electromagnetic energy

2. Polarization

E. The student will comprehend the concepts of time and distance as they affect wave phase angle and constructive/destructive interference.

F. The student will know basic electromagnetic interference factors in ship and weapon design.

G. The student will know electromagnetic wave propagation, including the principles of reflection, refraction, diffraction, and ducting.

H. The student will know the definition of the effects of ground plane, free space, re-radiation, sky waves, space waves, ground waves, and tropospheric waves.

I. The student will know the fundamental means of imparting information to radio waves and will comprehend the uses, advantages, and disadvantages of the various means.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 1

2. Introduction to Radar Systems, Chaps. 1, 2, 7, 11, 12

B. Student text: Principles of Naval Weapons Systems, Chap. 1

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chap. 1

V. Presentation

A. Introduction

1. Radar is an acronym for radio detection and ranging.

2. Radar is an electromagnetic wave that acts like any other electromagnetic wave (radio, light, etc.).

3. Apply the concepts in lessons two and three to radar, communications, and radio/navigation systems.

B. Discuss the use of electronic systems, communications, and electromagnetic waves in maritime and naval systems.

C. Discuss the characteristics of traveling waves and how they interrelate.

1. Frequency

2. Period

3. Wavelength

4. Coherency

5. Velocity

6. Amplitude

D. Discuss Maxwell's Theory.

1. An accelerating electric field will generate a time-varying magnetic field.

2. A time-varying magnetic field will generate a time varying electric field.

E. Briefly explain how electromagnetic waves are generated.

F. Discuss constructive and destructive interference.

1. Phase difference due to different distances

2. Phase difference due to time difference

3. Using interference to maximize efficiency

4. Considering electromagnetic interference factors in ship and weapon design

G. Explain polarization.

1. Horizontal

2. Vertical

3. Signal Reception

H. Discuss propagation paths.

1. Reflection

2. Refraction

3. Diffraction

I. Discuss wave propagation and the relationship between frequency and distance.

1. Ground waves

2. Sky waves

3. Space waves

4. Tropospheric waves

5. Ground plane

6. Free space

7. Re-radiation

J. Discuss transmission range factors.

1. Antenna height

2. Target height

3. Ducting

4. Losses due to spreading and absorption

K. Discuss the means of imparting information to radio/ radar waves.

1. Amplitude modulation

2. Frequency modulation

3. Pulse modulation

L. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 3 **HOURS: 3**

TITLE: Radar Principles and Systems

I. Learning Objectives

A. The student will comprehend the basic operation of a simple pulse radar system.

B. The student will know the following terms: pulse width, pulse repetition frequency, carrier frequency, peak power, average power, and duty cycle.

C. The student will know the block diagram of a simple pulse radar system and will comprehend the major components of that system.

D. The student will comprehend the basic operation of a simple continuous wave radar system.

E. The student will comprehend the concept of doppler frequency shift.

F. The student will know the block diagram of a simple continuous wave radar system and will comprehend major components of that system, including amplifiers, power amplifiers, oscillators, and waveguides.

G. The student will comprehend the use of filters in a continuous wave radar system.

H. The student will comprehend the function and characteristics of radar/radio antennas and beam formation.

I. The student will comprehend the factors that affect radar performance.

J. The student will comprehend frequency modulated CW as a means of range determination.

K. The student will comprehend the basic principles of operation of pulse-doppler radar and MTI systems.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 2

2. Introduction to Radar Systems, Chaps. 3, 4, 6, 8, 9

B. Student text: Principles of Naval Weapons Systems, Chap. 2

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignments

2. Reading assignment: Student text, Chap. 2

V. Presentation

A. Discuss the basic operation of a simple pulse radar system.

B. Describe pulse radar parameters.

1. Pulse width (PW)

a. Time of one pulse

b. Effects of varying PW

(1) Maximum range

(2) Minimum range

(3) Range resolution

2. Pulse repetition frequency (PRF)

a. Pulses per second

b. Effects of varying PRF

(1) Maximum range

(2) Accuracy

c. Relation to pulse repetition time (PRT)

3. Peak power

    a. Maximum signal power of any pulse

    b. Affects maximum range of radar

4. Average power

    a. Total power transmitted per unit of time

    b. Relationship of average power to PW and PRT

5. Duty cycle

    a. Ratio PW (time transmitting) to PRT (time of entire cycle, time transmitting plus rest time)

    b. Also equal to ratio of average power to peak power

C. Discuss the determination of range with a pulse radar.

D. Describe the components of a pulse radar system.

1. Synchronizer

2. Transmitter

3. Antenna

4. Duplexer

5. Receiver

6. Display unit

7. Power supply

E. Discuss the basic operation of a simple continuous wave (CW) radar.

1. Doppler frequency shift

    a. Source moving towards target

    b. Source moving away from target

    c. Stationary/Moving target

2. Advantages and disadvantages over pulse radar system

F. Describe the components of a CW radar system.

1. Two antennas (transmit, receive)
2. Oscillator or power amplifier
3. Mixer
4. Amplifier
5. Discriminator
6. Indicator
7. Filters: Noise reduction

G. Discuss radio/radar antennas and beam formation.

1. Half wave dipole (basic radiating element)
2. Beam power distribution
3. Beam requirements
4. Methods of obtaining directivity
    a. Linear arrays
        (1) Broadside arrays
        (2) Endfire arrays
    b. Quasi-optical systems
        (1) Reflector
        (2) Lenses
5. Function of wave guides

H. Discuss factors that affect radar performance.

1. Signal reception
2. Signal-to-noise ratio
3. Receiver bandwidth
4. Receiver sensitivity
5. Pulse shape
6. Pulse compression
7. Power relation
8. Scan rate

a. Mechanical

b. Electronic

9. Beam width

10. Pulse repetition frequency

11. Carrier frequency

12. Antenna gain

13. Antenna aperture

14. Radar cross section of target

I. Discuss combined radar systems.

1. Frequency modulated CW

2. Pulse doppler radar

3. MTI systems

J. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 4 **HOURS: 2**

TITLE: Feedback Control/Automatic Tracking Systems

I. Learning Objectives

A. The student will know the definitions of the following terms: input, output, feedback, error, open loop, and closed loop.

B. The student will comprehend the advantages of closed-loop control in a weapon system.

C. The student will comprehend the difference between the line-of-sight (LOS) and the tracking line.

D. The student will comprehend the operation of a simple automatic tracking system.

E. The student will comprehend the concepts, advantages, and limitations of conical scan, conical scan on receive only (COSRO), and monopulse.

F. The student will comprehend stabilization as associated with tracking systems.

G. The student will know the difference between range tracking and angle tracking.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chaps. 3, 5

2. Introduction to Radar Systems, Chap. 5

B. Student text: Principles of Naval Weapons Systems, Chaps. 3, 5

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

3. Sample problems

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chaps. 3, 5

V. Presentation

A. Describe control system terminology.

1. Input

2. Output

3. Feedback

4. Error

5. Open-loop control

6. Closed-loop control

B. Discuss the advantages of closed-loop control in weapon systems.

C. Explain the concepts of feedback in weapon systems\ control.

D. Introduce automatic tracking systems (relate to feed back control).

1. Target tracking parameters

a. Azimuth

b. Elevation

c. Range

d. Relative target velocity

2. Line-of-sight (LOS)

3. Tracking line

E. Describe angle-tracking servo systems.

1. Five basic functions

a. Sense position error magnitude and direction

b. Provide position feedback

c. Provide data smoothing/stabilization

d. Provide velocity feedback

e. Provide a power-driving device

2. Uses of angle-tracking servo systems

a. Monotrack fire control radars

b. Homing missiles

c. Acoustic homing torpedoes

d. Aviation fire control tracking systems

3. Methods of tracking

a. Conical scan

b. Conical scan on receive only (COSRO)

c. Monopulse

4. Discuss the advantages and limitations of each system.

F. Discuss data smoothing and stabilization.

1. Unstabilized

2. Partially stabilized

3. Fully stabilized

G. Discuss the differences between range tracking and angle tracking.

H. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIP SYSTEMS II (WEAPONS)

LESSON GUIDE: 5 **HOURS: 1**

TITLE: Track-While-Scan (TWS)

I. Learning Objectives

A. The student will comprehend the central concept of a TWS system.

B. The student will know the six basic functions of a TWS system.

C. The student will comprehend the concepts of acquisition, tracking, and turning gates.

D. The student will know the structure and purpose of a track file.

E. The student will comprehend the basic method of track gate prediction, smoothing, and positioning.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 6

2. Introduction to Radar Systems, Chap. 5

B. Student text: Principles of Naval Weapons Systems, Chap. 6

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method option

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chap. 6

V. Presentation

A. Introduction

1. Discuss the limitations of traditional search radar.

2. Discuss the problems associated with tracking a target with a fire control radar.

a. The target knows it's being tracked.

b. The target can initiate electronic attack or electronic protection.

c. The target can use weapons that home in on the radar.

B. Describe the central concepts of track-while-scan (TWS).

1. The sensor continues to perform primary function of search (scanning) and data input.

2. The remainder of system performs target tracking function.

3. Eliminates process of target designation from search radar to fire control radar.

C. Explain the fundamentals of TWS.

1. Six basic functions performed by a TWS system

a. Target detection

b. Target track correlation and association

c. Target track initiation and track file generation

d. Generation of tracking gates

e. Track gate prediction, smoothing, and positioning

f. Display and future target position calculation

2. TWS gates

a. Acquisition gate

b. Tracking gate

c. Turning gate

3. Track initiation and track file generation

a. Initiation of track file

b. Updating the file

4. Gate positioning and smoothing functions (compare with servo tracking systems)

D. Discuss the advantages of a TWS radar system.

E. Briefly discuss real world applications.

F. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 6 **HOURS: 1**

TITLE: Electronic Scanning and the Phased Array

I. Learning Objectives

A. The student will comprehend the basic principles of electronic scanning operation.

B. The student will know the advantages of electronic scanning.

C. The student will comprehend how phase relationships affect beam positioning.

D. The student will comprehend the three methods of beam steering.

E. The student will comprehend the principles of synthetic aperture radar.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 7

2. Introduction to Radar Systems, Chap. 7

3. "The *Ticonderoga* Story: Aegis Works"

B. Student text: Principles of Naval Weapons Systems, Chap. 7

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chap. 7

V. Presentation

NOTE: Emphasis should be placed on a theoretical vice mathematical approach to electronic scanning and phased array. Although pertinent, the mathematical approach extends beyond the scope of the course.

A. Introduction: Discuss the limitations of TWS and mechanical scanning radars.

B. Discuss benefits of electronic scanning.

1. Increased data rates

2. Instantaneous positioning of beams

3. Elimination of mechanical failures

4. Increased flexibility (simultaneous multimode operation)

C. Explain the basic principles of operation.

1. Review phase relationships

a. Constructive interference

b. Destructive interference

2. Methods of beam steering

a. Time delay scanning

(1) Time delay networks between the feed network and the radiating elements

(2) Frequency flexibility

(3) High cost, complexity, weight

b. Frequency scanning

(1) Serpentine wave guide

(2) Inexpensive, relatively simple, resistant to jamming

(3) SPS-48 air search radar

c. Phase scanning

(1) Phase-shifting networks between the feed network and the radiating elements

(2) More expensive than frequency scanning, less expensive than time delay

(3) SPY-1 radar (Aegis weapon system)

D. Discuss synthetic aperture radar (SAR).

E. Discuss the advantages of electronic scanning over mechanical scanning in target detection and tracking.

F. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 7 **HOURS: 2**

TITLE: Case Study -- USS *Vincennes*

I. Learning Objectives

A. The student will comprehend the moral and ethical responsibilities of the military leader.

B. The student will comprehend a leader's moral and ethical responsibilities to the organization and society.

C. The student will comprehend the relationship of integrity, moral courage, and ethical behavior to authority, responsibility, and accountability.

D. The student will comprehend the following personal qualities and be able to relate them to a leader's effectiveness:

1. Loyalty

2. Honor

3. Integrity

4. Courage

II. References and Texts

A. Instructor references

1. "High-Tech Horror," Time, 18 Jul 88, pp. 14-17

2. "Sea of Lies," Newsweek, 13 Jul 92, pp. 3

B. Student references

1. Instructor-developed handout regarding the *Vincennes* case

2. "High-Tech Horror"

3. "Sea of Lies"

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. VCR/Monitor

E. Videotape: “Seven Minutes That Stunned the Navy”

IV. Suggested Methods and Procedures

A. Method options:

1. Lecture/explanation of facts by instructor, followed by class discussion

2. Student presentation of facts followed by an instructor-facilitated discussion

3. Role play

4. Student debate

B. Procedural activities: Research the subject. "High-Tech Horror" and "Sea of Lies" can be found in most school libraries.

V. Presentation

A. Discuss the events leading to the *Vincennes* incident. *(See case study at end of this lesson.)*

1. Iran-Iraq War

2. Attack on the USS *Stark*

3. The USS *Samuel B. Roberts* hit a mine in an Iranian minefield in April 1988.

B. Discuss the changes in the Rules of Engagement (ROE) in the Persian Gulf.

1. Commanding Officers were authorized to take positive protective measures.

2. U.S. warships did not have to wait for the enemy to fire first.

3. U.S. assets required positive identification and description of intentions from all aircraft and ships operating in those waters.

4 Why did the Chairman of the Joint Chiefs of Staff think this was necessary?

a. Responsibility for American lives

b. Responsibility for the U.S. reputation

c. Responsibility for foreign lives

C. Discuss the use of force by USS *Vincennes* prior to the downing of the airbus.

1. Discuss the surface conflict with the gunboats. Compare weapons of the *Vincennes* to those of the gunboats. Were the gunboats really a threat?

2. Were the decisions and actions of Captain Rogers justified in his use of force against the gunboats?

a. Consider control of airspace with extended range of his helo's antiwarfare weapons.

b. Was the use of force justified under the ROE?

c. Was the use of force justified under the Law of Armed Conflict?

(1) Necessary action

(2) Proportional action

(3) Ethical action

D. Review the facts surrounding the downing of the Iran Air airbus airliner by the *Vincennes*.

E. Discuss the leadership considerations.

1. What was the CO's motivation?

a. Defend the crew

b. Follow the ROE

c. Improve the Navy's image

d. Improve America's image

(1) As a warning to other nations

(2) In the eyes of the U.S. public

2. Discuss responsibility.

a. Commanding Officer of USS *Vincennes*

b. Commanding Officer of USS *Sides*

c. Other members of the two crews

d. How could this incident have been avoided?

e. Who could have prevented these deaths?

f. Who was accountable/responsible for the deaths?

3. Discuss leadership traits.

a. Examples of loyalty

b. Examples of honor

c. Examples of integrity

d. Examples of courage, including moral courage

F. Summary

Vincennes
A Case Study
by
Lieutenant Colonel David Evans, U.S. Marine Corps (Retired)

Captain Mohsen Rezaian was piloting his fully loaded Iran Air Airbus through 13,000 feet on a routine Sunday morning flight across the Persian Gulf to Dubai, when a burst of shrapnel ripped off the left wing and tore through the aft fuselage.

We shall never know Captain Rezaian's last moment; but in that instant before oblivion he may have looked in horror out his left window and thought that the slab of flapping aluminum and severed hydraulic lines where the wing had been was the result of some sort of structural defect.

It is doubtful that he ever saw the two fiercely burning points of light streaking up at his airplane -- the Standard missiles launched by the cruiser *USS Vincennes* (CG-49).

It is also doubtful that Captain Rezaian ever heard the warning messages broadcast by the *Vincennes*, or by the frigate *USS Sides* (FFG-14), about 18 miles from the cruiser. The two ships were broadcasting on military and international air distress frequencies; and during the busy climb-out phase of his flight, Captain Rezaian likely was monitoring the approach control frequency at Bandar Abbas, where he took off seven minutes before, and air traffic control at Tehran Center.

If he had been monitoring the distress frequencies, the American-educated Captain Rezaian, although fluent in English, might not have known that the warning transmissions were intended for him. Indeed, as the Navy's report to the International Civil Aviation Organization (ICAO) would later state, only one transmission made by the *Sides*, just 40 seconds prior to the *Vincennes*' missile launch, was clear enough that it could not have mistaken as being intended for another aircraft.

Besides, Captain Rezaian's Mode 111 transponder, the civilian equivalent of the military's “identification friend or foe” (IFF) electronics, was broadcasting the unique code of a “commercial airliner.”

Flying at a speed of about six miles per minute, the Iranian pilot had no way of knowing that moments earlier he had crossed the 20-mile point where Captain Will Rogers, the skipper of the *Vincennes*, had announced to his crew and to other U.S. naval elements in the area, that he would shoot if the Iranian aircraft did not change course. Captain Rezaian could not have guessed that by now his lumbering A-300 Airbus had been evaluated in the *Vincennes* as a diving Iranian F-14 -- the spearhead of a "coordinated attack" from the air from gunboats on the surface -- and that Captain Rogers had given him an unspoken momentary reprieve by waiting until the airliner was 11 miles from the *Vincennes* before he authorized firing of the ship's SM-2 antiaircraft missiles.

