SUBMARINE QUALIFICATION NOTEBOOK
FOR USS SIRAGO (SS 485)

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NUM.1996.007.009
SUBMARINE QUALIFICATION NOTEBOOK

DECLASS IN FULL

per OPNAVINST 5513.16-02 by
COMNAVSEA DECLASS TEAM on
4-31-73

Other Agency Interest DECLASSIFIED
YES NO

P.O.C. for CLASS/DECLASS
Commander Naval Sea Systems Command
Attn: Security Office, SEA 01T
2531 Jefferson Davis Hwy
Arlington, VA 22242-5160

LTJG A.H. HAWK, USN
U.S.S. SARAGO (SS-485)
UNITED STATES NAVY

OFFICER REQUIREMENTS

FOR

SUBMARINE QUALIFICATION

***************

NOTEBOOK PREPARED

AND SUBMITTED

BY

LIEUTENANT JUNIOR GRADE, USN

(USN)

ALLAN H. HANK

(Name)
FOREWORD

"Qualification in Submarines" is required for all officers serving in submarines to ensure that every situation, no matter how grave, will be skillfully and competently handled by the first available officer.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>FOREWORD</th>
<th>Instruction for Qualification</th>
<th>iii</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFACE</td>
<td>Qualification Procedure</td>
<td>vii</td>
</tr>
<tr>
<td>PREFACE</td>
<td>Schedule for Qualification</td>
<td>x1</td>
</tr>
<tr>
<td>PREFACE</td>
<td>Instructions for Qualification</td>
<td>xv</td>
</tr>
<tr>
<td>CHAPTER 1</td>
<td>Damage Control</td>
<td>1-1</td>
</tr>
<tr>
<td>CHAPTER 2</td>
<td>Escape and Rescue</td>
<td>2-1</td>
</tr>
<tr>
<td>CHAPTER 3</td>
<td>Weapons</td>
<td>3-1</td>
</tr>
<tr>
<td>CHAPTER 4</td>
<td>Tactics</td>
<td>4-1</td>
</tr>
<tr>
<td>CHAPTER 5</td>
<td>Operations</td>
<td>5-1</td>
</tr>
<tr>
<td>CHAPTER 6</td>
<td>Supply</td>
<td>6-1</td>
</tr>
<tr>
<td>CHAPTER 7</td>
<td>Special Purpose Submarines</td>
<td>7-1</td>
</tr>
<tr>
<td>CHAPTER 8</td>
<td>Watch Standing, Navigation and Seaman-ship</td>
<td>8-1</td>
</tr>
<tr>
<td>CHAPTER 9</td>
<td>Engineering</td>
<td>9-1</td>
</tr>
<tr>
<td>CHAPTER 10</td>
<td>Requirements for Qualification for Command of Submarines</td>
<td>10-1</td>
</tr>
</tbody>
</table>
QUALIFICATION PROCEDURE

The procedure for qualification in submarines is set forth in the Bureau of Naval Personnel Manual, Article C-7303.

"At the end of 12 months service in operating submarines, of which a maximum of 3 months may be incident to shipyard overhaul, an officer, if so recommended by his commanding officer, shall be examined by a board to determine his qualifications in submarines. If the officer successfully passes the examination, he will be recommended for qualification in submarines, and, upon final approval by the Chief of Naval Personnel, he will be designated "Qualified in Submarines." If the candidate fails to pass the examination, the board will state in its report whether further retention in submarine duty, with a subsequent reexamination is recommended. If, after the required length of service, the commanding officer is unable to recommend that an officer be examined for qualification, he will forward a report to that effect to the Chief of Naval Personnel, stating the reasons therefore, and whether or not the commanding officer recommends that the officer concerned be given more time in which to prepare himself for the examination."

A commanding officer may recommend an officer for examination for the designation "Qualified in Submarines" when the following have been accomplished:

1. Fully and satisfactorily complete the requirements as set forth herein.

2. Acquire a working knowledge of the construction and operation of the machinery installation, of the submarine in which he is serving.

3. Understand the hull construction of the submarine in which he is serving.

4. Demonstrate that he is temperamentally qualified for submarine duty.

5. Serve the required time in operating submarines.

6. Be certified by a medical officer as to his physical qualifications as of the date of recommendation.

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vii
QUALIFICATION PROCEDURE (Cont'd)

Examination

1. The examining board will be appointed by the division commander and will consist of the division commander and two submarine commanding officers, neither of whom shall be the commanding officer of the officer to be examined.

2. The candidate shall be examined by the division commander and the other members of the board. The examination will consist of three (3) parts.

   a. An underway examination of operational requirements.

   b. An In-Port written examination.

   c. An In-Port oral examination.
SCHEDULE FOR QUALIFICATION

(To be filled out by the Executive Officer on reporting aboard)

To be completed by officer students prior to graduation from Submarine School. Officers assigned to submarines without having attended submarine school, will complete these items on board their submarine.

Chapter 1 Part I Damage Control
Chapter 2 Escape and Rescue
Chapter 3 Part I. Weapons
Chapter 4 Part I. Tactics
Chapter 5 Part I. and II. Operations
Chapter 6 Supply
Chapter 7 Special Purpose Submarines

1 JUNE 1959

To be completed on board assigned submarine:

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EXECUTIVE OFFICER'S MONTHLY INSPECTION

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CONFIDENTIAL
INSTRUCTION FOR QUALIFICATION

1. Within a week after reporting on board, an unqualified officer shall fill out the qualification schedule and have it approved by the commanding officer. The Notebook should be completed nine months after reporting on board an active submarine and practical factors should be completed within eleven months.

2. It is highly desirable that the unqualified officer be assigned duties as assistant head of department. He should be rotated through as many departments as practical during his first year on board. Should the officer personnel situation preclude rotation, or be such that the unqualified officer is assigned head of department duties, the responsibility of qualification must not be neglected. The officer should be afforded every opportunity to accumulate seagoing experience in submarines prior to qualification.