As torn aluminum and 290 bodies from the shattered airliner rained down on the waters off Qeshm Island, the pieces fell into place for Captain David Carlson, who as a commander then was skipper of the frigate *Sides*. This curious track number 4131, designated an Iranian F-14 by the *Vincennes*, simply had not behaved like a combat aircraft.

Indeed, as Captain Carlson would learn minutes after the Airbus plummeted into the water, the electronic specialists in the *Sides* combat information center had correctly identified the aircraft's commercial transponder code at virtually the same instant that the *Vincennes* fired her missiles.

Captain Carlson recalled their exclamations: "He shot down COMAIR [a commercial aircraft]!"

To Captain Carlson, the shootdown marked the horrifying climax to Captain Rogers' aggressiveness, first seen just four weeks before.

The *Vincennes* had arrived in Bahrain on 29 May and got underway for her first Persian Gulf patrol on 1 June. On the second day of this patrol, the *Vincennes* was on the scene when an Iranian warship (the frigate *Alborz*) had stopped a large bulk carrier (the *Vevey*) and had dispatched a boarding party to search the merchantman for possible war material bound for Iraq. Although it was within the Iranian skipper's rights to do so under international law, this appeared to be the first search-and-seizure of the Iran-Iraq War.

Simultaneously, the *Sides* was transiting out of the Persian Gulf to rendezvous with an inbound merchant vessel for a routine escort mission. Then-Commander Carlson had arrived on board the frigate by helicopter only four days earlier to relieve Captain Robert Hattan. Both men were in the *Sides'* combat information center (CIC).

As *Sides* approached the scene, it appeared to Captain Hattan that the *Vincennes* was too close to the Iranian frigate. "Hattan didn't like the picture. We were not at war with Iran, and Hattan understood the need to deescalate the situation whenever possible," Captain Carlson would later relate.

Nevertheless, the situation soon deteriorated when the *Vincennes* took tactical control of the *Sides*.

Captain Hattan recounted that "Rogers wanted me to fall astern of the Iranian frigate by about 1,500 yards. I came up on the radio circuit and protested the order from the *Vincennes*. I felt that falling in behind the Iranian [warship] would inflame the situation."

Captain Carlson added: "This event has to be put in its proper context. Less than two months earlier, half the Iranian Navy was sunk during operation Praying Mantis, and our government had been making strong statements about America's determination to protect neutral shipping. Now what does the Iranian skipper see? He's conducting a legal board-and-search, and here's an Aegis cruiser all over him. Next, an American frigate joins the action. Incidental to all this, Hattan knew that a U.S. reconnaissance aircraft was scheduled to fly over the area, which the Iranian might well detect on his air search radar. Hattan also knew that two other U.S. warships were behind us leaving the Persian Gulf. The Iranian captain would be seeing all sorts of inbound blips on his radar scopes, and he was alone."

"It was not difficult for Hattan to envision the Iranian skipper's apprehension that he was being set up. On top of that, let us say that *Sides*' position relative to the Iranian warship was not tactically satisfying," Captain Carlson said.

Tensions increased. The Iranians, clearly skittish, fired warning shots at a civilian helicopter flying overhead with an NBC crew on board.

"Hattan was very concerned that Rogers was going to spook the Iranian skipper into doing something stupid. He wanted out and recommended de-escalation in no uncertain terms," Captain Carlson said.

The higher headquarters at Bahrain, designated Joint Task Force Middle East, agreed and detached the *Sides* from the *Vincennes*' control and, in addition, ordered the cruiser to back off and simply observe the Iranian warship's activities.

This account stands in sharp contrast to the version in Captain Rogers' Naval Institute book, *Storm Center*, where he paints himself as the soul of caution. Captain Rogers described the incident as occurring during his second patrol, on 14 June, when he was barely into his first patrol. "Sensitive ground being broken; no one wanted to escalate the problem," Captain Rogers wrote.

Captain Carlson, who relieved Captain Hattan as commanding officer of the *Sides*, observes: "This confrontation happened on 2 June, and if anyone should get credit for cooling off a hot situation, it's Captain Hattan."

In a telephone interview, Captain Rogers agreed that 14 June is in error and 2 June will be used in subsequent editions of his book.

To Captain Carlson, it is not just a minor clerical error. "Rogers moved the June 2nd incident to the 14th and took credit for de-escalating the situation. But if the story is told as it actually happened, the Rogers comes across as a loose cannon on his first patrol. A junior four-striper [Hattan] had to set him straight and calm things down. The *Alborz* incident was the beginning of all the concern about his ship," Captain Carlson said.

Although this incident was the genesis of the "Robocruiser" moniker hung on the *Vincennes* by the men on board the *Sides*, it was not mentioned in the formal investigation of the shootdown or in any of the subsequent testimony of senior naval officers to the public. The implications of the aggressiveness Captain Rogers displayed on his first Persian Gulf patrol were glossed over.

On the morning of 3 July, Captain Carlson and his men in the *Sides'* combat information center had a close-up view of the fateful train of events leading up to the shootdown of the Airbus. Unlike the USS *Elmer Montgomery* (FF-1082), the third U.S. warship involved in the events that day, the *Sides* was equipped with the Link-11 data link. This electronic system enabled the *Sides* and *Vincennes* computers to exchange tactical information in real time. Although they were 18 miles away, Captain Carlson and his watch officers had a front-row picture of virtually the same information that Captain Rogers saw on the large-screen displays in the *Vincennes*.

Shortly after sunrise, the *Sides* was on her way back through the Strait of Hormuz to rendezvous with another merchantman scheduled for a U.S. Navy escort through the narrow strait and into the northern Arabian Sea.

Over the radio, personnel on board the *Sides* heard reports from the *Elmer Montgomery* of

Iranian gunboats in the Strait of Hormuz and in the vicinity of merchant shipping. "*Montgomery* reported sounds of explosions. There was vague discussion of some action taking place. Not much, but we were told by the surface staff [Commander Destroyer Squadron (ComDesRon) 25 in Bahrain] to increase speed and clos*e the Vincennes*' position as fast as possible."

Captain Carlson recalled, "Within minutes we got told, in effect, 'Nah, that's it, resume your normal speed.' Fifteen minutes passed, maybe half an hour. Again, the word came down to the *Sides* to crank up speed and join the *Vincennes*. This order, too, was soon canceled."

"I'm going down in my CIC now, thinking, 'Gee, this is starting off as kind of a fouled-up day, isn't it?' And then, lo and behold, the message came over the radio from Captain Rogers to the staff [DesRon 25] that his helicopter had been shot at," Captain Carlson said.

Earlier, at around 0720, Captain Rogers had launched his helicopter with orders to fly north and report on the Iranian gunboat activity.

Also acknowledging the information, according to Captain Carlson, was the staff of the Commander, Joint Task Force Middle East, Rear Admiral Anthony Less. Admiral Less's staff was on board the USS *Coronado* (AGF-11) at Bahrain. Captain Dick McKenna, commander of DesRon 25, and his staff were located on board the USS *John Hancock* (DD-981), at the Sitrah Anchorage in Bahrain.

"I smelled that something wasn't good here," Captain Carlson said. With good reason. Under the rules of engagement in effect at the time, the *Vincennes'* helicopter, piloted that morning by Lieutenant Mark Collier, should not have been flying close enough to be threatened by the light weapons on the Iranian small craft. If Lieutenant Collier was in danger, it was because he was not following the rules: to approach no closer than four miles.

In a letter published last August, in the wake of a *Newsweek* magazine cover story on the incident, Lieutenant Collier wrote that he was never closer than four miles from the Iranian craft. However, that letter is at variance with Lieutenant Collier's sworn testimony to the investigators, in which he conceded that he had closed to within two to three miles of the Iranian craft.

In fact, when the investigating officer asked Lieutenant Collier, "You were actually inside the CPA [closest point of approach] that you were told not to go inside, is that correct?" Lieutenant Collier replied,"Yes sir."

With the report that the *Vincennes*' helicopter had taken fire, Captain Carlson order his crew assigned to small arms details topside.

"I was in CIC, and I remember my tactical action officer, Lieutenant Richard Thomas, saying, 'My God, the *Vincennes* has really cranked up the speed here.' You could see it, the long speed line on the scope. 'Where the hell are they going?' I was wondering," Captain Carlson said.

When this question was posed in a telephone interview with Captain Rogers, he replied, "I wanted to get him [my helicopter] back under my air defense umbrella. That's why I was heading north."

This rationale raises questions. The *Vincennes*' helicopter could dash away from danger at 90 knots, three times the speed of the advancing mother ship and, in addition, Captain Rogers already
had control of the airspace his helicopter was occupying, some 19 miles distant given the extended range of his antiair warfare weapons.

In fact, in the 3 August 1992 Navy Times Captain Rogers offered a different explanation for his decision to press north. "Because of the bad atmospherics, any time the helo was farther than 15 miles, we lost contact," he said.

Captain Carlson recounted that "Rogers then started asking for permission to shoot at the boats. We already knew the helicopter was okay, and if the boats were a threat, you didn't need permission to fire."

Finally, after what Captain Carlson described as a couple minutes of "dickering" on the radio between Captain Rogers and the Joint Task Force staff in Bahrain, the *Vincennes*' skipper was given permission to shoot.

"My executive officer [Lieutenant Commander Gary Erickson] and I were standing together; we both went like this," Carlson said, pointing both thumbs down. "It was a bad move. Why do you want an Aegis cruiser out there shooting up boats? It wasn't the smart thing to do. He was storming off with no plan and, like the Biblical Goliath, he was coming in range of the shepherd boy," Captain Carlson said.

Captain Carlson directed Erickson to go to the bridge and to sound general quarters. "On the way out, Gary asked, 'What's your worst concern?' And I remember saying I was afraid that we might have to massacre some boats here," Captain Carlson said.

"I mean they were not a worthy adversary. Take a look at my ship, with a chain gun, 50-caliber machine guns, a grenade launcher, and a 76-mm. gun--all this against a guy out there in an open boat with a 20-mm. gun and a rocket-propelled grenade launcher. You'd rather he just went away," Captain Carlson said.

The *Sides* continued to track the *Vincennes* whose speed line indicated high speed. At 0920 the *Vincennes* joined with the *Elmer Montgomery* and took the frigate under tactical control. The two vessels pushed north, with the *Elmer Montgomery* maintaining station off the *Vincennes*' port quarter.

On board the *Vincennes*, a team of Navy journalists recorded events as seen from the cruiser's bridge on a video camera. On the videotape, the *Vincennes'* executive officer, Commander Richard Foster, informed the combat information center, "We've got visual on a Boghammer," a reference to the Swedish-built boats operated by Iran's Revolutionary Guards. The camera zoomed in to an Iranian boat, which appeared dead in the water and floating between the *Vincennes* and *Elmer Montgomery* as they raced by.

The two U.S. warships held fire. They were headed for bigger game, the blips on the surface search radar indicating more Iranian boats in the distance. According to the data later extracted from the *Vincennes'* computers, it appears to have been a stern chase situation, where the Iranian

boats were headed toward the safety of their territorial waters.

As shown by the *Vincennes*' videotape, the two American warships passed a second Iranian gunboat, this one to starboard of the cruiser. The boat's crew can be seen relaxing topside. Hardly threatening behavior and the Iranians appeared not the least threatened by the passage of the U.S. Navy cruiser.

Yet at this moment, at 0939, Captain Rogers asked for permission to fire at Iranian gunboats he described as closing the USS *Montgomery* and the *Vincennes*.

On the *Sides*, Captain Carlson was mystified. As he recounted in my interview with him: "Rogers' actions didn't make any sense on at least two levels. First, if he was bent on retaliation [for the shooting at his helicopter], why was Rogers waiting for a second demonstration of hostile intent? He could have engaged the boats he was pursuing at his convenience. Second, if the situation was so threatening, why ask for permission to fire? Under the rules of engagement, our commanders did not have to wait for the enemy to fire; they were allowed to exercise a level of discretion."

When he was asked about all this apparently unnecessary effort to obtain permission to fire, and the time it might consume, Captain Rogers offered a variety of reasons. To this writer, he stated, "It was ingrained in our training to ask the boss." However, on an ABC *Nightline* broadcast the evening of 1 July 1992, Captain Rogers related, "Time is a demon here. If I [sic] have a long time to sort things, you are going to take more time to look at this, and more time to look at that. But when you don't have time, you basically take what you have and...at some point in time you have to make the decision." Yet in an interview later that month, Captain Rogers told a *Navy Times* reporter, "It's always a good idea, if you have the time, to ask for permission."

At about 0940, the *Vincennes* and *Elmer Montgomery* crossed the 12-mile line into Iranian territorial waters. There is no mention of this crossing in the unclassified version of the official report of the investigation."

According to the investigation report, at 0941 Captain Rogers was given permission to open fire. Note, he was now inside Iranian territorial waters and ready to engage boats that had not fired at him.

From the data extracted from the *Vincennes*' Aegis combat system, the Iranian gunboats did not turn toward the cruiser until 0942 -- *after* Captain Rogers had been given permission to fire. Time 0942 is the vital piece of information that destroys the myth that the *Vincennes* and *Elmer Montgomery* were under direct attack by a swarm of gunboats.

The time the Iranian gunboats turned was duly recorded by the Aegis data tapes, but it was not contained in the investigation report. Not until four years later, when Admiral William J. Crowe, U.S. Navy (Retired), the former Chairman of the Joint Chiefs, testified to the House Armed Services Committee on 21 July 1992, did this significant datum come to public light.

Assuming his recollection is correct, Admiral Crowe said, "We actually know that they turned around toward *Vincennes* at time 42." But Admiral Crowe then diminished the significance of what he just revealed by hastening to tell the congressmen, "I won't confuse you with these times

and so forth."

At about 0943, the *Vincennes*' forward five-inch gun mount commenced to lob shells at the Iranian gunboats.

From the videotape recorded on *Vincennes*' bridge that day, the gunboats, seen as mere specks in the distance, returned fire; they did not initiate the shooting. The Iranian gunboats' light weapons were greatly outranged by the heavier ordnance on the *Vincennes*, and the spent shells from the Iranians' weapons fell harmlessly as a brief line of splashes in the water, hundreds of yards short of the *Vincennes*, and fully 45 seconds after the *Vincennes'* first rounds were fired.

At 0947, Captain Rezaian pushed the throttles on his Airbus to take-off thrust and began rolling down the runway at Bandar Abbas.

On board the *Sides* moments later, the tactical action officer (TAO) informed Captain Carlson, "Captain, we have a contact. *Vincennes* designated this contact as an F-14 coming out of Bandar Abbas." The contact was assigned track number 4131 by the *Sides*, and through Link-11 the *Vincennes*, following the same contact as track 4474, dropped that number and adopted *Sides*' track number.

Captain Carlson recalled, "I was standing between my TAO and weapons control officer. I asked, 'Do we have it?'"

"Yes, sir, we've got skin, it's a good contact." was the reply, indicating that electronic energy transmitted by the *Sides'* air search radar was bouncing off the plane.

"I glanced at it," said Captain Carlson. "It was around 3,000 feet, 350 knots. Nothing remarkable, so I said to the ESM [electronic support measures] talker, any ESM [emissions]?"

"No, sir. She's cold nose. Nothin' on her."

"Okay, are we talking to him?"

"Captain, we've gone out over the IAD [International Air Distress] and MAD [Military Air Distress], and so has *Vincennes*. We are trying every net with this guy, and so far we have no response," was the reply.

"Okay, light him up," Captain Carlson ordered. He explained that it was standard practice to illuminate Iranian military aircraft with missile fire control radar as a warning for them to turn around.

"When you put that radar on them, they went home. They were not interested in any missiles," Captain Carlson recalled.

"But this contact didn't move. I looked at the console again. More altitude. More speed. Got any ESM?" Captain Carlson asked.

"Nothing."

"And he's still not talking?"

"No, sir, we're getting nothing out of him."

"I evaluated track 4131 verbally as not a threat. My TAO gave me a quizzical look, and I explained. 'He's climbing. He's slow. I don't see any radar emissions. He's in the middle of our missile envelope, and there is no precedent for any kind of an attack by an F-14 against surface ships. So, non-threat,'" Captain Carlson recalled.

As Captain Carlson and his tactical action officer were evaluating an Iranian P-3's activities on the radar scope, they overheard Captain Rogers' transmission, announcing to higher headquarters his intention to shoot down track 4131 at 20 miles.

Captain Carlson was thunderstruck: "I said to the folks around me, 'Why, what the hell is he doing?' I went through the drill again. F-14. He's climbing. By now this damn thing is at about 7,000 feet. Then, I said in my mind, maybe I'm not looking at this right. You know, he's got this Aegis cruiser. He's got an intelligence team aboard. He must know something I don't know."

On the *Vincennes* the picture was different. Captain Carlson knew that from Captain Rogers' perspective the presumed F-14 would pass almost directly overhead. What he did not know was that the watchstanders might also have been telling Captain Rogers the contact was diving.

"Rogers saw it as a threat because he supposedly was being told it was diving. As I was going through the drill again in my mind, trying to figure out why I was wrong, he shot it down," Captain Carlson said.

"Then I found out that my guys back in the corner had evaluated the IFF [identification friend or foe] and had determined that it was a commercial aircraft. They were horrified."

"And this is where I take some responsibility for this mess. If I had been smarter, if I had said it doesn't smell like an F-14, and pushed for a re-evaluation, and if my guys had come forward, saying that's an IFF squawk for a haj [Islamic pilgrim] flight, I might have been stimulated to go back to Rogers and say, 'It looks like you've got COMAIR here.'"

"But I didn't do it, and the investigators walked away from that," Captain Carlson said.

In his book, Captain Rogers said that at 0953, just before the authorized missile firing, he again requested verification of the IFF code being broadcast by track 4131 as that of an Iranian military aircraft. "This was reaffirmed," he wrote.

The information on the transponder emissions is unambiguous, however. According to Admiral Fogarty's report of investigation, "The data from USS *Vincennes'* tapes, information from USS *Sides* and reliable intelligence information corroborate the fact that TN 4131 was on a normal commercial air flight plan profile...squawking Mode 111 6760, on a continuous ascent in altitude from take-off at Bandar Abbas to shoot down."

The number in the 6700-series indicated it was a commercial aircraft.

Both Captain Rogers and Captain Carlson had this information.

"I told the investigators that I believed there was sufficient information, had it been processed properly, to have stopped this thing from happening. And that point is never addressed in their report." Captain Carlson said. And Captain Carlson has a theory about this curious avoidance.

"Why do they walk away? Because if you want to hang Dave Carlson, you've got to hang Will Rogers, then the question is going to be why was he doing this shit in the first place? That means you've got to pull the rope and hang Admiral Less for giving him permission," Captain Carlson said.

"And worse than that, you would then have to go back in front of the American people and say, 'Excuse me, folks, but the explanation you just got from Admiral Crowe, the Chairman of the Joint Chiefs, saying that this was a justifiable action, and that the *Vincennes* was defending herself from an attack, cannot be supported by the facts," Captain Carlson said.

All this, of course, would have come out if information available within days of the tragedy had been made public.

The U.S. Navy's reluctance to face weeks of scandalous media attention was matched by what we might surmise as a certain political hesitancy against full disclosure. The *Vincennes* affair occurred four months away from the 1988 Presidential election. Then Vice President George Bush had gone before the United Nations on 14 July and declared, "One thing is clear, and that is that USS *Vincennes* acted in self-defense.... It occurred in the midst of a naval attack initiated by Iranian vessels against a neutral vessel and subsequently against the *Vincennes* when she came to the aid of the innocent ship in distress."

As it came to pass, none of this was true.

However, the truth of the matter would have given the Democratic candidate for President, Michael Dukakis, ammunition to embarrass George Bush.

There were good reasons for spinning the story in a way that put the Iranians in the worst possible light.

Further, a court martial might have raised many ugly questions about crew training, and more questions about why Admiral Less, with one of the most important and sensitive commands in the world, was not equipped with Link 11 for real-time access to vital tactical information. Add, too, questions about command selection. And ultimately, full disclosure would have led to bedrock questions about professional ethics. For example, what is the obligation of a serving officer like Captain Carlson, an eyewitness to an event, to speak up when the facts as he sees them cast doubt on the "official" story? Indeed, what is the obligation of higher authority to own up to a mistake?

Instead, an incomplete investigation was blessed. Captain Rogers was left in command of the *Vincennes* and, in fact, he and key officers were rewarded with medals for their conduct. As an added fillip, all hands aboard the *Vincennes* and the *Elmer Montgomery* received combat action

ribbons.

The investigation left gaping holes in at least four elements. They could be labeled the four T's -- of time, tactics, truth, and television.

>Time: Admiral Fogarty's investigative report and the approving endorsements dwelt at great length on the confusion and pressure of events in the five minutes preceding Captain Rogers' order to launch missiles at the Airbus, but none of the senior leaders commented on the actions that created the time pressure. Captain Rogers had been cruising at top speed for fully 30 minutes into the fray. If he had proceeded more slowly, Captain Rogers could have purchased more time to sort out the tactical situation on the surface, and perhaps to resolve a second ambiguous track (110 miles away but descending) which he wrote later in his book was a factor in his decision to shoot.

"We weren't leaning on our toes trying to create a problem," Captain Rogers told this writer. However, the course and speed records for his own ship suggest otherwise.

>Tactics: By all accounts Captain Rogers' Aegis cruiser was dispatched hurriedly to the Persian Gulf to counter the threat of Iranian Silkworm antiship missiles. With its 1,100 pound warhead, a 23-foot Silkworm launched from the beach would have severely crippled or sunk any ship it hit. Aegis was the shield.

Instead of positioning his ship to best deal with the Silkworm threat, and to manage the air picture, Captain Rogers stormed into littoral waters. Moreover, he was allowed to hazard this prime asset by higher authority. Admiral Fogarty's report does not question these key matters of tactical judgement, although they are relevant to the employment of Aegis-capable ships in future coastal operations.

>Truth: Admiral Fogarty's investigation accepts the testimony of console operators in the *Vincennes*' combat information center who said the supposed F-14 was diving. However, one officer, Lieutenant William Montford, who was standing right behind Captain Rogers and testified that he never saw indications that the aircraft was descending. At about 0951, Montford warned Captain Rogers that the contact was "possible COMAIR."

The Aegis data tapes agree with his view. Beyond doubt, the console operators' electronic displays showed the aircraft ascending throughout. Admiral Fogarty chalked up the disparity in the statements of the majority to "scenario fulfillment" caused by "an unconscious attempt to make available evidence fit a preconceived scenario." He offered no opinion regarding the veracity of the console operator's statements.

Admiral Fogarty's report also noted that the Iran Air Airbus took off to the southwest, although at least four people in the *Vincennes*' CIC testified that it took off in the other direction, toward the northeast--another major contradiction that is left unresolved.

Captain Rogers' recollections also contain inconsistencies. Case in point: his disclosure on the mysterious track 4474. Recall that the Iranian Airbus was briefly designated as 4474 by the *Vincennes*.

Captain Rogers claimed that a Navy A-6 flying more than 150 miles away was entered into the Naval Tactical Data System by the destroyer Spruance (DD-963) on patrol outside the Persian Gulf, using the same track number, 4474.

According to Captain Roger's explanation, this track was passed that morning to HMS *Manchester*, and through automatic exchange of data among shipboard computers the track appeared on the *Vincennes* display screens at just about the same time the supposed Iranian F-14 (now track 4131) was 20 miles from the *Vincennes*.

The re-appearance of track 4474, Captain Rogers claimed, added to the perception of an in-bound threat and contributed to his decision to shoot.

But Captain Rogers wrote in Storm Center, and Admiral Fogarty's report confirms, that he decided before it was 20 miles away to shoot down the inbound Iranian aircraft. If track 4474 did not re-appear on the screen until it was 20 miles away, then by definition track 4474 could not have been a factor in pushing Captain Rogers to make his initial decision to shoot.

>Television: After the engagement, the Navy camcorder crew boarded one of the *Vincennes*' launches to assess damage to the cruiser. The close-up views of the starboard side of the hull, where Captain Rogers told Admiral Fogarty's investigators shrapnel or spent bullets had struck the ship, are revealing.

Yes, there are dents and scrapes. Most look like the normal wear and tear that would result from the hull rubbing against objects pierside. There are shallow craters in the steel, but at the deepest point, where one would expect that the strike of a bullet would leave bare metal, the paint is in pristine condition.

Not shell craters. Mere dents. It appears that Admiral Fogarty displayed little interest in confirming Captain Rogers' damage report for himself. After all, the *Vincennes* was tied up at Bahrain during the inquiry.

The videotape shows more, such as the navigator on the bridge announcing to the officer of the deck that the *Vincennes* was crossing the 12-mile line demarcating Iran's territorial waters en route to the open waters of the Persian Gulf after the engagement.

The totality of information now available suggests that Captain Rogers "defended" his ship into Iranian territorial waters, and when the air contact appeared, he blew the call.

What has happened since?

Captain Rogers retired in August 1991, and to this day insists, "At no time were we in Iranian territorial waters." "I think it's a problem of semantics," he said in a 2 July 1992 appearance on the "Larry King Show" to publicize his book.

Call it spin control. Call it denial psychosis. Call it what you will, the International Civil Aviation Organization (ICAO) report of December, 1988, clearly placed the *Vincennes* well inside Iran's territorial waters.

Captain David Carlson has written and spoken out publicly criticizing Captain Rogers' account of the tragedy.

"Captain Rogers has got the whole force of the Joint Chiefs of Staff and of the United States Navy supporting him," Captain Carlson said.

"I will be silent as soon as someone else in the Navy stands up for what really occurred," Captain Carlson declared.

Although Captain Carlson has not received a scintilla of support from the top echelon, he has received numerous letters from fellow officers. Some are rather illuminating, such as this extract:

"... I came in contact with Capt. Rogers while he was enrolled in the Commander's Tactical Training Course at Tactical Training Group, Pacific. At the time, I was the Operations Evaluation Group Representative to the staff. As such, I assisted...instructors...in the training wargames...Capt. Rogers was a difficult student. He wasn't interested in the expertise of the instructors and had the disconcerting habit of violating the Rules of Engagement in the wargames. I was horrified, but not surprised, to learn *Vincennes* had mistakenly shot down an airliner." he wrote.

The top military officer involved in the *Vincennes* affair was Admiral William J. Crowe, the Chairman of the Joint Chiefs. His five-page endorsement of Admiral Fogarty's investigation put the rap on Iran for allowing its airliner "to fly directly into the midst of a gunfight."

Admiral Crowe's accusation begs the question: How could the pilot, or the air traffic controllers at Bandar Abbas, possibly have known of the surface engagement under way?

When the *Newsweek* magazine cover story on the *Vincennes* affair appeared last July, headlined "Sea of Lies," Admiral Crowe, now retired, was called to testify before the House Armed Services Committee. Again, he placed much of the blame on the Iranians. Admiral Crowe also trashed the *Newsweek* story for its "slim evidence" and "patently false charges of a cover-up."

But if not a "sea of lies," the official story is hardly a river of truth. The full body of evidence is anything but slim. It includes Admiral Fogarty's investigation, the separate report to ICAO, ships' logs, dozens of interviews, and the 38-minute video recorded by the Navy camcorder crew, just to itemize some of the evidence.

Admiral Crowe conceded in his 21 July 1992 appearance before the House Armed Services Committee that the Aegis tapes pulled from the *Vincennes* definitely showed her crossing into Iranian territorial waters, and the time was known to the second.

Admiral Crowe declared that under the right of innocent passage the *Vincennes* had de facto clearance to enter Iranian waters. Innocent passage? Captain Rogers wasn't passing anywhere. And if not innocent passage, then did he have the right under hot pursuit to pass through the 12-mile line? He was not already engaged. He was not under imminent threat. Indeed, according to the annotated supplement to the Commander's Handbook on the Law of Naval Operations, for hot pursuit to apply the initiating event must occur in the pursuing state's territorial waters.

Neither of Admiral Crowe's conditions apply.

Indeed the pursuit appears to have started at about 0916, when the Iranian boats were at least seven nautical miles away. Visibility was four nautical miles, at best. Sitting low in the water, looking into the haze, the boat's crews would likely have not even been aware initially of the haze-grey cruiser bearing down on them.

Representative Larry Hopkins (R, KY), questioning Admiral Crowe, asked, "Do you find any fault...with what Captain Rogers did under the circumstances?"

Admiral Crowe answered that he did not find "malperformance of a criminal nature."

The subtlety of this point apparently slipped by Representative Hopkins and his colleagues, but Admiral Crowe's remark should raise eyebrows among naval professionals. What he said, in effect, was that Captain Rogers cannot be held accountable because he was not criminally negligent. Yet under military law a commander can be held accountable for a non-criminal act -- a major difference from civil jurisprudence.

A retired Army colonel who attended the hearing was surprised and disappointed by Admiral Crowe's testimony.

As part of a four-page commentary on this hearing, he wrote: "Graduate seminars of my day would mine the admiral's words to prove our Navy is too dangerous to deploy...."

I see a sole winner in the Navy's present struggle. It is not the nation, but the Air Force's contractors. I shudder, not at paying for the hardware that will come, but for the piper who waits near the door," this colonel concluded glumly.

And this remark came from an officer who knows how vital the Navy's role in littoral waters will be in coming years. Indeed, the latest maritime strategy document, issued 1 October and titled "...From the Sea," redirects the Navy's Cold War focus on open-ocean combat with a now-nonexistent Soviet fleet to "littoral or 'near land' areas of the world."

The *Vincennes* affair is more relevant than ever as a vivid example of the kind of military-political gymnastics in which the Navy may be engaged in coming years. It is important for the Naval Service and for all Americans to look at the events that July day five years ago objectively, and to learn, especially since Iran continues to be demonized as a threat to stability in the region.

Basic facts are still in dispute. The full text of Admiral Fogarty's investigation merits declassification, and especially the geographic track files of the vessels and air contacts involved. Indeed, the secrecy still surrounding the Airbus shootdown only serves to conceal ethical and operational weaknesses from ourselves.

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 8 **HOURS: 2**

TITLE: Electronic Warfare

I. Learning Objectives

A. The student will comprehend the basic principles of electronic warfare (EW) and the three divisions of EW: electronic support (ES), electronic attack (EA), and electronic protection (EP).

B. The student will know the role of active and passive electronic warfare in the fleet operations.

C. The student will know the basic characteristics and requirements of electronic warfare receivers.

D. The student will comprehend the principles and the categories of EA.

E. The student will comprehend the principles of EP.

F. The student will comprehend the parameters of radars and radar systems pertaining to EP.

G. The student will know the basic EW capabilities of U.S. Naval platforms.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 11

2. Introduction to Radar Systems, Chap. 12

3. Jane's All the World's Aircraft

4. Jane's Fighting Ships

5. Jane's Naval Weapons Systems

6. The Naval Institute Guide to World Naval Weapons Systems

7. "Slick Warriors and the '32'"

B. Student text: Principles of Naval Weapons Systems, Chap. 11

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

NOTE: The transparencies have the former electronic warfare terms, but they are still good teaching aids if the instructor points out the terminology changes to the students. (See "NOTE" in paragraph V below.)

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chap. 11

V. Presentation

NOTE: In 1994, the Navy made the following terminology changes which are not reflected in most references:

1. Electronic support measures (ESM) has been changed to electronic support (ES).

2. Electronic countermeasures (ECM) has been changed to electronic attack (EA).

3. Electronic counter-countermeasures (ECCM) has been changed to electronic protection (EP).

A. Introduction

1. Electronic warfare (EW) is a component of command and control warfare (C2W).

2. C2W is defined as the military strategy which implements information warfare (IW). C2W includes the integrated use of operations security (OPSEC), military deception, psychological operations (PSYOPS), electronic warfare (EW), and physical destruction.

3. C2W will be discussed in more detail in Lesson 9, "C^4ISR and Information Warfare."

4. EW has become increasingly important.

   a. Increased reliance on radar and over-the-horizon targeting.

   b. Increased use of communications and tactical data systems.

   c. Increased speed of missiles and weapon systems requires high speed detection and tracking.

   d. Active-homing or passive-homing long-range missiles give little warning.

B. Introduce the basic electronic warfare terminology, including abbreviations and definitions:

   1. Electronic support (ES): Surveillance of the electromagnetic spectrum for immediate threat recognition and other tactical actions such as threat avoidance, homing, and targeting.

   2. Electronic attack (EA): The use of electromagnetic or directed energy to attack personnel, facilities, or equipment with the intent of degrading, neutralizing, or destroying enemy combat capability.

   3. Electronic protection (EP): The protection of friendly combat capability against undesirable effect of friendly or enemy employment EW.

C. Discuss electronic support (ES).

   1. Passive EW

      a. Electronic intelligence (ELINT): Information derived from foreign non-communications electromagnetic information, particularly radar emissions.

      b. Communications intelligence (COMINT): Information derived from foreign communications transmissions by other than the intended recipients.

      c. Advantages and limitations of passive EW.