3. In the interest of uniformity, the following are essential:

   a. All work must be included in a three-ring loose leaf notebook. (SubScol provided)

   b. All writing must be legible. **Typing is not required.**

   c. All discussion shall be in writer’s own words and stated briefly. State the question before writing the answer.

   d. Drawings are to be simple, neat, workable sketches made by actually tracing out each system. Arrows showing flow and colored pencils should be used for clarity.

   e. At the end of each chapter, a date and statement by the appropriate examining officer that all work within the chapter has been properly completed. Chapters completed at the Submarine School will be examined by the appropriate instructor.

   f. Classify notebook Confidential. Material of higher classification shall not be used.

   g. In the references at the beginning of each chapter, those items marked with an asterisk (*) should be read. The other items should be used as necessary for reference purposes.

   h. Completed assignments must be checked and approved by the Executive Officer and the Commanding Officer.
CHAPTER 1

DAMAGE CONTROL - Part I

(To be completed at Submarine School)

References:

Damage Control Manual
BuShips Manual, Chapter 88
General Information Book
BuShips Journal, Sept 54, Page 88
Manufacturers' Instruction Books
Navy Department and Force Instructions
Standard Submarine Organization and Regulations Manual
NWIP 23-10

A. Buoyancy and Stability, Written Notebook Requirements:

1. What are load conditions A, N, and M, and what is the reserve buoyancy in each?

   Condition A - tight ship. Ship complete, ready for service in every respect, including lead ballast, liquid in machinery, operating using all in tanks at full charge electric, ice storage batteries at minimum operating level, water in torpedo impulse tanks, and emergency rations, and fresh water, but without any stowage or reserve or variable fuel. In condition A, the reserve buoyancy is 923 tons.

   Condition N - surface condition, driving trim with normal fuel. Ship in operating conditions with normal fuel oil tanks half, normal quantity of other items of variable load, fuel ballast tanks empty, main ballast tanks empty, safety tank empty, and reserve ballast adjusted to bring the ship to driving trim. In this condition, the reserve buoyancy is 571 tons. - continued on page 1-1A -

2. What are the load conditions under which the submarine cannot submerge, and where is this information found?

   The submarine cannot submerge in heavy #1 condition, or in light #1 or light #2 condition if negative tanks is not flooded. This information is found on the equilibrium polygon. It is calculated from data obtained during the inclining experiment. The heavy #1 condition referred to above is the heavy #1 (MX16) condition.
Question #1 continued

Condition N - submerged with normal fuel. Ships in operating condition identical to condition N (on preceding page) except that main ballast, fuel ballast and safety tanks are flooded. The ship, in this condition has neutral buoyancy and zero fore-and-aft trim. In this condition the ship has no reserve buoyancy.

Condition M - surface condition. Driving trim with maximum fuel. Ships in operating condition with a full load of full oil in normal fuel tanks and fuel ballast tanks and normal quantity of other items of variable load. Main ballast tanks and safety tank empty. Variable ballast adjusted to bring the ship to diving trim. In this condition the reserve buoyancy is 420 tons.

Condition M - submerged condition with maximum fuel. Ships in operating condition identical to condition M (above) except that main ballast tanks and safety tanks are flooded. The ship has neutral buoyancy and zero fore-and-aft trim. In this condition the ship has no reserve buoyancy.
3. How is the equilibrium polygon established, and how is it used?

The equilibrium polygon is a graphic representation of the changes in weight and moment which are possible by varying the amount of liquid in the variable ballast and variable fuel oil tanks. The horizontal axis is the moment of ballast water about the reference point in the middle of auxiliary tanks near the center of the ship. The vertical axis is the weight by the specific water. The equilibrium polygon is primarily for the easy design to determine if the submarine can be properly ballasted in all conditions of loading.

4. What is meant by transverse and longitudinal metacentric height?

As shown in the above diagram, when a vessel is tipped, the center of buoyancy moves from B to B1. The metacentre is the point of intersection of a vertical line through the center of gravity and a vertical line through the new center of buoyancy. The distance BM is known as the metacentric height. When M coincides with B, the metacentric height is positive and the ship is stable. A negative metacentric height makes the ship unstable. Transverse metacentric height is illustrated in the above diagrams. Longitudinal metacentric height is calculated with respect to the longitudinal axis.

5. Compare the relative transverse and longitudinal stabilities surfaced and submerged, describing the relative positions of B, M, and G.

On the surface, the longitudinal stability of a submarine is roughly 3.50 times greater than the transverse stability. The points B, M, and G are in the following positions from the keel: B, B, and M. As the ballast tanks fill, the displacement becomes less with consequent rising in B and lowering of M. Here is a point during submerged or surfacing when B coincides with 6 and 6 M becomes very small but positive. During a normal dive the point is passed so quickly that there is no time for the ship to take a list. When the ballast tanks are fully filled (B coincides to the normal center of buoyancy of the pressure hull), and stability is required with 6 below B, the longitudinal 6 M and the transverse 6 M are the same for a submerged submarine except for the effect of free surface, free communication, and bubble effect of present.
6. Compare the range of stability and the angle of heel for given upsetting moments in load conditions N and M.

Righting arms for the range have been calculated for both conditions N and M up to 90° of inclination. The ship is stable beyond 90° for both conditions, but no data has been collected to designing the full range of stability. It is probable that equipment within the ship would come loose beyond 90° angle of heel. The maximum righting arm for condition N occurs at 35° angle of heel and has a value of 49 feet. The maximum righting arm for condition M occurs at 72° angle of heel and has a value of 57 feet.

7. Describe the information contained in and the use made of the following plans:

a. Displacement and other curves.

The displacement and other curves are a set of curves which show the various properties of the shape of the underwater body of the ship. The curves are made up by either 845 ships or during activity from the designed series of the ship. A single set of curves is applicable to all ships with the same hull form. Each curve depicts a different property of the hull form for the various drafts.