   2. Subdivided into:

      a. Threat warning and avoidance

      b. Direction finding

      c. Target homing and tracking

   3. ES receiver design requirements

a. Wide spectrum surveillance

b. Wide dynamic range

c. Unwanted signal rejection

d. Angle-of-arrival measurement

e. Signal analysis capability

f. Display

g. Recording system

4. Signal collection process

a. Signal warning

b. Signal sorting

c. Signal analysis

D. Discuss electronic attack (EA).

1. Active and passive EW

2. Nondestructive EA

a. Confusion: Mask or hide real targets by cluttering the radar display

(1) Jamming

(a) Noise jamming

(b) Spot jamming

(c) Barrage jamming

(d) Sweep jamming

(2) Chaff

(3) Infrared flares (Torch)

b. Deception: To create a false image (create a false target for the enemy to see on their displays) or change the image’s characteristics on the enemy’s radar display (enlarge or shrink the image)

(1) Repeaters: Create a false echo by delaying the received radar signals and retransmitting at a slightly later time

(2) Transponders: Create a false signal by playing back a stored replica of the radar signal

(3) Chaff

(4) Radar decoys

(5) Blip enhancers

(6) Radar cross-section modification

3. Destructive EA

a. Anti-radiation missiles

(1) SLAM

(2) HARM

(3) Sidewinder

b. Directed energy

4. Advantages and limitations of passive EA

5. Advantages and limitations of active EA

E. Discuss electronic protection (EP).

1. Passive and active EW

2. Radar design

a. Power

b. Frequency

c. Pulse repetition frequency (PRF)

d. Pulse length

e. Antenna design

f. Scan pattern

3. Burnthrough: Increase signal strength to overpower jammer noise

4. Emission control (EMCON)

5. Operator training

6. Advantages and limitations of passive EP

7. Advantages and limitations of active EP

F. Discuss the basic EW capabilities of U.S. Naval platforms.

1. Shipboard EW

a. SLQ-32 Sidekick

(1) Radar warning, detection, and jamming

(2) Uses and internal library to automatically detect and categorize

(3) Found on all combatants

b. Infrared flares: All combatants

c. Chaff: All combatants

d. SSQ-108 Outboard

(1) Real-time, over-the-horizon passive detection, localization, and targeting

(2) *Spruance* class (DD-963)

e. SLQ-49 chaff buoy: *Arleigh Burke* class (DDG-51)

2. Airborne EW

a. ALQ-99 EW system

(1) Detection, identification, tracking

(2) Communication, data link, and radar jamming

(3) Deception: Mimics radar signals

(4) EA-6B *Prowler*

b. ALQ-126 EA system

(1) Radar jamming

(2) F-14 *Tomcat* and F/A-18 *Hornet*

c. ALQ-142 ES system

(1) Detection, identification, location

(2) SH-60 *Seahawk*

d. ALQ-165 EA system

(1) Radar jamming

(2) F/A-18 *Hornet*

e. ALR-47 ES system

(1) Detection, identification, location

(2) S-3 *Viking*

f. ALR-73 ES system

(1) Detection, direction-finding, signal data collection

(2) E-2 *Hawkeye*

g. Chaff: SH-60 *Seahawk*

G. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 9 **HOURS: 2**

TITLE: C^4ISR and Information Warfare

I. Learning Objectives

A. The student will know the concept of command, control, communications, computers, intelligence, surveillance, and reconnaissance (C^4ISR) within the armed forces.

B. The student will know the concept of command and control warfare (C2W) within the armed forces.

C. The student will know the characteristics, advantages, and disadvantages of various communication frequency ranges.

D. The student will be familiar with the procedures for effecting communications security, including the common causes of security compromise and the safeguard methods to prevent unauthorized disclosure.

E. The student will know the use of computers and digital electronics in naval and maritime communications.

F. The student will know the significance of intelligence in the application of naval warfare.

1. The student will know the definition of intelligence as it applies to naval warfare.

2. The student will comprehend the scope of naval intelligence.

G. The student will comprehend the role of information warfare (IW) in national security.

1. The student will know of the concept of IW.

2. The student will know of the concept of information infrastructure.

3. The student will know the opportunities and vulnerabilities associated with the concept of IW (defensive and offensive).

H. The student will comprehend the basic application of space and electronic warfare in naval operations.

1. The student will know the military space roles, including the role of space systems in strategic and tactical command and control architectures.

2. The student will know the military opportunities and applications in space.

   a. The student will know the principles of space-based communications.

   b. The student will know the basics of space-based remote sensing and applications to space-based surveillance opportunities.

3. The student will know how to utilize space assets and information for mission planning.

II. References and Texts

A. Instructor references

1. "C^4I for the Warrior," Surface Warfare magazine

2. Doctrine for Command, Control, Communications, and Computer (C^4) Systems Support to Joint Operations

3. Joint Warfare of the U.S. Armed Forces

4. Joint Vision 2010

5. Force 2001: A Program Guide to the U.S. Navy

6. Forward...From the Sea

7. ...From the Sea

8. Naval Command and Control

9. Naval Intelligence

10. Naval Warfare

11. "...Now Build the Best," Surface Warfare magazine

12. Principles of Naval Weapons Systems, Chap. 20

13. What Is Information Warfare?

14. The Naval Institute Guide to World Naval Weapons Systems

B. Student texts

1. Principles of Naval Weapons Systems, Chap. 20

2. Naval Intelligence

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

3. Invite PNS or other post-command staff as guest lecturer

B. Procedural and student activity options

1. Study or research assignment

2. Reading assignments

a. Principles of Naval Weapons Systems, Chap. 20

b. Naval Intelligence, Chap. 1 (minimum)

V. Presentation

A. Discuss C^4ISR.

1. Command, control, communications, computers, intelligence, surveillance, and reconnaissance are the information and decision support systems to assist commanders at all levels to plan, direct and control their activities.

2. Explain why C^4ISR is necessary.

a. Operations in the littoral environment require faster response times.

b. Joint operations require higher levels of coordination and communication between forces.

c. More sophisticated weapons systems require higher situational awareness and more information to the operator/shooter as well as to the commander.

3. C^4ISR has four functions.

a. Creates a common tactical picture. All information is shared by operators and tactical commanders, who can extract the pieces relevant to their specific needs and tactical situation.

b. Ensures connectivity. Ensures rapid and reliable information exchange. Global Information Exchange System (GLOBIX) and Tactical Data Information Exchange System (TADIXS) are examples. Refer to Force 2001 for more current/future examples.

c. Directly links sensor-to-shooter. Focuses on the process of putting a weapon on target. Ensures all information is directly available to system operators, from surveillance to identification, targeting, engagement, guidance, and battle damage assessment (BDA).

d. Supports and uses information warfare (IW). IW is used to avoid hostilities or gain an information advantage before weapons are deployed or plans are executed.

4. C^4ISR supports the warfighter at all levels.

a. The watchstander

b. The composite warfare commanders

c. The commander of joint task force

d. The shore commanders

B. Command and control (C2), command and control warfare (C2W)

1. C2 is the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission.

2. C2W is actions taken to deny information to, influence, degrade, or destroy adversary command and control capabilities, while protecting friendly command and control capabilities against such actions.

3. Objectives of C2W

a. Defeat the enemy by destroying its C2W system

b. Separate the enemy's command structure from its forces

c. Protect one's own C2W systems

d. Connect commanders and forces

4. C2W is based on the philosophy that preventing an enemy's use of its forces may be just as good as defeating that force.

5. C2W has five tools to achieve its objectives.

a. Operations security (OPSEC): Prevents information on one's own operations from being discovered by an enemy's command and control systems.

Example: Not publishing ship departure/arrival information.

b. Military deception: Gives enemy commanders information that misleads them about one's own operations.

Example: After the Iraqi invasion of Kuwait, allied forces amassed on Kuwait's southern border to give the impression that the offensive would come from the south. Additionally, a massive amphibious force stood off Kuwait's coast, preparing for a landing. Leaks to the press led to considerable media coverage of an imminent amphibious landing and ground offensive from the south. However, General Schwartzkopf deftly moved troops to the Northwest before countering Iraqi troops by surprise, allowing allied forces to pin Iraqi troops between the southern edge of Kuwait and the Persian Gulf.

c. Psychological operations: Delivers information to enemy forces in ways that make it difficult for enemy leaders to influence or control their forces or population.

Example: Leaflets dropped on Iraqi troops during Operation Desert Storm.

d. Electronic warfare: Example is jamming; HFDF.

e. Physical destruction: Attacks upon enemy command and control assets.

Example: Tomahawk strikes against Iraqi AAW radar sites to retaliate for unauthorized troop movement in the northern no-fly zone.

6. The C2W decision-making process is based on the OODA loop.

a. OODA is observe, orient, decide, act.

b. Requires intelligence at all stages.

c. Commanders must complete the OODA loop faster and more effectively than the enemy.

d. C2W can slow down the enemy's OODA loop while speeding up one's own OODA loop.

7. Space systems play a significant role in strategic and tactical command and control.

a. Satellite communication systems

b. Satellite-based intelligence and information systems

c. Required to collect and disseminate information to shore-based commanders for mission planning

C. Discuss communications.

1. Satellite communications

a. Connects forward-deployed tactical units with shore-based decision support centers

b. UHF satellite communications

(1) Limited to a relatively narrow bandwidth

(2) Low, unprotected data rates

c. SHF satellite communications

(1) High data rates and high capacity

(2) Access to joint C^4I systems

(3) Initially, antennas were large (>7 ft diameter), but latest version expected to be 4-7 ft diameter. Antenna size is related to the gain (power), not the frequency of the signal.

d. EHF satellite communications

(1) Anti-jam, anti-scintillation

(2) Low interception and detection probability

(3) Will be installed on shore stations, submarines, and ships

2. Discuss the uses of different frequencies and the

advantages and disadvantages of each.

a. LF: Long-range communications (marine communications, navigational aids)

b. HF: Long-range communications (back-up for satellite-based fleet communication systems)

c. VHF: Short-range communications (safety, bridge to bridge, and Coast Guard)

d. UHF-line of sight: Short-range communications (battle group)

3. Tactical data communication systems

a. The most important communication system during combat situations is a real-time, common track picture available to all units.

b. The Navy predominantly uses Link 11, Link 16, and Link 4A to exchange tactical information between operational units.

(1) Link 11/TADIL A (Tactical Digital Information Exchange Link A)

(2) Link 16/TADIL J/JTIDS (Joint Tactical Data Link System)

(a) To replace Link 11

(b) Extends the composite warfare commanders' tactical picture to include joint and allied information

(c) Secure, jam-resistant, high data rate

(3) Link 4A/TADIL C

c. Advanced Combat Direction System (ACDS)

(1) Combines tactical data from Links 4A, 11, and 16 with onboard and off-board weapon and sensor data.

(2) Produces a coherent, operator-tailored tactical display for non-Aegis ships.

(3) ACDS Block O installed in 12 CV/CVN's, 4 LHD-1's, and several combatants. ACDS Block 1 in CVN-69 and LHD-1, and currently being installed on others.

4. Communication security (COMSEC)

   a. The protection resulting from all measures designed to deny unauthorized persons information from the possession and study of telecommunications

   b. Communication security management system (CMS): System to ensure communication security

   c. Composed of four elements

      (1) Cryptosecurity: Actions to ensure the proper use and maintenance of cryptosystems

      (2) Transmission security: Measures to protect transmissions from interception and exploitation

      (3) Emission security: Measures to deny unauthorized individuals information that can be derived by intercepting and analyzing emissions from telecom-munications systems

      (4) Physical security: Physical measures to safeguard communications equipment, material, and documents

   d. Discuss the common causes of security compromise.

D. Discuss computers.

1. The quantity of information requires effective information management only possible by computer systems.

2. Computers are required to sort, process, organize, correlate, and disseminate information.

3. Computers are required to maintain the real-time element in the information exchange.

4. Required for all elements of C^4I

   a. Blend critical tactical, operational, and administrative data to the warfighter so tactical objectives drive operations.

   b. Deliver rapid information to operational commanders; allow commanders to access the information through a "pull" vice "push" system.

c. Present information in a multimedia format to best suit the operator or the equipment.

d. Standardize the equipment to reduce training and increase proficiency.

e. Standardize hardware designs to allow upgrade and additions to equipment.

E. Discuss intelligence.

1. Definition of intelligence

a. Product resulting from the collection, exploitation, processing, integration, analysis, evaluation, and interpretation of available information concerning foreign countries or areas.

b. Distinguish between information and intelligence. Integration and analysis, combined with a thorough understanding of mission requirements, convert *information* into useable *intelligence.*

2. Scope of intelligence. Naval intelligence is used at several levels to support policy, planning, and operations.

a. Strategic intelligence: For plans and policies at the national and international level

b. Operational intelligence: For plans and operations within a region or theater; for employment of forces

c. Tactical intelligence: For tactical operations at the component or unit level; for immediate actions

3. Functions of intelligence

a. Prepares the battlespace

(1) Defines environmental or physical characteristics

(2) Evaluates threat

(3) Determines the threat's course of action

b. Provides early warning

c. Evaluates the situation: Evaluates the

threat based upon current action and changing situations

d. Identifies and targets the enemy's vulnerabilities

e. Assesses battle damage: Assesses own and enemy's equipment, forces, and C2W

f. Manages intelligence information

g. Prevents enemy's offensive and defensive intelligence efforts

4. Intelligence uses information warfare (IW).

a. IW is action taken to achieve information superiority by affecting adversary information, information-based processes, information systems and computer-based networks while defending one's own information, information-based processes, information systems and computer-based networks.

b. The information infrastructure is comprised of three components, which intermesh to provide the "BIG PICTURE" (GCCS). The three components are:

(1) Surveillance grid

(a) Satellites

(b) Electronic warfare and signals intelligence

(c) Human intelligence

(2) Communication grid (i.e. - INMARSAT)

(3) Tactical grid (i.e. - JMCIS)

(a) Computers

(b) Database management

c. IW subsumes C2W, which is centered on a military command and control target set. IW has an expanded target set, to include both offensive and defensive IW planning and execution.

d. Offensive IW (opportunities)

(1) Offensive IW will degrade or exploit an

adversary's collection or use of information.

(2) Examples

(a) "Antihead" method: Traditional means of removing the commander or command center

(i) Requires knowledge of commander/command center location.

(ii) Knocking out command center systems can effectively destroy the enemy.

(iii) Example: Precision attack to destroy an enemy's command and control capability.

(b) "Antineck" method: Nontraditional method of cutting enemy's communications

(i) Enemy's command and control becomes disabled.

(ii) Effectiveness depends on enemy's reliance on communication networks.

(iii) Example: Electronic intrusion into an information and control network to convince, confuse, or deceive enemy military decision makers.

e. Defensive IW (vulnerabilities)

(1) Defensive IW is the protection of our ability to conduct information operations.

(2) Examples

(a) Physical security measures

(b) Encryption

(c) Antivirus protection

(d) Secure data transmissions

F. Discuss space and electronic warfare.

1. Space dominance is integral to strategic and tactical command and control architectures.

   a. C^4I assets are delivered to deployed forces via space. (Example, see "...Now Build the Best," p. 25.)

   b. The flow of command and control resources and information to and from the fleet is dependent on space systems.

2. Military opportunities and applications in space include space-based communications, sensing, and surveillance.

   a. UHF satellite communications are used worldwide for information exchange, navigation, surveillance, identification, tracking and other reasons.

   b. SHF/EHF satellite communications available on limited basis to provide greater range of available frequencies, and to protect communications against scintillation effects associated with nuclear blasts

   c. Strategic/Ballistic missile attacks can be warned against from remote infrared sensors in space.

3. Some mission planning is dependent on information derived from space assets.

   a. Meteorological data for voyage/operation planning

   b. Preview *lay of the land* before execution of mission, to include terrain, ocean depth, shoreline characteristics, vehicle/aircraft trafficability

G. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 10 **HOURS: 3**

TITLE: Principles of Underwater Sound

I. Learning Objectives

A. The student will comprehend the physical properties associated with sound travel in water.

B. The student will know why sound energy is employed for underwater surveillance and detection.

C. The student will comprehend sound propagation losses due to spreading, absorption, scattering, and bottom loss.

D. The student will comprehend the concepts of self-noise and ambient noise, including the sources and effects.

E. The student will comprehend the concepts of signal-to-noise ratio and its application to underwater sound.

F. The student will comprehend and be able to apply the basic sonar equations for passive and active sonar and will comprehend the concept of figure of merit (FOM).

G. The student will comprehend the effects of temperature, pressure, and salinity on sound speed values.

H. The student will know the basic thermal and sound-velocity structure of the ocean.

I. The student will comprehend the use of Snell's Law in determining sound ray path structure.

J. The student will comprehend the concept of sound ray traces.

K. The student will comprehend the three basic sound-speed gradients and how they affect sound propagation to produce the following paths: surface duct, shadow zone, sound channel, convergence zone, and bottom bounce.