- continued on page 1-3A -

b. Cross curves of stability,

Cross curves of stability are made by inking a drawing of the ship's lines at a given angle, and laying off a series of water lines. For each water line the value of the righting arm is calculated for the assumed center of gravity. Righting arms in feet are plotted vertically against ton displacement horizontally.

- continued on page 1-3B -
Question #7 (a) continued

The range of drafts covered extends from zero to somewhat above the maximum operating draft to be expected, and are figured with zero trim and list. In addition to displacement, the following curves are normally made up:

1. Vertical center of buoyancy

This curve means draft in feet is plotted against displacement in tons. A curve of center of buoyancy above the base line, as a diagonal line representing center of buoyancy at various drafts, are plotted to calculate KB.

2. Transverse metacentric (KM)

3. Longitudinal metacentric radius (BM)

4. Moment to change trim one inch

This curve is used to find the moment in foot tons required to change the trim one inch by either the bow or stern.

5. Center of flotation

This curve is used to find the longitudinal center of flotation or center of gravity of the waterplane, with reference to the mid- perpendicular or another reference point.

6. Tons per inch immersion

7. Addition to displacement for one foot trim systems
The cross curves are used to make stability curves by drawing a vertical line on the cross curve sheet at the displacement corresponding to the mean draft of the ship, at the intersection of this vertical line with each of the cross curves, read the values of righting arm on the scale of feet at the left. This value of righting arm is then plotted at the corresponding angle of heel on the grid for the stability curve. A smooth line is drawn between the series of such righting arm values from 10° to 90° angle of heel to give the stability curve.
B. Hull Strength, Written Notebook Requirements:

1. List and describe the factors which determine basic hull strength.

I. Basic factors which determine hull strength:

A. Stress-strain curve of metal used
   1. Yield strength
   2. Ultimate strength

B. Ratio of hull thickness to hull diameter. Strength varies directly.

C. Ratio of length between frame to hull diameter. Strength varies inversely.

Beyond certain limits of t/D, no further loss or gain of strength is attained. With proper t/D and L/D the hull is calculated to fail by true shell yield. The other failure type is called elastic instability, and indicates improper t/D and L/D. This failure occurs before true shell yield strength is reached. Hoop stress and column effect cause node-type failure patterns between supports or hard spots. Circular form is of prime importance.

II. Additional factors influencing attainment of basic designed hull strength:

A. Hull openings
   1. Material surrounding the opening is built up to compensate for loss of shell strength due to the material removed.
   2. Build-up areas form hard spots and weaken the overall shell due to uneven yielding with the shell.
   3. Circular openings about 6” radius are least harmful. Rept test are openings with at least 6” radius corners.

- continued on page 1-4A -
Question #1 continued

B. Welds
1. Welds at best cause locked-in stresses
2. Both the seam outline and the weld cross-section itself must be carefully designed to minimize stresses and hard spots.
3. Workmanship must prevent cracks, undercuts, pores, and insufficient penetration.
4. All welds must be thoroughly inspected by approved instrument systems for freedom from faults.
2. List and describe the service factors which affect the actual hull strength during the lifetime of the submarine.

In service factors affecting actual hull strength:

1. Corrosion. Weakens the metal. To prevent use vinyl paint system with proper surface preparation and application methods. Vinyl retains its sealing envelopes longer than other paints.

2. Irregularities such as nicks, cuts, burrs and protrusions are stress raisers and weaken the hull. Prevent or properly repair these irregularities.

3. Welds. Welds cause stresses. Extreme care must be exercised to insure only top quality welds are attained. All welds must be thoroughly inspected.

4. Unauthorized repairs or alterations. Permit nothing to be accomplished on the hull which can weaken it.
3. **Explain the possible effects of exceeding test depth without reaching collapse depth.**

Exceeding test depth without reaching collapse depth is hazardous due mostly to the unknown factors involved. Collapse depth is calculated and it is impossible to forecast exactly how much pressure individual hulls will withstand. Hull fittings and piping are likely spots to be affected by unusual stresses. Unusual stresses on the hull and fittings may weaken the ship to the extent that it will no longer be able to withstand stresses normally encountered when operating at test depth.

4. **Describe the report required after exceeding test depth.**

The report required after exceeding test depth is a letter explaining the circumstances involved to the Chief of Naval Operations via BUSHIPS with copies to CONSUBRON SIX and CONSUBLANT. Paragraph 11-112 of Buship's Manual states: "In every instance when the above limits of submergence are exceeded, a report in full of all attended circumstances must be made to the Chief of Naval Operations, via the Bureau of Ships."
C. Emergency Procedures, Written Notebook Requirements:

1. List the steps required to maintain depth control if each compartment were individually flooded while submerged.

The volumes of each compartment in cubic feet, tons, and pounds of salt water can be found in Part II, Question 1 of this chapter. The volumes found in that table are used in the following examples of compensating for a flooded compartment.

When a compartment is flooded, its weight in tons of salt water is multiplied by its mean distance forward of aft of the center of buoyancy to produce a moment in foot tons. The equivalent upward or downward moment as possible is calculated for tanks which would be blown in an effort to regain forward and aft trim and overall trim. It should be noted that any two compartments (excluding the conning tower) becoming flooded will result in an uncontrollable moment and negative buoyancy. The conning tower is roughly compensated for by blowing safety tanks.

(a) Forward Torpedo Room Flooded

- 127.4 tons x 104 feet = 13,200 ft tons produced as a downward moment
- 26.61 tons x 122 feet = 3,370 ft tons - MBT #1 blown
- 12.26 tons x 132 feet = 1,620 ft tons - Bow Buoyancy tank blown
- 26.66 tons x 96.6 feet = 2,460 ft tons - Forward trim tank blown
- 64.54 tons x 44.71 feet = 2,800 ft tons - MBT #2A and #2 blown
- 162.92 tons x 26.50 feet = 2,710 ft tons - MBT #2C and #2D blown

Total ft tons blown = 12,960 ft tons produced as an upward moment

Even trim is possible by blowing the above tanks and adjusting negative.

(b) Forward Battery Compartment Flooded

- 119.7 tons x 62 feet = 7,500 ft tons produced as a downward moment
- 26.61 tons x 122 feet = 3,370 ft tons - MBT #1 blown
- 12.26 tons x 132 feet = 1,620 ft tons - Bow Buoyancy tank blown
- 26.66 tons x 96.6 feet = 2,460 ft tons - Forward trim tank blown
- 64.54 tons x 44.71 feet = 2,800 ft tons - MBT #2A and #2B blown

Total ft tons blown = 10,600 ft tons produced as an upward moment

Even trim is possible by blowing and adjusting the above tanks.

- continued on page 1-7A -
In the above example, it can be seen that by blowing all tanks available toward the same upsetting moment neutral buoyancy and forward arch stability may be maintained. In actuality, a quick flooding of any dry compartment by collision, etc. would probably be over compensated for by the diving officer giving the order to blow everything. This order would give him immediate positive buoyancy and he must act quickly by opening vents to control the severe upward surge or forward lift bubble.

If each compartment were to flood, luck the diving officer would maintain depth control by blowing or pumping tanks in the vicinity of the affected compartment. The example for exact compensation illustrates this procedure for the forward torpedo room and the forward battery. Naturally, if control were flooded there would be little opportunity for the diving officer to do any compensating. The after battery would be compensated for by blowing the forward and after groups to the desired level. The forward and after engine rooms would be compensated for by blowing the after group. Maneuvering room, being small, could be handled by MBT 60c and 60d, and after trim tanks. The after torpedo room could receive blowing the after trim tank and the after group.
2. List the most probable methods of chlorine generation inside the submarine, and describe the urgency of the hazard in each case.

Chlorine gas is generated when salt water comes in contact with submarine battery electrolyte. The most probable cause of this situation would be a collision with an accompanying flooding. The primary concern of the submarine would be to stop the flooding and the generation of chlorine would be secondary. However, the effects of chlorine must not be overlooked.

Chlorine presents an urgent hazard. It can be detected by its heavy, pungent odor like a bleach. The forward engine room personnel should be the first to sense it since they will be near the ship's ventilation exhaust.

The most important way to combat chlorine is to ventilate properly, isolate the affected compartment and remove the salt water from the battery wells. If the gas becomes great, MSA air tanks can be used. Chlorine gas is fatal in sufficient quantities, and should be considered as an urgent hazard in spite of the fact that the usually accompanying flooding will be the foremost casualty.
3. List the most probable causes of class A, B, and C fires inside the submarine or her tanks, and describe the best methods of combating each.

Class A fires are fires in ordinary combustible materials (such as bedding, clothing, wood, canvas, rope, and paper) where the cooling effect of water is of first importance in extinguishment. Material of this type must be cooled throughout the entire mass before extinguishment is complete. In fires of this nature, which are widespread, water with a direct solid stream is best. However, because of the time involved in breaking out the hose, putting it on the trim line hose connection and lining up the trim manifold, this method usually is not used. Most Class A fires are detected early, and a ready CO₂ bottle is broken out and the fire is smothered with CO₂.

Class B fires are fires in inflammable liquids (such as gasoline, oil, grease, paint and turpentine). Materials of this type burn at the surface where the vapors are given off, and a smothering or blanketing of the burning liquid is best for extinguishment. Foam is not used in submarines because of the residue it leaves when spread. This type of fire could easily occur when using varnish paint topside or when spraying varnish in the tanks, and CO₂ would be best for smothering and depriving the fire of oxygen. An oil fire within the submarine would be fought with CO₂ and by isolating the affected compartment to cut off the source of oxygen.

Class C fires are fires in electrical equipment, and are quite common in submarines. In most electrical fires it will be necessary to de-energize the circuits before any progress can be made.

-continued on page 1-9A-
Question #3 continued

CO₂ is a non-conductor of electricity and will not damage electrical equipment. Every compartment contains at least one CO₂ bottle. The maneuvering room is the most common place for electrical fires, and the personnel there are particularly alert to detect any unusual odors or noises which might indicate fire.
4. List the most probable types of hull and pipe damage from:
(a) collision forward surfaced, and (b) collision in the conning tower submerged, and describe the patching methods used in each case.

The most probable types of hull and pipe damage resulting from collision are:

1) Holes in the pressure hull
2) Ruptured lines and piping

If the hole in the pressure hull has a diameter of about 6 inches or less, it may be plugged quickly with "T", "I" or "L" bolts, rubber sheeting, and steel plate. This is a temporary patch which, if properly used, would retain the use of the compartment. Pressure leakage of the patch could be taken care of by use of the trim and drain pumps. The best patch, if time permits, is the welded patch. Small holes may be plugged by drilling, tapping, and inserting a screw or bolt. To help control flooding from large holes it is necessary to use shoring to hold large plugs in place. Buck stanchions, bunks, mattresses, torpedo room "I" beams and engine room floor plates are excellent shores or strong backs to distribute weight or pressure.

Again, rupture of leaking pipelines can be made by use of items available in the material bag in the damage control kit. This bag contains the following essentials for repairing pipe lines:

1) Band-it strength strips, steel bands and buckles
2) Hinges and "C" clamps
3) Lead and rubber gasket material
4) Ball of marline
5) Wooden wedges, ranging from 1 inch to 2 1/2 inches

- continued on pages 1-10A -
Question #4 continued

In large water or oil lines where the flow cannot be stopped, damage can be checked by jamming any available plug into the hole, sawing the plug almost flush, placing a sheet of rubber over the plug and binding it with marlin. Later the line can be bypassed and proper repairs made. This type of patch is only practical in large lines carrying fairly small pressures. This type of patch using marlin could be used on elbows and places where a hinge clump or bend it bend, and strongbacks cannot be used, or when the proper size clump or bend is not immediately available. Band-it, hinge and "C" clamps are effective for patching small lines and hoses.