L. The student will comprehend the basic properties of ocean currents.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 8

2. Principles of Underwater Sound, Chaps. 1, 2

B. Student text: Principles of Naval Weapons Systems, Chap. 8

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

E. VCR/Monitor

F. Videotape: "Underwater Sound Raypath Theory"

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignments

2. Reading assignment: Student text, Chap. 8

V. Presentation

A. Describe the reasons why sound energy is used for underwater surveillance and detection.

1. Range of penetration in the medium

2. Ability to differentiate between objects in the medium

3. Speed of propagation

B. Discuss the fundamental concepts of sound propagation.

1. Three elements required to produce sound

a. Source: Any vibrating object

b. Medium

c. Detector/Receiver

2. The vibrating object causes a series of compressions and rarefactions in the medium.

3. Review the relationship between frequency and wavelength.

C. Describe factors contributing to transmission loss.

1. Spreading (divergence)

2. Attenuation

a. Absorption

(1) Process of converting acoustic energy into heat

(2) Increases with higher frequency

b. Scattering and reverberation

(1) Volume: Marine life, bubbles, etc.

(2) Surface: Function of wind speed

(3) Bottom loss

(a) Not a problem in deep water

(b) Significant problem in shallow water combined with refraction and absorption into bottom

3. Explain how to compute total propagation loss.

D. Describe sources and effects of background noise.

1. Self-noise

a. Machinery

b. Flow noise

(1) Ship speed

(2) Marine fouling

c. Cavitation

2. Ambient noise

a. Hydrodynamic noise

b. Seismic noise

c. Ocean traffic

d. Biological noise

E. Explain the terms associated with the basic sonar equation.

1. Signal-to-noise ratio (S/N)

2. Detection threshold (DT)

3. Equipment parameters

a. Own sonar source level (SL)

b. Self-noise level (NL)

c. Receiving directivity index (DI)

4. Environmental parameters

a. Transmission loss (TL)

b. Reverberation level (RL)

c. Ambient noise level (NL)

5. Target parameters

a. Target strength (TS)

b. Target source level (SL)

F. Explain the passive sonar equation: For a target to be detected, (DT) must be less than or equal to (SL - TL - NL + DI).

G. Explain the active sonar equation: For a target to be detected, (DT) must be less than or equal to:

1. (SL - 2TL + TS - NL + DI) in a noise-limited situation

2. (SL - 2TL + TS - RL) in a reverberation-limited situation (RL = NL - DI)

H. Explain figure of merit (FOM).

1. Measure of sonar capability

2. Passive FOM formula: For a detection probability of 50 percent, the maximum transmission loss is (SL - NL + DI - DT).

3. Active FOM formula: For a detection probability of

50 percent, the maximum transmission loss is (SL + TS - NL + DI - DT).

4. Methods to improve FOM

5. Uses of FOM

   a. Equipment tuning to peak performance

   b. Prediction of detection ranges (if propagation losses are known)

I. Discuss the speed of sound in the ocean.

1. Speed of sound is affected by the medium.

   a. Elasticity

   b. Density

   c. The speed of sound in a fluid is dependent upon volume elasticity (bulk modulus) and density.

2. Variables affecting the speed of sound

   a. Salinity: An increase in salinity of one part per thousand (ppt) will result in an increase in the speed of sound of approximately 1.3 m/sec.

   b. Pressure

      (1) More important than salinity.

      (2) Every meter of depth increase results in a 0.017 m/sec increase in sound speed.

   c. Temperature

      (1) Predominant factor above 1,000 meters.

      (2) An increase in temperature of one degree Celsius will cause a corresponding increase of 3 m/sec in sound speed.

3. Thermal characteristics of the ocean

   a. Surface layer

   b. Seasonal thermocline

   c. Permanent thermocline

   d. Deep isothermal layer

4. Typical deep-sea sound velocity profile

a. Sound velocity profile is a composite of the pressure, salinity, and temperature profiles.

b. Temperature is the dominant factor.

5. Ocean currents can create an unexpected thermal layer.

a. Traps sound waves

b. Can be advantageous (extends range) or not (prevents sound waves from reaching the receiver)

6. Ocean fronts

a. Narrow zones separating water masses of different characteristics

b. Usually exhibit large horizontal gradients of temperature and pressure

J. Discuss ray propagation theory.

1. Snell's Law

2. Ray traces

3. "Sound is lazy": Sound bends towards areas of slow speed.

(a) Isothermal: Sound speed constant, so sound travels in a straight line from source.

(b) Positive gradient: Sound speed increases with depth so sound waves bend up.

(c) Negative gradient: Sound speed decreases with depth so sound waves bend down.

K. Describe propagation paths for various conditions.

1. Layer depth phenomena

2. Surface duct

3. Shadow zone

4. Sound channel

5. Convergence zone (CZ)

6. Bottom bounce

L. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 11 **HOURS: 2**

TITLE: Underwater Detection and Tracking Systems

I. Learning Objectives

A. The student will comprehend the application of the physical properties associated with sound travel in water to sensing and detection systems.

B. The student will comprehend the basic theory and operation of active and passive sonar systems.

C. The student will comprehend the basic principles of magnetic anomaly detection (MAD).

D. The student will know the three basic types of transducers and will comprehend the basic theory and operation of transducers.

E. The student will comprehend the theory and operation of hydrophones.

F. The student will comprehend the differences between active and passive sonar systems, including the advantages and disadvantages of each system.

G. The student will know the various other sonar systems, including sonobuoys, dipping sonar systems, tactical towed array sonar systems, and sound surveillance systems (SOSUS).

H. The student will comprehend the fundamentals of sound energy doppler and how it is used to determine target aspect and motion.

I. The student will know the methods of acoustic countermeasures.

J. The student will know the basic ASW capabilities of the major U.S. Navy platforms.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chaps. 9, 11

2. Jane's All the World's Aircraft

3. Jane's Fighting Ships

4. Jane's Naval Weapon Systems

5. The Naval Institute Guide to World Naval Weapons Systems

6. Principles of Underwater Sound, Chaps. 3, 4, 13

B. Student text: Principles of Naval Weapons Systems, Chaps. 9, 11

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies and PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

E. VCR/Monitor

F. Videotape: "Tracking the Threat"

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chaps. 9, 11

V. Presentation

A. Discuss magnetic anomaly detection (MAD).

1. Basic operation

2. Advantages/Disadvantages over sonar systems

B. Explain basic sonar systems.

1. Active/Echo ranging systems

2. Passive/Listening systems

C. Discuss transducer theory.

1. Types of devices

a. Crystal

b. Ceramic

c. Magnetostrictive

2. Hydrophones

3. Directivity

4. Power

D. Describe active sonar systems.

1. Searchlight echo ranging (early sonar)

a. Operation

b. Limitations

2. Scanning sonar systems

a. Operation

b. Principal advantages over searchlight system

3. Displays

a. Scanning switch operation

b. Sonar cathode ray tube (CRT)

E. Describe passive sonar systems.

1. Purpose/Function

2. Hydrophone arrays

a. Cylindrical

b. Conformal

c. Spherical

F. Discuss the following advantages and disadvantages of active and passive sonar systems.

1. Limitations of sonar due to the physical properties of sound travel in water

2. Limitations of active and passive sonar in detection

3. Limitations of active and passive sonar in tracking

G. Discuss the following types of sonar and compare to hull-mounted sonar.

1. Tactical towed array sonar system (TACTAS)

2. Sonobuoys

a. Passive

b. Active

c. Special purpose

3. Dipping sonar

4. Sound surveillance system (SOSUS)

H. Describe the use of doppler in ASW.

1. Up doppler

2. Down doppler

3. Doppler degree

4. Target aspect

I. Discuss the tactical considerations of sonar employment.

1. Items under the control of the ASW commander

2. Items not under the control of the ASW commander

J. Discuss acoustic emission control (EMCON) and acoustic countermeasures.

K. Describe the ASW capabilities of various U.S. Navy platforms.

1. Surface ships

a. *Ticonderoga* class (CG-47), *Arleigh Burke* class (DDG-51), and *Spruance* class (DD-963) have similar systems.

(1) Sensors

(a) SQS-53 bow-mounted sonar

(b) SQR-19 passive towed array (TACTAS)

(c) SQQ-89 system combines input from both sensors

(2) Weapons: Mk-46 torpedoes, to be replaced

by Mk-50

c. *Oliver Hazard Perry* class (FFG-7)

(1) Sensors

(a) SQS-56 or SQS-53 bow-mounted sonar

(b) SQR-19 passive towed array (TACTAS)

(c) Most ships have the SQQ-89 system which combines input from sensors.

(2) Weapons: Mk-46 torpedoes, to be replaced by Mk-50

2. Aircraft

a. P-3 *Orion*

(1) Sensors

(a) MAD

(b) Up to 100 sonobuoys

(2) Weapons: Mk-46 torpedoes, to be replaced by Mk-50

b. S-3 *Viking*

(1) Sensors

(a) MAD

(b) Up to 60 sonobuoys

(2) Weapons

(a) Mk-46 torpedoes, to be replaced by Mk-50

(b) Mk-54 depth charges

c. SH-60 *Seahawk*

(1) Sensors

(a) MAD

(b) Up to 25 sonobuoys

(c) AQS-13F dipping sonar

(2) Weapons

(a) Mk-46 torpedoes, to be replaced by Mk-50

(b) Depth bombs

d. SH-3 *Sea King*

(1) Sensors

(a) MAD

(b) Up to 25 sonobuoys

(c) AQS-13 dipping sonar

(2) Weapons

(a) Mk-46 torpedoes, to be replaced by Mk-50

(b) Depth bombs

3. Submarines: *Los Angeles* class (SSN-688)

a. Sensors

(1) BQQ-5 hull-mounted sonar

(2) BQR-23/25 passive towed array

b. Weapons: Mk-48 torpedoes

L. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 12 **HOURS: 2**

TITLE: Military Explosives/Warheads

I. Learning Objectives

A. The student will comprehend the fundamental chemical and physical principles of conventional and nuclear warheads.

B. The student will comprehend the principles of explosives.

C. The student will know the basic categories of chemical explosives.

D. The student will know the characteristics that determine the suitability of explosives for military use.

E. The student will know the functional parts of a basic warhead.

F. The student will comprehend the principle effects of detonating nuclear and conventional warheads, including the varying effects of blast, heat, and initial radiation from a nuclear burst.

G. The student will comprehend the high-explosive train and the mechanics of detonation.

H. The student will comprehend the principles of operation of various warheads.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chaps. 12, 13

2. Damage Controlman 3&2, Chaps. 8, 9

3. Jane's Naval Weapon Systems

4. The Naval Institute Guide to World Naval Weapons Systems

B. Student text: Principles of Naval Weapons Systems, Chaps. 12, 13

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

E. VCR/Monitor

F. Videotape: "Development of Military Explosives"

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chaps. 12, 13

V. Presentation

A. Define explosion.

B. Explain the characteristics of military explosives.

1. Availability and cost

2. Sensitivity

3. Stability

4. Power/Performance

5. Brisance

6. Density

7. Volatility

8. Hygroscopicity

9. Toxicity

C. Discuss the mechanism of a chemical explosive reaction.

1. Changes occur in the electron configurations, causing rapid decomposition or rearrangement of the compound.

2. The four features common to all chemical explosives are as follows:

a. Formation of gases

b. Evolution of heat

c. Rapidity of reaction

d. Initiation of reaction

D. Discuss the categories of chemical explosives.

1. Low explosive: For propulsion

2. High explosive: For weapons

a. Primary (sensitive)

b. Secondary (insensitive)

E. Discuss the mechanism of a nuclear explosive reaction.

1. Explosion caused by uncontrolled nuclear fission

a. Atoms of unstable isotopes are split by high speed neutrons.

b. The split of the nucleus creates energy and more neutrons.

c. These neutrons go on to split more nuclei, creating a chain reaction.

2. Blast: Shock wave and negative suction wave

3. Creation of heat and radiation

4. Energy released during a nuclear reaction is much greater than the energy released during a chemical reaction (equal weight of material).

5. Nuclear weapons are used because they create a highly destructive shock wave, not because they produce radiation.

6. The use of nuclear weapons is minimal.

F. Describe the functional parts of a simple warhead.

1. Fuze

2. Explosive fill

3. Warhead case

G. Explain the process of a high-explosive train.

1. Initiating force (detonator)

2. Auxiliary explosive (booster)

3. Main charge

4. The shock wave travels from the detonator, is reinforced by the booster, and activates the main charge.

H. Discuss warhead characteristics.

1. Damage volume

2. Attenuation

3. Propagation

I. Discuss warhead types and the effects of detonation.

1. Blast

a. Conventional

(1) Creates shock wave followed by negative suction

(2) Examples

(a) Tomahawk (TASM, TLAM-C)

(b) Harpoon

(c) Phoenix

(d) AMRAAM

b. Underwater

(1) Creates a series of high pressure bubbles

(2) Examples

(a) Mines

(b) Depth charges

c. Nuclear

(1) Creates shock wave followed by negative suction, heat, radiation

(2) Examples

(a) Trident

(b) Tomahawk (TLAM-N)

d. Mach effect: Used to increase the effect of a blast warhead

2. Fragmentation

a. Damage due to velocity and material

b. Examples

(1) SM-2

(2) Sidewinder

(3) HARM

3. Shaped charge

a. Impact causes casing to collapse, resulting in a high-velocity jet of armor-piercing liquid.

b. Example: Mk-50 torpedo

4. Continuous rod

a. Damage by high-speed, radially-expanding rods

b. Examples

(1) SM-1

(2) Sparrow

5. Special purpose

a. Thermal

b. Biological and chemical

c. Radiation

d. Pyrotechnics

e. Antipersonnel

f. Chaff

g. Cluster bombs

h. Mines

i. Torpedoes

j. Antitank

J. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 13 **HOURS: 1**

TITLE: Fuzing

I. Learning Objectives

A. The student will comprehend the basic functions of a fuze system in a conventional or nuclear warhead.

B. The student will comprehend the functions of the three basic fuze components: target sensors, safing and arming devices, and detonators.

C. The student will know the basic types of fuzes.

D. The student will comprehend the concepts of reliability and redundancy as they apply to safety and arming.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 14

2. Jane's Naval Weapon Systems

3. The Naval Institute Guide to World Naval Weapons Systems

B. Student text: Principles of Naval Weapons Systems, Chap. 14

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chap. 14

V. Presentation

NOTE: This lesson applies to both nuclear and conventional fuzes; it is unnecessary to distinguish between the two in this course.

A. Discuss the basic concepts of fuzing.

1. Definition of fuze

2. Four functions of a fuze system

a. Keep the weapon safe

b. Arm the weapon

c. Recognize or detect the target

d. Initiate the detonation of payload

3. Three components of a fuze

a. Detonator

b. Target sensor/Target detection device (TDD)

c. Safing and arming device (S&A device)

B. Fuzes are categorized by the manner of fuze operation (i.e., by target sensor).

1. Impact or contact (backup fuzes)

a. Sidewinder

b. Mk-46 torpedo

c. Tomahawk

d. Harpoon

2. Ambient

a. Senses particular environment

b. Example: Depth charges

3. Timer (including delay)

a. Example: Hand grenades

b. Impact fuzes can be combined with a timer to ensure the weapon is deep within its target

before detonation.

4. Proximity: Can be active, semi-active, or passive

   NOTE: Differentiate a TDD from a guidance device.

   a. Electromagnetic

   b. Magnetostatic

   c. Acoustic

   d. Seismic

   e. Examples

      (1) SM-2

      (2) Sidewinder

      (3) Sparrow

      (4) Mines

5. Command detonate

6. Combination (two or more of above types)

C. Discuss the safing and arming device concept.

1. Safing and arming devices isolate detonator from booster.

2. Activation forces

   a. Time

   b. Acceleration (setback)

   c. Deceleration (creep)

   d. Centrifugal force

D. Explain redundancy as it applies to fuze system safety and reliability.

1. Safing and arming devices are arranged in series for safety.

2. Detonators and target sensors are arranged in parallel for reliability.

3. Use mathematical illustrations to prove system design provides a safe and reliable fuze.

E. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 14 **HOURS: 1**

TITLE: Guidance and Control Principles

I. Learning Objectives

A. The student will comprehend the purpose and function of a guidance and control system.

B. The student will know the three phases of guidance.

C. The student will comprehend how control, homing, and self-contained guidance systems are utilized singularly and together to direct missiles to their intended target.

D. The student will comprehend the basic operation of accelerometers.

E. The student will comprehend preset and variable flight paths.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 15

2. Jane's Naval Weapons Systems

3. The Naval Institute Guide to World Naval Weapons Systems

B. Student text: Principles of Naval Weapons Systems, Chap. 15

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

E. VCR/Monitor

F. Videotapes

1. "Laser Weapons for the Fleet"

2. "Warship"

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chap. 15

V. Presentation

A. Describe guidance and control systems.

1. Purpose: Control flight path

2. Components

a. Attitude control system

b. Flight path control system

3. Function is based on the principle of feedback.

B. Explain the three phases of guidance.

1. Boost

2. Midcourse

3. Terminal

C. Discuss types of guidance systems and give examples of weapons.

1. Controlled by electromagnetic devices

a. Control guidance

(1) Command

(a) SM-2 MR (during midcourse phase)

(b) SM-2 ER

(c) Mk-48 torpedoes can be wire guided

(2) Beamrider

b. Homing guidance

(1) Active

(a) Tomahawk (TASM) (during terminal phase)

(b) Harpoon (during terminal phase)

(c) Phoenix (during terminal phase)

(d) AMRAAM (during terminal phase)

(e) Mk-46 and Mk-48 torpedoes

(2) Semiactive homing (SAH)

(a) Phoenix (during midcourse phase)

(b) Sparrow

(c) SM-2 MR (during terminal phase)

(3) Passive

(a) SLAM (infrared version of Harpoon)

(b) HARM (radiation)

(c) Sidewinder (infrared)

(d) Mk-46 and Mk-48 torpedoes (acoustic)

2. Self-contained guidance systems

a. Preset

(1) Tomahawk (TASM) (during midcourse phase)

(2) Harpoon (during midcourse phase)

(3) Phoenix (during midcourse phase)

(4) AMRAAM (during midcourse phase)

(5) Mk-46 and Mk-48 torpedoes can follow a preset search pattern.

b. Inertial: Discuss principles of accelerometers.

(1) Trident

(2) Tomahawk (TLAM) (during beginning of midcourse phase)

c. Terrestrial: Tomahawk (TLAM) (during end of midcourse phase and during the terminal phase)

d. Celestial navigation

D. Discuss guided flight paths.

1. Preset

a. Constant

b. Programmed

2. Variable

a. Pursuit

b. Constant bearing

c. Proportional navigation

c. Line-of-sight (being phased out)

E. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 15 **HOURS: 2**

TITLE: Weapon Propulsion and Architecture

I. Learning Objectives

A. The student will comprehend gravity, impulse, and reaction propulsion.

B. The student will comprehend the factors involved in impulse propulsion, including the explosive propellant train, the factors controlling burn rate, and interior ballistics.

C. The student will know the different types of reaction propulsion systems.

D. The student will comprehend the basic principles of fluid dynamics and be able to apply them in shipboard situations.

1. The student will know the concepts of lift and drag, atmospheric properties and effect, subsonic and supersonic flow characteristics, and high speed aerodynamics.

2. The student will know aerodynamic and hydrodynamic controls.

E. The student will comprehend basic weapons architecture.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 16

2. Jane's Naval Weapons Systems

3. The Naval Institute Guide to World Naval Weapons Systems

B. Student text: Principles of Naval Weapons Systems, Chap. 16

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chap. 16

V. Presentation

A. Discuss gravity propulsion and give examples of weapons with gravity propulsion.

1. Bombs

a. Rockeye

b. Walleye

2. Mk-46 torpedo when launched from an aircraft (until submerges)

B. Discuss impulse propulsion and give examples of weapons with impulse propulsion.

1. Explosive propellant train

a. Primer

b. Igniter

c. Propellant powder

2. Solid propellants

3. Factors controlling burning rate

4. Burning rates

a. Degressive/Regressive

b. Neutral

c. Progressive

5. Interior ballistics

a. Chemical source

b. Working substance (high pressure gas)

c. Equipment to release and direct the working substance

d. Pressure-travel curve

6. Propulsion created by a high pressure gas is also impulse propulsion.

7. Examples of weapons with impulse propulsion

a. Guns

(1) 5 inch/54 Mk-45

(2) 20mm Vulcan Phalanx Mk-15 (CIWS)

(3) 20mm Vulcan cannon

b. Initial propulsion of Trident, Tomahawk, and Harpoon when launched from a submarine

C. Discuss reaction propulsion and give examples of weapons with reaction propulsion.

1. Basic elements

a. Combustion chamber

b. Exhaust nozzle

c. Diffuser (if air is required)

2. Rocket engines

a. Solid fuel rocket

(1) Trident

(2) SM-2

(3) Sparrow

(4) Phoenix

(5) HARM

(6) Sidewinder

(7) AMRAAM

b. Liquid fuel rocket

3. Thermal jet engines

   a. Turbojet

      (1) Tomahawk

      (2) Harpoon

   b. Ramjet

4. Torpedoes

   a. Mk-46 torpedo: Two-speed, reciprocating external combustion engine

   b. Mk-48ADCAP torpedo: Pump jet, external combustion engine

   c. Mk-50 torpedo: Stored chemical energy system

D. Discuss fluid dynamics.

1. Aerodynamics: The study of the motion of gaseous fluid flows and of their actions against and around bodies in motion in that fluid.

   a. There are four forces that act upon a missile in flight.

      (1) Thrust: Due to the force from the engine

      (2) Weight: Due to the force of gravity

      (3) Lift: Due to the difference of air pressure above and below the airfoils, perpendicular to the direction of flight

      (4) Drag: Due to the friction caused by air in front of and along the missile, opposes missile motion

   b. Bernoulli's Principle: Air flow on the top of an airfoil is faster than that on the bottom, thus the density of the air is less on the top of the airfoil, causing the missile to rise.

   c. Aerodynamic forces are greatly due to atmospheric properties.

      (1) Static pressure

         (a) Caused by the weight of the air upon an object

         (b) Static pressure decreases with an increase in altitude.

(2) Density

(a) Mass of air per unit volume

(b) Density decreases with an increase in altitude.

(3) Temperature: Temperature decreases with an increase in altitude.

(4) Humidity: As humidity increases, air density decreases (less air molecules and more water molecules per unit volume).

(5) Viscosity

(a) Air's resistance to flow

(b) Viscosity increases as temperature increases.

d. Atmospheric conditions change with altitude, season, weather, location, and time of day.

e. Lift is directly related to the density of the air and the missile's velocity and angle of flight.

(1) As static pressure decreases, lift decreases.

(2) As density decreases, lift decreases.

(3) As humidity increases, lift decreases.

(4) As altitude increases, the combination of atmospheric effects reduces lift and the angle of attack must be adjusted.

f. Drag is affected by atmospheric conditions.

(1) As temperature increases, viscosity increases.

(2) As viscosity increases, friction and drag increase.

g. At high speeds, the effects of aerodynamic forces and atmospheric forces are amplified.

h. Subsonic and supersonic flow characteristics

(1) At supersonic speeds, air is compressed and the density of the air changes.

(2) At subsonic speeds, density changes are minimal and can be ignored. As area decreases, velocity increases.

2. Hydrodynamics: The study of the motion of fluids and of their actions against and around bodies in motion in that fluid.

a. Air and water are both fluids and act similarly.

b. There are differences due to differences in density and mass, and the lack of compressibility of water.

c. Torpedoes, like missiles, are affected by lift and drag, and pitch, roll, and yaw.

d. Torpedoes, unlike missiles, are affected by buoyancy.

E. Discuss control surfaces.

1. Missiles

a. Canard control

(1) Small control surfaces are forward.

(2) Lifting surfaces are aft.

b. Wing control

(1) Control surfaces are near the center of the airframe.

(2) Control surfaces also provide lift.

c. Tail control

(1) Control surfaces are aft.

(2) Lift surfaces are near the center of the airframe.

2. Torpedoes

a. Upper and lower fins control roll and pitch.

b. Port and starboard fins control pitch.

F. Discuss basic missile architecture.

1. Guidance system

2. Warhead and fuze

3. Autopilot

4. Propulsion system

5. Control surfaces

G. Discuss basic torpedo architecture.

1. Propulsion system

2. Control and guidance system

3. Warhead and fuze

H. Discuss gun ammunition architecture

1. Penetrating

2. Fragmenting

3. Special purpose

I. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 16 **HOURS: 1**

TITLE: Case Study: OOD Midwatch

I. Learning Objectives

A. The student will comprehend the moral and ethical responsibilities of the military leader.

B. The student will comprehend a leader's moral and ethical responsibilities to organization and society.

C. The student will comprehend the relationship of integrity, moral courage, and ethical behavior to authority, responsibility, and accountability.

D. The student will comprehend the following personal qualities and be able to relate them to a leader's effectiveness:

1. Loyalty

2. Honor

3. Integrity

4. Courage

II. References and Texts

A. Instructor references:

1. Watch Officer’s Guide

2. Ethics for the Junior Officer, Issue 116

B. Student text: None

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts

C. PowerPoint presentation

D. LCD projector

IV. Suggested Methods and Procedures

A. Method options: Since the case studies in this course follow similar lines of discussion, use different teaching methods to maintain the students' interest.

1. Lecture/explanation of facts by instructor, then discussion.

2. Student presentation of facts, then discussion.

3. Student discussion of facts based on instructor questions, then discussion.

4. Role play: Some students play the roles of the main individuals involved; the other students ask questions.

5. Debate teams representing the different points of view.

B. Procedural and student activity options

1. Research the subject

2. Reading assignment: Instructor-developed handouts

V. Presentation

A. Case Scenario

1. Officer of the Deck

a. Responsibility

(1) Direct representative of the Captain

(2) Carry out the ship’s routine

(3) Safety of the ship

(4) Can not be delegated

b. Authority

(1) Limited by the Commanding Officer’s Standing Orders

(2) May be delegated

c. Relationship with the Captain

2. Background Information

a. Commanding Officer – An extremely gifted ship handler with an extremely short temper. His leadership style emphasizes yelling and berating poor performance.

b. Relieved Officer – The Weapons Officer in this case is the officer of the deck off going.

The officer has a poor reputation in the wardroom. He generally puts himself before his people or the ship. He is a master at placating the Commanding Officer.

c. Torpedo Transmission Checks – Periodic maintenance performed on a torpedo that requires applying ship electrical power to weapon. Commanding Officer's permission is generally required for such checks.

d. Incident: *See the Student Handout.* The class should then discuss the options and responsibilities of the OOD. Possible outcomes are listed below.

3. Responses to student decisions. *(The students should suggest something like the options below; the consequence of the decision is listed as a suggestion. The instructor is free to elaborate.)*

a. Wait until the morning – The CO wakes to your post watch turnover brief. He is furious you didn't get the checks done on time. The exercise is delayed three hours.

b. Conducted the checks without permission

(1) Nothing happens - The matter is never discussed. Are there any consequences to your decision or did you really get away with it?

(2) CO questions how the checks were completed– The Commanding Officer finds out the tubes are loaded and asks you why. He does not remember giving permission. What would you say?

(3) Casualty during the checks – During the transmission checks, a junior torpedoman incorrectly believes he has started a hot run in the torpedo room. He calls it away on the 31MC. You respond immediately and call it away on the 1MC. A few minutes later, the MMC (TM) calls up on the 31MC reporting no casualty, just a mistake. What are the consequences?

c. Call the Commanding Officer – He yells at you and asks you if you have a brain. He then gives permission. What have you gained and what have you lost in this situation?

d. Call the Weapons Officer, Off-Going OOD – He tells you he forgot to get permission, but to

go ahead and do the checks and tube load the torpedoes. What do you do?

B. Discuss the leadership considerations.

1. What would be the OOD’s motivation?

a. To do nothing

b. To conduct the evolution without the CO’s permission

c. To call the Commanding Officer and wake him up

d. To call the Weapons Officer and have him get permission

2. Discuss the OOD’s responsibilities.

a. Pre-watch tour

b. Keep the Commanding Officer informed

c. Follow the Standing Orders

d. Keep the ship’s schedule

3. How could this situation have been prevented?

C. Discuss the moral and ethical considerations.

1. What are the moral and ethical considerations in the use of force against another nation?

a. Example for the rest of the crew

b. Effect on the Commanding Officer’s level of trust

2. Are there examples of moral courage or lack of courage in this situation?

a. By the OOD

b. By the Weapons Officer

c. By the Torpedoman Chief

3. Does the end result justify the means?

a. If the OOD was just doing what he knew the Commanding Officer would want, are his action justified?

b. Since his reasons were honorable, aren't the actual actions honorable?

c. Using the same logic, were these actions morally correct?

D. Summary

OOD MIDWATCH CASE STUDY

You are the officer of the deck (OOD) on a submarine. You took the watch at 1157 from the ship's Weapons Officer (Department Head). You conducted the required pre-watch tour of the ship prior to taking the watch. You know from reading the night orders that tomorrow will be the first day of the ship's pre-Tactical Readiness Examination exercise. You will shoot two exercise torpedoes. You are a newly qualified Officer of the Deck and expect to get your Submarine Warfare Qualification later this month.

At 0300, the Torpedo Division Chief stops by the control room to find out about conducting transmission checks and tube loading the two exercise torpedoes. You realize that you do not have permission to do either. The Commanding Officer's Standing Orders clearly state that weapons checks and tube loading torpedoes require the Commanding Officer's permission. The MMC (TM) quickly responds after you tell him you don't have permission. He tells you that he specifically asked the Weapons Officer, who was the officer of the deck before you, to get permission. He then tells you that since the torpedoes in question are exercise torpedoes, the Commanding Officer's Standing Order doesn't apply. He explains that as long as the OOD gives permission, it will be alright -- after all, the torpedoes have to be ready for the shoot later that morning.

The previous day, the ship conducted two drill sets involving both a forward fire and propulsion casualties. The drill debriefs went well into the evening. The Commanding Officer was up for about the last 40 hours because of a night SEAL insertion the previous mid-watch. The other Junior Officers have told you to NEVER call the CO at night for a non-emergency.

What are your options?

What do the regulations say to do in this situation?

What about what the Chief said?

What would you do?

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 17 **HOURS: 1**

TITLE: Launching Systems

I. Learning Objectives

A. The student will know the general requirements and functions of launching systems.

B. The student will know the basic types of launchers.

C. The student will comprehend the principles of gravity, impulse, and reaction launchers.

D. The student will know the different types of impulse launchers.

E. The student will comprehend the principles of gun-type launchers and recoil systems.

F. The student will know the different types of reaction launchers.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 17

2. Jane's All the World's Aircraft

3. Jane's Fighting Ships

4. Jane's Naval Weapons Systems

4. The Naval Institute Guide to World Naval Weapons Systems

B. Student text: Principles of Naval Weapons Systems, Chap. 17

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

E. VCR/Monitor

F. Videotapes:

1. "Harpoon Antiship Weapon System"

2. "Tomahawk"

3. "Sea Warriors"

4. "Warship"

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment: Student text, Chap. 17

V. Presentation

A. Discuss the general requirements of a launching system.

1. Speed

2. Reliability

3. Safety

4. Compatibility

B. Explain the functions of a launching system.

1. Storage

a. Primary magazines

b. Ready service magazines

c. Lockers

2. Transfer

a. Storage to launcher

b. Limits rate of fire

3. Loading

4. Control

    a. Positioning to line-of-fire (LOF)

    b. Weapon orders

5. Launching

C. Discuss the three basic types of launchers and give examples.

1. Gravity

    a. Only used with slow-moving aircraft

    b. Example: Torpedoes dropped from helicopters

2. Impulse

    a. The force to separate the weapon from the launcher is created by the launcher.

    b. Gun-type launchers

        (1) Uses gases created by a low explosive

        (2) Internal stresses

        (3) Recoil/Counter-recoil systems

        (4) Soft recoil systems

        (5) Examples

            (a) 5-inch/54 Mk-45

            (b) 20mm Vulcan Phalanx Mk-15 (CIWS)

            (c) 20mm Vulcan cannon

    c. Ejector-type launchers

        (1) Uses gases created by a high-pressure gas system on the launching platform

        (2) Examples

            (a) Tube launchers on submarines for Tomahawk, Harpoon, and Mk-48 torpedoes

            (b) Tube launchers for Trident

            (c) Tube launchers for Mk-46 torpedoes

            (d) Launchers for Phoenix and Sparrow

(e) Launchers for bombs dropped from high-speed aircraft

3. Reaction

a. The force to separate the weapon from the launcher is created by the weapon.

b. Rail launchers

(1) The weapon travels along a rail, tube, ramp, or tower.

(2) The launcher provides initial guidance, stability, and flight control.

(3) Not widely used in the Navy due to space and weight constraints of Navy platforms.

(4) Examples

(a) LAU-130 folding fin rocket launcher

(b) MLRS, Barrage rockets

c. Zero length

(1) The weapon travels along a rail less than 8 centimeters.

(2) The launcher provides no initial guidance or flight control.

(3) The weapon must have immediate flight control.

(4) Examples

(a) Mk-26 twin-arm missile launcher

(b) Mk-13 single-arm missile launcher

d. Platform

(1) Used when the weapon must achieve high altitude as quickly as possible.

(2) The launcher provides no initial guidance or flight control.

(3) No missile in the Navy requires this type of launcher.

e. Canister

(1) Launcher also used for weapon storage

(2) Weapon contained within the launcher during launch and initial flight

(3) Requirements

(a) Launcher must withstand the heat and shock wave created by weapon launch

(b) Requires an exhaust gas system

(c) Must be able to withstand the complete burn of the rocket motor in the event of a launch malfunction

(4) Examples

(a) Vertical Launch System (VLS)

(b) Harpoon launcher

(c) Box launcher for Sea Sparrow, ASROC, and Tomahawk

D. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 18 **HOURS: 2**

TITLE: Fire Control

I. Learning Objectives

A. The student will comprehend the basic geometry of the fire control problem.

B. The student will be able to apply the basic fire control problem.

C. The student will know the basic factors of the fire control problem.

D. The student will comprehend the factors effecting the solution of the fire control problem.

E. The student will comprehend the basic concepts of relative target motion, bearing rate, and speed across line-of-sight.