Damage to a line that has been blown in two, can be repaired by use of the plastic emergency patch consisting of fibrous glass reinforced plastic. The plastic patch is capable of withstanding pressures up to 300 psi and temperatures up to 200°F.
5. Describe the methods of controlling heavy flooding from hull ruptures, both below the waterline surfaced and in the overhead submerged.

Whenever a hull rupture occurs the collision alarm is sounded and the submarine is completely sealed up.

If a rupture occurs below the waterline when surfaced the affected compartment is placed under a pressure by use of the 225 pound internal air salvage system. This action will bring the water down to the level of the hole. On the surface or at periscope depth this pressure will not affect the occupants of the compartment enough to impair their damage control efforts. Very little damage control equipment is carried aboard submarines. Horing and wedges would be very difficult to store. To stop the flooding a temporary plug is applied made up of anything at hand such as mattresses, bedding, stanchions, etc. When the leakage has been slowed so that the drain pump can keep the level of the water low the pressure is released. At that time a hull patch (as described in Chapter 6 of the Submarine Damage Control Manual) would be obtained by the damage control party and they would apply the patch to the hole so that the leakage would be stopped or slowed as much as possible.

If a rupture occurs in the overhead when the submarine is submerged a large degree of ingenuity in the use of available equipment together with quick thinking and decisive action is an important factor in conjunction with hull patching. A large hole might mean abandoning the compartment. However, if the hole has a diameter of about 6 inches or less, it may be plugged quickly with a collapsible "T" belt.

- continued on page 1-11A -
Question #5 continued

rubber sheeting and steel plate. This is a temporary patch which, if properly used would retain the use of the compartment. Excessive leakage of the patch could be taken care of by use of the trim and drain pumps.

If the situation permits, the submarine should surface and weld a temporary patch over the hole until permanent repairs can be made.
6. Describe the means of minimizing the effects of an air nuclear burst surfaced.

An air nuclear blast is accompanied by a blinding flash, a shock wave, a heat wave, and radiation. If possible, the best possible action would be to submerge. If this is not possible immediately, the OOD and any other personnel on the bridge should shield themselves from the blast as best they can. The OOD should lead the submarine directly away from the blast. The ship should dive as soon as possible to cleanse the superstructure of radioactive dust or particles and to avoid contact with any large waves which may be formed by the blast.

As soon as the OOD has an indication that a blast will occur or has occurred, he should shut all bulk openings. The still and all possible sea water circulating systems should be secured.

7. Describe the means of minimizing the effects of a deep underwater nuclear burst submerged.

Minimum effects for deep underwater nuclear blast submerged are encountered at greatest depth. Battle stations should be manned and the ship rigged for depth charges. The ship should be headed directly away from the direction of the blast and the area cleared of the best possible speed. The still and all possible sea water circulating systems should be secured.
8. Describe the most probable methods of enemy biological attack in port, and the methods of combatting these methods.

The most probable method of biological attack would be via aerosolized organisms which include bacteria, fungi, rickettsia, or viruses or a combination of these are dropped to explode and spread over a wide area. Another method of transmission is via ships or aircraft entering port and polluting the water with bacteria. In both of these cases the biological attack is directed at the population of the area. The only effective method of combatting these would be a strong air and sea defense which would prevent any aircraft or ships from getting through.

The most probable method of attack against a submarine would be sabotage of the food supply before it was taken on the ship or a visitor could pollute the food supply or the ventilation with a bacteria or virus.

However, biological warfare is usually aimed at population masses and the submarine's main problem would be to carefully inspect everything coming on the ship and allow no visitors on the ship.

9. Describe the method of air purification and revitalization used during submergence periods of unusually long duration.

These are three air revitalization and purification:

1. Bleeding air into the boat
2. Bleeding oxygen into the boat
3. Spreading CO₂ absorbent

The air bleeding method is accomplished as follows:

Bleed into the boat air from the compressed air banks at the rate of 31 cubic feet of air at atmospheric pressure per man-hour. This is done by pumping a vacuum of 2 in. of the boat and discharging the air from the HP air compressor to a low tank before bleeding air. The tank is then labeled as containing contaminated air. Then air from another tank is bled into the boat. This process is repeated as required.

Bleeding air is a method of revitalization.

- continued on page 1-13A -
Question #9, continued

A method of air purification consists of spreading CO₂ absorbent when it is known that the ship will be submerged until the CO₂ percentage could reach 27% concentration. Each canister of CO₂ will remove the carbon dioxide accumulated during a period of 144 man hours. The contents of the can should be spread evenly over the mattresses covers on the lower bunk or in the lower portions of non-breathing compartments immediately after submerging for an extended period. The absorbent must remain dry, and care must be taken to ensure that the absorbent dust is not breathed, since it is a harsh irritant to the nose and lungs. The chemical must be spread smoothly and thinly over a wide area for maximum effect. When it is working, it gives off heat and a crust forms on the surface. When it no longer evolves heat, it must be stirred gently to bring fresh absorbent to the surface.

Complete data for formulas, etc., concerned with air purification are found on pages 3-77 of the Ship's Organization Book.

Air revitalization is similar to blowing air into the boat with the exception that oxygen from oxygen bottles is fed into the boat instead of air from the air banks. The high pressure value on the top of the bottle is opened, the low pressure valve is cracked and oxygen is fed so that the high pressure gauge drops 8.65 times the number of men in the compartment. The normal amount of oxygen in air is 21% and the lower allowable limit is 17%. 
CHAPTER 1
DAMAGE CONTROL - PART I

This is to certify that all work within this section has been completed.

Approved:

J.P. Eadie, II, LTJG, USN

R.M. Weidman, Jr., LCDR, USN

E. Peters, LCDR, USN

CONFIDENTIAL
CHAPTER 1

DAMAGE CONTROL - Part II

(To be completed on board your submarine)

A. Written Notebook Requirements:

1. Make a simple line sketch of your submarine showing all tanks and compartments and listing the floodable space in each tank and compartment in cubic feet, tons salt water, and pounds of salt water.

   A line sketch of the storage showing all tanks and compartments appears on page 1-14A.

   A table listing the floodable space in each tank and compartment in cubic feet, tons salt water, and pounds of salt water appears on pages 1-14B and 1-14C.
Compartments and Tanks, Side View

Compartments and Tanks, Plan View
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2. Make a simple line sketch of your submarine showing the location of all damage control equipment, including fixed systems used for damage control, such as salvage air and drain systems.
3. Describe the uses of all damage control equipment carried in your submarine.

OBA - The oxygen breathing apparatus is a self-contained apparatus designed to protect the wearer in any irrespirable atmosphere. The wearer breathes in a closed system. His exhaled air is purified and replenished with oxygen as it passes through the chemical in the canister.

Portable oxygen/hydrogen cutting and welding outfit - The portable cutting and welding outfit can be used for temporary or permanent repairs. Due to its compactness and small size it can be easily carried by two men to the scene of the damage. The outfit may be used to handle the following jobs:

1. Oxygen/hydrogen cutting
2. Oxygen/hydrogen welding
3. Oxygen/hydrogen brazing

Fire extinguishers are of the CO₂ type. They are useful in fighting class A, B, and C fires. Foam is not carried aboard submarines. Sea water is difficult to bring into fact and effective use. CO₂ is used primarily for all classes of fires.

The medical bag contains emergency medications, prepared bandages, splints, and drugs for first aid use.

The tool bag contains wrenches, screwdrivers, fuse pullers, general tools and wooden plugs.

The portable submersible pump is used to assist other pumps or to pump areas which could not be pumped by any other means. Non-collapsible hose is used with the submersible pump.

Band-It kits and straplocks are used to repair pipe ruptures.
4. List the following regarding your submarine:
   a. Tons per inch immersion.
      At condition N, surfaced, tons per inch immersion equals 12 1/2 tons per inch (25,000 pounds).
   b. Moment to change the trim one inch.
      At condition N, surfaced, diving trim, moment to change trim one inch equals 215 foot tons.
   c. Moment to change the list one degree.
      At condition N, surfaced, diving trim, moment to change the list one degree equals 42.54 foot tons.
   d. Metacentric height in load conditions N and M.
      Metacentric height in load condition N = 1.32 feet.
      Metacentric height in load condition M = 1.24 feet.
   e. Range of stability in load conditions N and M.
      The range of stability in load conditions N and M is over 90°, but the complete range has never been calculated.
   f. Reserve buoyancy in load conditions N and M.
      Reserve buoyancy in load condition N = 571.34 tons.
      Reserve buoyancy in load condition M = 428.04 tons.
CHAPTER 1

DAMAGE CONTROL - PART II

This is to certify that all work within this section has been completed.

Approved:

J.P. Eadie, II, LTJG, USN

R.M. Weidman, Jr., LCDR, USN

B. Peters, LCDR, USN
CHAPTER 1

DAMAGE CONTROL - Part III

(To be completed on board your submarine)

A. Practical factors requiring notebook recording:

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1. Satisfactorily demonstrate ability to use the following damage control equipment:
   a. OBA, with quick-starting canister.
   b. Damage control kit, consisting of tool roll, material bag, and band-it kit.
   c. Plastic patch.
   d. Adams patch.
   e. Hull patch.
   f. CO₂ extinguisher.
   g. Dry powder extinguisher.
   h. CO₂ absorbent.
   i. CO₂ indicator.
   j. Oxygen bottle.
   k. CO indicator.
   l. Hydrogen portable indicator.
   m. All radic equipment carried.

2. Supervise a radiological monitoring team and a radiological decontamination team during an atomic attack drill.

3. Satisfactorily perform duties of damage control officer during a fire drill and during a collision drill.
CHAPTER 2

ESCAPE AND RESCUE

(To be completed at Submarine School)

A. Written Notebook Requirements and Sketches:

1. Sketch an escape trunk.
2. Discuss in detail the escape procedure used in each torpedo room.

**Forward Torpedo Room**

The senior man in FTR is in charge and directs all activities. CO2 absorbent should be used, taking care that it won't become wet. Attempt to establish communications with ATR and remove all pyrotechnics and CO2 bottles to the forward battery compartinent or a dry torpedo tube.

In depths less than 150 feet set the oxygen bottle regulator at 60 pounds in excess of sea pressure; or if below 150 feet charge the Money lungs with 225 pound air. Remove locks from all valves; test all valves for freedom of operation; test 225 pound air supply to the trunk and blow dust from the charging hose on the trunk. The first team of three men enter the trunk with their lungs, the ascending line buoy, and the life raft. They then securely log the upper and lower hatches, swing the door, and commence rapidly flooding the trunk. When the water level is above the door, secure flooding and pressurize with 225 pound air until the doors open. Clear the escape route of obstructions and release the life raft and the ascending buoy, securing their respective lines to the submarine when they are on the surface. Charge lungs and proceed up the ascending line. The last man to leave the trunk tags twice on the lower hatch to indicate that the trunk is empty. The men remaining in FTR wait one minute, shut the door with the inboard shutting device, drain the trunk, and then repeat the escape process in four man teams, with the exception of handling the life...
raft, and the ascending buoy, until all the men have escaped.

The new Buoyant Ascent method employs the above procedures with the following exceptions:

1. A life jacket with special relief valves is used instead of the Monsen lung. The escapee inflates the air from his lungs in the way to the surface. The life jackets are inflated using the regular charging lines in the trunk.
2. No ascending line is used.