F. The student will comprehend the following exterior ballistic effects upon the trajectory of the weapon: gravity, drag, wind, drift, and Coriolis force.

G. The student will know the basic concepts of the detect-to-engage sequence.

II. References and Texts

A. Instructor references

1. Principles of Naval Weapons Systems, Chap. 19

2. NROTC Supplement to *Principles of Naval Weapons Systems Workbook*, Chap. 3

B. Student texts

1. Principles of Naval Weapons Systems, Chap. 19

2. NROTC Supplement to *Principles of Naval Weapons Systems Workbook*, Chap. 3

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

B. Procedural and student activity options

1. Study assignment

2. Reading assignment

a. Student text, Chap. 19

b. Supplement, Chap. 3

V. Presentation

A. Introduction

1. The fire control problem is part of the detect-to-engage sequence, which involves one or more units.

a. Target is detected by one or more sensors.

b. Additional sensors are used to gain better information on the target.

c. Target information is sent to other units through the naval tactical data system or other means.

d. Target is identified.

e. Original unit or other unit completes a threat analysis.

f. The operational commander evaluates the threat and the ability to counter the threat.

g. The operational commander assigns a launch platform, if necessary, based on threat evaluation.

h. The launch platform completes the fire control solution, assigns a weapon, and attacks the target.

2. The fire control problem consists of determining target position, target motion, and a weapon path that intercepts the target at a particular point.

3. The problem begins when a target is assigned by the operational commander and ends when the target is destroyed.

4. The fire control problem is difficult because several factors are uncontrollable.

   a. Target motion is different for every target (ship, aircraft, submarine, missile).

   b. Target motion can change for any one target at any time.

   c. Weapon motion is different for every weapon.

   d. Weapon motion is affected by several outside forces that can change at any time.

B. The fire control problem can be divided into two problems:

   1. Relative target motion problem

   2. Ballistics problem

C. Discuss the relative motion problem.

   1. Solves a tracking problem that consists of position-keeping between own ship and the target

   2. Does not deal with the weapon

   3. Target motion analysis (TMA)

      a. Process of mathematically analyzing available target and own ship motion data

      b. Input

         (1) Ship motion from own ship sensors

            (a) Navigation systems

            (b) Gyrocompass

            (c) Electromagnetic log

            (d) Dead reckoning analyzer indicator (DRAI)

            (e) Depth indicator equipment

         (2) Target position (range or bearing)

            (a) Radar

(b) Sonar

(c) Electronic warfare equipment

(d) Data systems (NTDS)

c. Analysis of the input data collected over several time intervals

d. Output

(1) Target course and speed

(2) Target position (range and bearing)

e. Predicted target position from TMA is compared to actual target position to determine errors.

4. Target position-keeping: Analysis of target motion to determine the rate of change of target position

D. Discuss the ballistics problem.

1. Solves the problem of getting the weapon to the target

2. Requires the following information, which must be updated continuously:

a. Target data

(1) Target position from sensors

(2) Target motion from TMA

b. Own ship data from ship sensors

c. Weapon exterior ballistics

(1) The study of the forces that cause a projectile in flight to change direction and velocity

(2) Involves the following factors:

(a) Gravity

(b) Drag

(c) Wind

(d) Drift

(e) Coriolis force

d. Weapon specifics

E. Discuss the fire control problem.

1. Computations

a. Relative motion equations

b. Ballistics equations

c. Ballistics computation procedure flow diagrams

2. Solutions

a. Weapon time of flight

b. Bearing rate

c. Line of sight (LOS): The course the weapon must follow to intercept the target

d. Speed across LOS

e. Launch angles

(1) Launch azimuth

(2) Launch elevation

f. Weapon positioning orders

F. Describe the simplified flow diagram of a fire control problem.

G. Demonstrate how to apply the fire control problem.

H. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 19 **HOURS: 2**

TITLE: Mine Warfare

I. Learning Objectives

A. The student will know the mission of mine warfare.

B. The student will know the methods of classifying mines.

C. The student will know the basic types of mines in the U.S. Navy's current inventory.

D. The student will comprehend the factors involved in planning a minefield.

E. The student will comprehend the principles of mine countermeasures.

II. References and Texts

A. Instructor references

1. Force 2001

2. The Naval Institute Guide to World Naval Weapons Systems

3. NAVSEA Mine Familiarizer

4. U.S. Navy Mine Countermeasures Familiarizer

5. "Weapons That Wait...and Wait..."

6. Weapons That Wait: Mine Warfare in the U.S. Navy

B. Student text: None

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

3. Suggest MOI assist in USMC applications

4. Student presentations

B. Procedural and student activity options

1. Prepare presentations

2. Outside reading from magazine articles

V. Presentation

A. Introduce mine warfare by giving a brief history.

1. Revolutionary War: Bushnell's keg mine (powder keg, tar covered, flintlock firing device)

2. Civil War

a. Mines first widely used.

b. The Confederacy used large scale mining on land and sea.

3. World War II

a. U.S. mine efforts were concentrated in the Pacific.

b. 23,000 mines were laid which sank or damaged 1,075 Japanese ships.

4. Vietnam War: Extensive mining in inland waterways

5. The U.S. has considerably reduced the use of mines since the end of the Cold War.

6. Recent events

a. USS *Samuel B. Roberts*

b. USS *Princeton*

c. USS *Tripoli*

7. Operation Desert Storm showed the need for a rapid clearing of shallow water minefields in preparation for an amphibious assault.

B. Discuss the mission of mine warfare.

C. Discuss classification of mines.

1. By method of delivery

a. Air-delivered mines

b. Surface-delivered mines

c. Submarine-delivered mines

2. By position in water after delivery

a. Moored mines

b. Bottom mines

c. Drifting mines (not in U.S. inventory)

3. By method of actuation

a. Contact mines

b. Influence mines

(1) Magnetic

(2) Acoustic

(3) Pressure

(4) Combination

4. Contact mines are usually moored mines.

5. Influence mines are usually bottom mines.

D. Describe the mines currently in the U.S. Navy's inventory.

1. Destructor mines: Mk-36, Mk-40, Mk-41

a. Shallow-water bottom mine

b. Target: Surface

c. Delivery platform: Aircraft

2. Mark 50 series

a. Mk-52 and Mk-55

(1) Shallow-water bottom mine

(2) Target: Submarines and surface

(3) Delivery platform: Aircraft

b. Mk-56 and Mk-57

(1) Medium-depth moored mine

(2) Target: Submarines

(3) Delivery platform: Aircraft (Mk-56) and submarines (Mk-57)

3. CAPTOR mines: Mk-60

a. Deep-water moored mine/rising mine

b. Target: Submarines

c. Delivery platform: Aircraft, submarines

d. The CAPTOR (encapsulated torpedo) mine releases a torpedo when it detects a ship.

4. Quickstrike mines: Mk-63, Mk-64, Mk-65

a. Shallow-water bottom mine

b. Target: Surface

c. Delivery platform: Aircraft

5. Submarine-launched mobile mine (SLMM): Mk-67

a. Shallow-water bottom mine

b. Target: Surface

c. Delivery platform: Submarine

d. Self-propelled

E. Explain minefield planning and considerations.

1. Determine performance objectives (desired number of casualties, desired threat level, etc.).

2. Determine minefield planning objectives (MPO). The planner must make the most effective use of weapons and delivery systems to accomplish the MPO.

3. Types of minefields

a. Offensive

b. Defensive

c. Protective

4. Environmental considerations

   a. Geographic location (choke point, harbor, port)

   b. Water depth

   c. Currents

   d. Bottom type and slope (so mines do not "walk" or roll)

   e. Prevailing sea state

5. Delivery considerations

   a. Type of minefield

   b. How many mines are to be delivered?

   c. Is the minefield area defended?

   d. What types of mines are to be delivered?

   e. What is the required accuracy of delivery?

6. Delivery vehicles

   a. Aircraft

      (1) The most suitable vehicle for delivery of offensive mines

      (2) P-3 *Orion*

      (3) S-3 *Viking*

   b. Surface ships

      (1) Normally used for laying defensive or protective minefields

      (2) The U.S. does not use surface ships to lay mines.

   c. Submarines

      (1) For laying mines covertly

      (2) For laying mines in well-defended areas inaccessible to aircraft and ships

      (3) *Los Angeles* class (SSN-688)

F. Discuss mine countermeasures (MCM).

1. Objectives

a. Self-protection

(1) Silencing: Protection from acoustic mines

(2) Degaussing: Protection from magnetic mines

(3) Steaming slowly to prevent abrupt pressure changes: Protection from pressure mines

b. Clearance

(1) Mine sweeping

(a) Mine neutralization of a large area

(b) Moored mines: Cut mine cables, then activate to destroy

(c) Acoustic and magnetic mines: Sweep area with acoustic/magnetic noise-makers

(2) Mine hunting

(a) Searching and neutralizing individual mines

(b) Involves searching an area for objects that look like mines, then investigating to determine if the object is a mine

(c) Usually use sonar to detect suspected mines

(d) To detect and neutralize pressure mines and other mines that are difficult to sweep

2. MCM force composition

a. Surface

(1) *Avenger* class (MCM-1): Mine countermeasures ship

(2) *Osprey* class (MHC-51): Coastal mine hunter ship

b. Airborne: MH-53 *Sea Stallion* helicopter

c. Underwater

(1) Explosive ordnance disposal (EOD)

(2) Special warfare forces

G. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 20 **HOURS: 4**

TITLE: U.S. Navy and Marine Corps Platforms and Weapons

I. Learning Objectives

A. The student will know the designations and missions of ships, aircraft, and weapon systems of the U.S. Navy and U.S. Marine Corps.

B. The student will know the basic mission, characteristics, capabilities, and weapon systems of the following U.S. surface platforms:

1. *Ticonderoga*-class cruiser (CG-47)

2. *Arleigh Burke*-class destroyer (DDG-51)

3. *Spruance*-class destroyer (DD-963)

4. *Oliver Hazard Perry*-class frigate (FFG-7)

C. The student will know the basic mission, characteristics, capabilities, and weapon systems of the following U.S. submarines:

1. *Los Angeles*-class attack submarine (SSN-688)

2. *Ohio*-class ballistic missile submarine (SSBN-726)

D. The student will know the basic mission, characteristics, capabilities, and weapon systems of the following U.S. aircraft:

1. F-14 *Tomcat*

2. F/A-18 *Hornet*

E. The student will know the basic mission, characteristics, capabilities and weapon systems of the Marine Expeditionary Unit (MEU).

F. The student will know the ships, aircraft and combat vehicles that support the MEU.

II. References and Texts

A. Instructor references

1. <u>The Almanac of Sea Power</u>

2. <u>Final Report to Congress: Conduct of the Persian Gulf War</u>

3. Jane's All the World's Aircraft

4. Jane's Fighting Ships

5. Jane's Naval Weapons Systems

6. The Naval Institute Guide to World Naval Weapons Systems

7. NROTC Supplement to *Principles of Naval Weapons Systems Workbook*

8. The Almanac of Sea Power

9. "Slick Warriors and the '32'"

10. "The Ticonderoga Story: Aegis Works"

11. "USN Seeks 'Technology Roadmap' for Next DDG"

B. Student text: None

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and transparencies or PowerPoint presentation

C. Overhead and/or LCD projector

D. Transparencies: Course series

E. VCR/Monitor

F. Videotapes:

1. "Top Gun"

2. "LHA"

3. "Today's Submarine Force"

4. "Sea Power for the 90's"

5. "Sea Warriors"

6. "Warship"

7. "Storm from the Sea"

G. Aegis Program Office training aids (see “Instructional Aids”, page x)

H. Slide projector and slides (see “Instructional Aids,”

page x)

IV. Suggested Methods and Procedures

A. Method options

1. Lecture and demonstration

2. Discussion

3. Guest lecturers: Use the experience of the other instructors in the unit.

4. Student presentations: Divide the class into groups with each group responsible for the presentation of one platform.

5. Slide presentation

B. Procedural and student activity options

1. Prepare presentations

2. Outside reading from magazine articles

V. Presentation

A. Discuss the *Ticonderoga*-class cruiser (CG-47) and the *Arleigh Burke*-class destroyer (DDG-51).

1. Both ships have the Aegis weapon system.

a. Designed for an antiair warfare (AAW) mission (against Soviet antiship missiles), but now considered multi-mission: AAW, antisubmarine warfare (ASW), antisurface warfare (ASUW), and strike warfare.

b. Aegis is a complete weapon system centered around the SPY-1 radar and the command and decision system.

c. Incorporates fast reaction time and high fire power.

d. Able to send target information automatically to other units.

e. Data displays combine input from all sensors.

2. Components of the Aegis weapon system

a. SPY-1 radar system

(1) Purpose

(a) Primary air and surface search radar

(b) Primary fire control radar

(c) SM-2 guidance: Command guidance during mid-course phase

(2) Characteristics

(a) Four electronically scanned, phased arrays

(b) Uses a four-bay computer suite

(c) TWS techniques are used by the computers.

(d) SPY-1 computers also perform automatic antijamming procedures (e.g., burn-through), uplink/downlink, and jamming.

b. Command and decision (C+D) system

(1) Purpose

(a) Performs overall system coordination; controls all systems

(b) Provides the operator/machine interface for Aegis

(c) While many system functions are automatically controlled by computer (e.g., search, tracking, EA), operator inputs via the C+D system provide ultimate system/weapon control.

(2) Functions

(a) Track file generation based on information from internal sensors, NTDS, and LAMPS

(b) Threat evaluation/classification

(c) Threat priority decisions

(d) Make/recommend weapon assignments

(e) Recommend fire

(f) Training support

(3) The C+D system is used to select the Aegis system mode ("doctrine") and this deter-

mines how the system will react to detected targets.

(a) Automatic special: Automatically fires all weapons (except Tomahawk, CIWS, and 5"/54 guns) based on the preset threat criteria

(b) Automatic: Performs all functions except fire

(c) Semiautomatic

(d) Casualty (manual)

c. Aegis display system

d. Weapons control system (WCS)

(1) Standard missile (SM-2MR)

(2) 20mm Vulcan Phalanx Mk-15 (CIWS)

(3) Harpoon

(4) Tomahawk

(5) 5 inch/54 Mk-45 guns

(6) Mk-46 torpedoes, to be replaced with Mk-50

(7) Weapons from other platforms

(a) Ship's own SH-60 helicopter

(b) Aircraft

(c) Surface ships

e. Fire control system

f. Missile launching system

(1) Mk-26 launching system: Only on the first five ships of the *Ticonderoga*-class cruiser

(a) SM-2MR

(b) ASROC

(2) Vertical Launch System (VLS): On the *Ticonderoga*-class cruiser (CG-52 and up) and the *Arleigh Burke*-class destroyer

(a) SM-2MR

(b) Tomahawk

(c) ASROC (in development)

g. Operational readiness test system, ORTS

h. Aegis combat training system, ACTS

3. Compare the *Ticonderoga*-class cruiser (CG-47) and the *Arleigh Burke*-class destroyer (DDG-51).

a. Size

(1) CG-47: 9500 tons, 567 feet long

(2) DDG-51: 8400 tons, 504 feet long

b. Propulsion: Four gas turbine engines, two shafts (DDG-51 has more shp)

c. Weapon capacity

(1) *Ticonderoga* class has two 64-cell VLS for 122 missiles

(2) *Arleigh Burke* class has one 64-cell and one 32-cell for 96 missiles

d. Helicopters

(1) *Ticonderoga* class can hold two SH-60 *Seahawks.*

(2) *Arleigh Burke* class only has a helicopter pad.

e. *Arleigh Burke* class has Kevlar armor

B. Discuss the *Spruance* class destroyer (DD-963).

1. Mission: Antisubmarine warfare (ASW)

a. Still considered the best surface platform for ASW

b. Advanced self-noise reduction features for quiet ASW operations (e.g., Prairie/Masker System)

2. Size: 8,000 tons, 563 feet long

3. Propulsion: Four gas turbine engines, two shafts

4. Weapon systems

a. SQQ-89 ASW weapon system

(1) SQS-53 bow-mounted sonar

(2) SQR-19 tactical towed array sonar system

(3) LAMPS Mark III

(4) Mk-116 ASW control system

(5) SVTT-32 over-the-side torpedo tubes for Mk-46 torpedoes

(6) ASROC

(a) From box launcher on non-VLS ships

(b) From VLS (still in development)

b. Antiair warfare (AAW)

(1) NATO Sea Sparrow point defense subsystem

(2) 20mm Vulcan Phalanx Mk-15 (CIWS)

c. Antisurface warfare (ASUW)

(1) 5-inch/54 Mk-45 guns

(2) Harpoon

(3) Tomahawk: Most have been backfitted with VLS; the remainder have box launchers.

C. Discuss the *Oliver Hazard Perry*-class frigate (FFG-7).

1. Most of the older ships of this class are in the Naval Reserve Force (NRF).

2. Missions: ASW, ASUW, AAW

3. Size: 4100 tons, 453 feet long

4. Propulsion: Two gas turbine engines, one shaft

5. Weapon systems

a. Antisubmarine warfare (ASW): SQQ-89 ASW system in ships in the active fleet

(1) SQS-53 bow-mounted sonar

(2) SQR-19 tactical towed array sonar system

(3) LAMPS Mark III

(4) Mk-116 ASW control system

(5) SVTT-32 over-the-side torpedo tubes for Mk-46 torpedoes

b. Antiair warfare (AAW)

(1) SM-1MR

(2) 20mm Vulcan Phalanx Mk-15 (CIWS)

c. Antisurface warfare (ASUW)

(1) 3-inch/62 Mk-75 OTO Melara gun

(2) Harpoon

D. Discuss the *Los Angeles*-class attack submarine (SSN-688).

1. Missions: ASW, ASUW

2. Size: 6900 tons (submerged), 360 feet long

3. Propulsion: One nuclear reactor, two turbines, one shaft

4. Sensors and detection systems

a. BQQ-5A passive/active hull-mounted sonar

b. BQR-23/25 passive towed sonar array

c. Radar for surface operations/navigation

d. Mine and ice detection and avoidance systems (SSN-751 and up)

5. Weapons systems

a. Tomahawk (TASM and TLAM): SSN-719 and up have 12 VLS launch tubes external to the pressure hull.

b. Harpoon

c. Mk-48 torpedoes

d. A total of 26 weapons can be tube-launched from tubes located amidships (any combination of Tomahawk, Harpoon, torpedoes).

e. Mk-67 or Mk-60 mines can be laid from the torpedo tubes.

6. With the decrease in the Soviet submarine threat, several new missions are being explored.

a. Deployment of Special Forces (SEALs)

b. Battle group operations

E. Discuss the *Ohio*-class ballistic missile submarine (SSBN-726).

1. Mission: Deterrence; part of the nuclear triad

2. Size: 18,700 tons (submerged), 560 feet long

3. Propulsion: One nuclear reactor, two turbines, one shaft

4. Sensors and detection systems

a. BQQ-6 passive hull-mounted sonar

b. BQS-9 active/passive hull-mounted sonar for close contacts

c. BQR-15 passive towed sonar array

d. Radar for surface operations/navigation

5. An extremely low frequency (ELF) communication system can receive messages/orders from aircraft while the submarine is submerged.

6. Weapons systems

a. Trident I or Trident II nuclear ballistic missile from 24 missile tubes

b. Mk-48 torpedoes from torpedo tubes

F. Discuss the F-14 *Tomcat* and the F/A-18 *Hornet*

1. Considerable research and development (R&D) funds are being contributed to F-14 and F/A-18 programs. Rapid changes in roles, missions, and weapons are occurring.

2. With the elimination of the A-6, the cancellation of the A-12 (in January 1991), and the delay in the A/F-X projects, the Navy is modifying and improving the existing aircraft to carry out the attack and strike missions.

3. No more F-14's will be built, but many of those in existence will receive considerable upgrades.

4. Missions

a. F/A-18 *Hornet*

(1) Carrier-based and land-based attack/fighter

(2) Considered the A-6E's replacement

b. F-14 *Tomcat*: Carrier-based, long-range interceptor with attack capabilities

5. Propulsion

a. Two turbofans

b. Speed

(1) F/A-18: More than 1,360 mph

(2) F-14: More than 1,500 mph

c. Flight time: Approximately 3 hours

6. Capabilities

a. F/A-18 *Hornet*

(1) Multimode digital air-to-air and air-to-ground tracking radar can track 10 targets.

(2) Digital flight controls and two flight computers

b. F-14 *Tomcat*

(1) Able to track 24 targets and attack 6 simultaneously

(2) AWG-9 weapon control system for automatic target detection and tracking

7. Weapons

a. Air-to-air

(1) Sidewinder

(2) Sparrow

(3) Phoenix (F-14 only)

(4) Advanced medium range air-to-air missile (AMRAAM)

(5) M61 Vulcan 20mm cannon

b. Air-to-surface

(1) Maverick (F/A-18 only)

(2) Harpoon (F/A-18, to be added to F-14)

(3) HARM (F/A-18, to be added to F-14)

(4) Mk 80 series general purpose bombs (F/A-18 only)

(5) GBU-10/12/16 laser-guided bombs (F/A-18 only)

(6) CBU-59 APAM and CBU-20 Rockeye cluster bombs (F/A-18 only)

G. Discuss the Marine Expeditionary Unit (MEU).

1. Fleet Marine Force (FMF)

a. Serves the fleet in the seizure and defense of advanced bases and in the conduct of land operations.

b. Organized into air-ground landing forces of different sizes trained in amphibious tactics and techniques

c. Marine expeditionary unit (MEU)

(1) Smallest FMF air-ground task force

(2) Primary purpose: Ready force of high visibility to show U.S. presence and resolve during crisis situations

(3) Routinely assigned to forward deployed ships

(4) Capable of operations against small, lightly armed enemy

(5) May be used as the base unit of a larger build-up

2. Composition of MEU

a. Divided into air, ground, and combat support services commands

b. 2,500 troops

c. 18-24 helicopters

d. Can have fixed wing aircraft

e. Supported by 4-7 amphibious ships

f. The ground combat element is the battalion landing team (BLT).

3. Weapons of the MEU

a. M-16 rifle: Primary hand-held infantry weapon

b. Personal Defense Weapon: Beretta 9mm semi-automatic M9 pistol

c. Machine guns

(1) .50 caliber M2: Mounted on tripods, vehicles, and helicopters

(2) M60E3: Fired from shoulder, hip, sitting, or prone

d. Hand grenades

(1) Fragmenting warhead: Anti-personnel

(2) Chemical warhead

(a) Tear gas or other irritant for anti-personnel

(b) White phosphorous or colored smoke for signaling, marking, screening, or incineration

e. Grenade launchers

(1) M203 40mm grenade launcher: Used with the M16A2 rifle

(2) Mod 19 40mm rapid grenade launcher: Mounted on the ground and on vehicles and helicopters

f. Squad automatic weapon (SAW): Fired from shoulder, hip, or underarm

g. Shoulder-launched, multipurpose assault weapon (SMAW): Dual-mode and anti-armor rockets

h. 60mm and 81mm mortar: Smooth-bore, muzzle-loaded, indirect-fire weapons

i. Antitank weapons

(1) Tube-launched, optically-tracked, wire-command link guided missile (TOW)

(a) Heavy antitank or assault weapon

(b) Carried by vehicle or aircraft

(2) M-47 Dragon antitank guided missile

(a) Medium antitank or assault weapons

(b) Hand-carried, shoulder-fired

(3) Light anti-armor weapon (LAW)

(a) Self-contained launcher and rocket

(b) Hand-carried, shoulder-fired

j. Artillery: 155mm towed howitzer

k. Mines: Antitank and anti-personnel

4. Combat vehicles

a. Landing craft air cushion (LCAC)

(1) Amphibious personnel and cargo carrier

(2) Travels high speeds and long distances

b. Amphibious assault vehicle (AAV): Amphibious personnel carrier

c. Light armored vehicle (LAV): Amphibious, multi-role vehicle

d. Main battle tank M1A1

5. Aircraft

a. CH-46 *Sea Knight*: Transports personnel and supplies

b. CH-53 *Sea Stallion* and *Super Stallion*

(1) Transports personnel, supplies, equipment

(2) *Super Stallion* is larger; can lift an LAV and most fighter, attack, and EW aircraft

c. UH-1 *Huey*

(1) Versatile and durable

(2) Transports personnel and supplies

(3) Can be armed

d. AH-1 *Super Cobra*: Close-in fire support and assault fire suppression

e. AV-8 *Harrier*: VSTOL fighter/attack aircraft

f. F/A-18 *Hornet*: All-weather attack aircraft

6. Navy support ships

a. Amphibious assault

(1) Operates helicopters and VSTOL aircraft, transports marines, weapons, vehicles (including LCACs, tanks, LAVs), and equipment

(2) *Wasp* class (LHD-1): Newest ship

(3) *Tarawa* class (LHA-1): Floodable well deck

(4) *Iwo Jima* class (LPH)

b. Amphibious transport dock: *Austin* class (LPD-4)

c. Dock landing

(1) Flooded well deck enables these ships to load and launch LCACs at sea.

(2) *Whidbey Island* class (LSD-41)

(3) *Anchorage* class (LSD-36)

H. Summary

NAVAL RESERVE OFFICERS TRAINING CORPS
NAVAL SHIPS SYSTEMS II (WEAPONS)

LESSON GUIDE: 21 **HOURS: 1**

TITLE: Case Study: Aircraft Mishap Incident

I. Learning Objectives

A. The student will comprehend the moral and ethical responsibilities of the military leader.

B. The student will comprehend a leader's moral and ethical responsibilities to organization and society.

C. The student will comprehend the relationship of integrity, moral courage, and ethical behavior to authority, responsibility, and accountability.

D. The student will comprehend the following personal qualities and be able to relate them to a leader's effectiveness:

1. Loyalty

2. Honor

3. Integrity

4. Courage

II. References and Texts

A. Instructor references: Articles in Proceedings, and various news magazines.

1. “Who Should Have Tried Captain Asby?” Proceedings, May 1999, pp 2, 4.

2. “U.S. Fighter jet. . .” Newsweek, February 16, 1998.

3. “Tolerance Is Low for Low-Flying Training Around the World,” Boudreaux. L.A. Times, February 23, 1998.

B. Student text: Handout attached

III. Instructional Aids

A. Chalkboard/Easel

B. Instructor-developed handouts and PowerPoint presentation

C. LCD projector

IV. Suggested Methods and Procedures

A. Method options: Since the case studies in this course follow similar lines of discussion, use different teaching methods to maintain the students' interest.

1. Lecture/explanation of facts by instructor, then discussion.

2. Student presentation of facts, then discussion.

3. Student discussion of facts based on instructor questions, then discussion.

4. Role play: Some students play the roles of the main individuals involved, the other students ask questions.

5. Debate teams representing the different points of view.

6. Guest lecturer who can present in detail the procedures and regulations that help ensure aircraft safety in the Navy and Marine Corps.

B. Procedural and student activity options

1. Research the subject

2. Reading assignment: Instructor-developed handouts

V. Presentation

A. This case study can be used in a variety of ways. As presented, the case is based on the event in Italy 1998; it is not intended to be a mock trial of those involved in the Prowler – gondola incident. This case study is simply based on the Aviano Incident because of the limited information that the author had of the actual incident and should <u>not</u> be considered a completely historical account. The instructor may feel it is more valuable to stick to the facts presented in the media and have the students discuss their opinion on what the crew of the EA-6B should have done.

B. Case Scenario

1. The students should consider themselves as the new guy at the squadron. They are on detachment duty from their home base in Washington State to a joint command in Italy.

2. The students should consider themselves to be one of the ECMO’s on a Prowler conducting a rare low-level training mission.

3. Both the Pilot and Navigator are popular in the squadron. The pilot is slated to transition to an F/A-18 squadron within 6 months. He has been flying high altitude missions and hasn't completed a low level training mission in 7 months. The Navigator is the senior junior officer in the squadron.

4. Aircraft crews have a responsibility to tell their pilot to "Knock it off", if they feel the pilot is being reckless.

5. The following is an excerpt from Instructor Reference #3:

Italians have long protested in vain about NATO flights roaring at eye level past their mountainside villages, especially after such flying was stepped up to support NATO operations in war-torn Bosnia-Herzegovina. Some offending flights came from Aviano, the expanding U.S. base in northeastern Italy, but many were Italian.

Mauro Gilmozzi, the mayor of Cavalese, says that villagers reported four incidents of unidentified warplanes hitting ski-lift cables in the Alpine region between 1990 and 1997, and two incidents of others flying under the cables in Cavalese in the 1980s. No casualties resulted, but the lack of explanations from higher authorities disturbed him. So did a letter the Italian air force sent last year to a Cavalese resident admitting that its pilots often dip below the minimum altitude while "flying blind" -- without navigational instruments. The letter insisted that such training was safe and in the interest of national defense. "At least 100 people from our village have telephoned the authorities about antennas knocked off their roofs, windows broken, babies awakened, old folks frightened," the mayor said in an interview.

"I've called the Italian air force four or five times myself. In the end, I concluded there is nothing a small village can do when it's the very state that plans these flights." Similar protests came from other villages dotting the mountains, but they were never coordinated and rarely got beyond the regional air force command.

The Defense Ministry in Rome says it has had just 20 complaints from the Alps in the past three years; of those, five involving U.S. aircraft were passed on to Aviano, but U.S. officials there denied any altitude violations -- until the Prowler cut the gondola cables about 300 feet above the

ground.

6. Incident: *See handout at the end of the lesson.*

C. Discuss the leadership considerations.

1. What was the navigator’s motivation?

2. What was the pilot’s motivation?

3. Discuss the pilot’s responsibilities.

4. Was the training necessary?

   a. Could the training be handled in other less dangerous ways?

   b. If the pilot did deviate from the pre-brief, what could you do about it?

5. What responsibilities do junior officers have when faced with ambiguous requirements?

D. Discuss the moral and ethical considerations.

1. What are the moral and ethical considerations in this case?

   a. Death of U.S. citizens?

   b. Death of foreign civilians?

   c. Is destroying evidence ever justified?

   d. What if the evidence will be used to carry out injustice?

2. Are there examples of moral courage in this situation?

3. Does the end result justify the means?

   a. Where should the line be drawn between realistic training and safety?

   b. If the crews’ reasons were honorable, aren't the actual actions honorable?

   c. Using the same logic, were these actions morally correct?

E. Summary

AIRCRAFT MISHAP INCIDENT CASE STUDY

You are on the last training flight of the deployment. Your EA-6B detachment has almost completed its six-month tour patrolling the skies of Yugoslavia. Your squadron CO has managed to get permission for your aircraft to complete a much needed low level training mission. You know such opportunities are rare because of limited fuel allotted for training and because the local government has been complaining about the jets “barnstorming” through the Alps. You have heard stories about some other units back in the States that play it pretty loose, but your Commanding Officer believes in sticking to your services’ training standards. You don’t mind, because flying along at 1000 ft at 550 kts is plenty of excitement for you. At the RAG, you almost earned BARF as your call sign after your first few low levels. The pre-brief goes off without a hitch; your pilot also runs a tight show and briefs the mission at a minimum altitude of 1000 ft and maximum speed of 450 kts. During the preflight checklist, you hear the navigator set the radar altimeter alarm at 800 ft.

About twenty minutes into the flight, that old feeling hits you, and you start regretting the greasy brauts you ate for lunch. Just when you thought you were cured, it hits you. As you reach for the "barf" bag, you can already hear over the intercom the ECMO give a play by play to the front seats on your performance. You hear some laughter and a few quips about the new guy not handling the fun stuff. You remember that the navigator was taping the flight for a training video. Great! Everyone is going to know. You feel better quickly and notice that the plane seems low, but that always seems to be the case in these mountain valleys; and you don’t hear the radar altimeter alarm, so you don’t say anything. The next thing you know, the aircraft pitches down and rolls right. Something yellow blurs past and the aircraft shakes a little. You ask what is going on and hear the navigator and the pilot discussing something about a gondola. Gondola? There aren’t any gondolas on this mountain. Since you are working on your navigator qualifications, you have a chart of the route and, sure enough, there isn’t a gondola on the chart. The pilot tells everyone else in the plane that he thinks he may have just missed a gondola. Your plane immediately returns to the airbase.

It turns out that although you missed the gondola, your wing tip cut one wire and the vertical stabilizer cut the other wire supporting the gondola. It fell to the bottom of the valley, killing 20 persons aboard. The cable was 300 feet above the valley floor. At the airbase, you are all immediately split up and questioned. You don’t say much, because you were busy with your station and the backseat affords little view. You tell the investigators that you are sure you heard no radar altimeter alarms.

That night, the other ECMO visits you with the navigator. They want to know what you think about the video tape. The navigator has not even looked at it, but he figures that the host country will use the puking incident to hang the entire crew. You have felt partially responsible and are afraid that you might have distracted the pilot.

Aircraft Mishap Incident Case Study (con't):

What could have been done to prevent the accident?

What responsibilities did the crew have to ensure the mission went according to briefing?

Pilots on low levels must closely watch the terrain to ensure aircraft safety. Must they also watch the altimeter at the same time to adhere to regulations?

Should the crew have trusted an automatic alarm?

Who is responsible for the accuracy of the charts?

Who sets the safe flight envelopes? The Italians required a minimum altitude of 2000 feet. The squadron was unaware of the requirement. Who is responsible?

The navigator wants to turn the tape in, but the other ECMO wants it to simply disappear. What would you do and why?