**After Torpedo Room**

The senior man in the ATR is in charge and directs all activities. Attempt to establish communications with the FTR and remove all pyrotechnics and CO2 bottles to the maneuvering room or into a dry torpedo tube. In depths less than 150 feet set the oxygen bottle regulators at 60 pounds in excess of sea pressure, or if below 150 feet charge the Monsen lungs with 225 pound air. By the escape shaft in the lowered position. Make sure that the watertight door is shut and dogged, and bulkhead paddles under the hatch, secure the loading hatch and cinch the dogs, eject electric torpedoes, and turn off all lights except for battle lanterns. After blowing down the charging lines, each man puts on his lung. Flood the room rapidly through the signal

-continued on page 2-3A-
ejector, a torpedo tube, or through WRT tank with the access opening off. When the water level reaches the skirt, pressure is equalized with sea pressure using 225-pound air and the patch will open, and the trunk will flood. Sending the body and the ascending line, securing it to the submarine, charge the bungs and commence individual escapes. After a few men have ascended, the life raft is sent up, and all men ascend in succession.

The buoyant ascent method may also be used in the after torpedo room.
3. Discuss the following air revitalization processes:

a. Supply fresh air from air banks.

b. Supply O₂ from O₂ bottles.

c. Reduce CO₂ concentration by use of CO₂ absorbent.

   a. To supply fresh air from the air banks it is first necessary to remove as much of the stale air as possible. This is accomplished by pumping down the pressure in the submarine to about 200 pounds of pressure, using the high pressure air compressor, and discharging this air into the lowest air bank which should then be tagged as containing stale air. Fresh air from one of the other tanks can then be bled into the submarine.

   b. To revitalize the air by supplying O₂ from the O₂ bottles stowed in all compartments, it is only necessary to crack open the high pressure gage, open slightly the low pressure gage, and allow oxygen to bleed into the compartment until the high pressure gage shows a drop of 5.65 pounds of pressure times the total number of men in the compartment. All compartments follow this procedure, using a bottle completely before shifting to a new bottle.

   c. CO₂ absorbent is carried in 15 pound cannisters in all compartments. Each cannister will remove the CO₂ produced by approximately 150 men in one hour. If it is anticipated that the submarine will remain submerged for a period of 17 hours or longer, CO₂ absorbent should be spread evenly over mattresses, cover on the lower bunk, or in the lower portions of men lying compartments. Care must be exercised to prevent causing the absorbent to give off dust since the chemical is caustic and the absorbent must remain thoroughly dry. Little stirring of the absorbent will assist the CO₂ absorption process. When the chemical no longer evolves heat, it has become saturated and more absorbent must be added.
4. Under increased pressures what effect does the following gases have on a person's reaction?

a. Carbon Dioxide

b. Nitrogen

c. Oxygen

   a. Carbon dioxide in concentrations of 2% or above under increased pressures will progressively produce giddiness, loss of coordination, unconsciousness, and possibly CO₂ poisoning which is fatal.

   b. Under increased pressures nitrogen has a narcotic effect on the body, evidenced by decreased ability to do work, changes in mood, slowing up of mental activity, and fixation of ideas. Frequent errors may be made in simple arithmetical calculations, and in the reading of dates. The body reacts the same as in the case of lack of oxygen or alcoholic intoxication.

   c. Oxygen under increased pressures has a toxic effect. It causes strychnine-like effects upon the nervous and muscular systems causing the victim to have a sense of suffocation, and inability to breathe, shuddering and jerking of the muscles, and convulsions. It may also act as an irritant to the delicate lung membranes.

B. Completed submarine escape training.

Date 24 October 1958

         Allan H. Hawk
(Signed)
CHAPTER 2

ESCAPE AND RESCUE

This is to certify that all work within this chapter has been completed.

Approved:

E. M. Jones, Ltjg, USNR

R.M. Weidman, Jr., LCDR, USN

B. Peters, LCDR, USN
CHAPTER 3
WEAPONS - Part I

( To be completed at Submarine School )

References:

Weapons Textbooks issued to officer students
NavOrd OrdAlt 00
NavOrd 0; NavOrd 00
OP 0

A. Written Notebook Requirements:

1. Discuss the reasons for the torpedo tube interlock system.

   The torpedo tube interlock system prevents:
   1. Opening the breach door while the muzzle door is open.
   2. Opening the muzzle door while the breach door is open.
   3. Opening the muzzle door when the drain valve is open.
   4. Opening the drain valve when the muzzle door is open.

   -continued on page 3-1A-

2. What is a torpedo tube bore gauge? When is it used? Why is it used? How are torpedo tube shutter clearances obtained? When are they obtained?

   The standard bore gauge is cylindrical in shape 31.08 inches in diameter longer than the cylindrical section of a torpedo. It is used to check the diameter of the tube to insure free passage of the torpedo. The tube should be bored gauged during each drydock period. Bore gauging the tubes minimizes the possibility of torpedos sticking in the tube.

   -continued on page 3-1A-
1. - Continued
5. Firing the tube unless all the following steps have been performed:
   a. Mezzle door locked open
   b. Breach door locked shut
   c. Drain valve locked shut
   d. Depth and speed setting spindles retracted out of the tube

2. - Continued
   Torpedo tube shutter clearances are obtained by the use of a guide plate attached to the inside of the mezzle door.

   Torpedo tube shutter clearances should be obtained whenever the submarine is in the drydock.
3. What is the purpose of bore sighting a nest of torpedo tubes? When is it done?

Torpedo tubes are bore sighted to align their mean point of impact with the submarine's periscope. This is accomplished when the submarine is in drydock. Bench marks are then permanently established on the submarine for use in future checking.

4. What is the purpose of a torpedo tube strongback?

A torpedo tube strongback provides additional strength to a breech floor after it has been shut and locked, which when attached enables the door to withstand sudden increases in pressure as occur during depth charge attacks and reduces the possibility of damage to the door mechanism.

5. What information is found in NavOrd List 0, NavOrd List 00, OP 0, NavOrd OrdAlt 00?

NAVORD LIST 0 is an annually issued index listing each NAVORD LIST used in the Navy and its current revisions.
NAVORD LIST 00 tabulates the individual NAVORD lists assigned to a particular vessel to support its installed armament and ordnance equipment.
OP 0 is an index of all OP's used in the Navy.
NAVORD ORDALT 00 is an annually issued tabulation of all ORDALTs.
6. Give the characteristics for all exploders applicable to service torpedoes.

1. MK 6 MOD 13 is a contact type exploder used in the MK 14 torpedo, and is fired by an inertial ball switch which allows a charged capacitor to fire the detonator. An impeller driven DC generator, after the delay device is de-energized at 360 yards, produces a voltage which is regulated by a voltage regulator tube charging the capacitor. The rotation of the impeller also raises the detonator out of the safety chamber into the booster cavity after about 425 yards.

2. MK 9 MOD 4 is a contact-influence type exploder used in the MK 16 torpedo, containing a search coil which is used to detect the gradient magnetic field surrounding the target vessel. Upon receiving the signal from the search coil, the exploder mechanism fires the electric detonators, these in turn, fire the tetrel charge in the arming device MK 3 MOD 0 which by the booster MK 5 MOD 0 is detonated which in turn sets off the main charge.

3. MK 11 MOD 2 is an impeller-armed, electrically fired, contact type exploder used in the MK 27 MOD 4 torpedo. When the torpedo reaches a speed of 8 knots, the impeller begins to rotate. When it has rotated a pre-set distance of 360 yards, it will have rotated the detonator shutter to the armed position. Just before the arming distance cycle is completed, the distance switches close, completing the circuit to the inertial firing switch. The impeller is then ejected and the exploder is armed and ready to fire. Upon target impact the firing switch closes and the explosive train is initiated.

---continued on page 3-3A--
4. MK 14 MOD 2 is a contact type, impeller-armed exploder used with the MK 28 torpedoes, at 200 yards an anti-reflex device throws the safety switch. This closes the firing circuit which at this point is still blocked by the depth-disarming switch. At 800 yards the detonator holder having emerged completely from the safety chamber, is now inside a cavity in the bottom of the boost tube. The exploder is now mechanically armed. As the torpedo descends through 80 feet the depth-disarming switch closes and the exploder is electrically armed, awaiting the electrical impulse from the inertial ball switch.

5. MK 19 is a contact type exploder used with the MK 37 MOD 1 and the MK 39 MOD 1 torpedoes. The exploder is electrically armed with an AC motor, after the fin velocity switch completes the circuit (torpedo's speed 13 knots or greater). The detonator shutter is prevented mechanically from rotating into the armed position while in the tube by the bore rod which can not be fully extended until the torpedo is fired. By the use of a delay mechanism consisting of caps and gears, called the Accumulator, a 15 second arming time is required, making a minimum arming distance of 225 yards at high speed and 150 yards at low speed.

For the torpedoes to be fully armed the fin velocity switch must be energized, the torpedo must have enabled (minimum of 600 yards), and the torpedo must be in its set stratum.
7. For all service torpedoes and mines, list the following:

a. Speed
b. Range
c. Homing characteristics
d. Propulsion plant (general).
e. Mechanical set functions, electrical set synchronous and nonsynchronous functions with limits.
f. Running depth
g. Maximum firing depth
h. Operating characteristics after enabling.
i. Other special features, such as ACR, ASC, DCO, depth disarming switch, ceiling switch, etc.

The above listed characteristics appear on pages 3-5 and 3-6.
<table>
<thead>
<tr>
<th>Torp.</th>
<th>Speed</th>
<th>Range</th>
<th>Homing Characteristics</th>
<th>Prop. Type</th>
<th>Gyro Enabling Range</th>
<th>Running Depth</th>
<th>Electric Setting</th>
<th>Maximum Firing Depth (Feet)</th>
<th>Characteristics</th>
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<td>Hi 46</td>
<td>Hi 4500</td>
<td>Straight Run</td>
<td>Steam</td>
<td>Oto160</td>
<td>0 to 44</td>
<td>None</td>
<td>200</td>
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<td>14,000</td>
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<td>Steam Oxygen From Naval</td>
<td>Oto155 0 to 15,000 10 to 50</td>
<td>Depth Gyro Enabling Right or Left Circle</td>
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<td>Circles right or left depending upon setting.</td>
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<td>Oto155 0 to 15,000 10 to 50</td>
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<td>5600</td>
<td>Homes when sound is picked up</td>
<td>Battery</td>
<td>Oto135 600 to 3100</td>
<td>AL 70 Stratum</td>
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<td>19.6</td>
<td>4000</td>
<td>Homes when sound is picked up</td>
<td>Battery</td>
<td>Oto135 500 to 2500</td>
<td>125° Gyro Enabling</td>
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<td></td>
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<td>To acquire target need 208° above horizon. If misses target will home on new target, still misses target.</td>
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<td>19.6</td>
<td>4000</td>
<td>Homes when sound is picked up</td>
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<td>125°</td>
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<td>To acquire target need 208° above horizon. If misses target will home on new target, still misses target.</td>
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<td>Mine</td>
<td>Type</td>
<td>Firing Mechanism</td>
<td>Planting Depth</td>
<td>Up to</td>
<td>Weight of Charge</td>
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<td>Planting Depth</td>
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<td>Torp. (kts)</td>
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<td>Gyro</td>
<td>Enabling Range (yards)</td>
<td>Running Electric Depth (Feet)</td>
<td>Max. Firing Depth (Feet)</td>
<td>Characteristics</td>
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Influence Bottom

- All models:
- Sterilizer:
  - 8½ to 190 days
  - 3-145 days

Firing Time:
- 3hr + 3 to 100 days
- ½-10hrs + 10 to 100 days

3-6A

[Signature]
8. Discuss the on-board maintenance procedures for the following weapons:

a. Torpedo Mk 14 (23)  
b. Torpedo Mk 27-4  
c. Torpedo Mk 28  
d. Torpedo Mk 16  
e. Torpedo Mk 37  
f. Torpedo Mk 39  
g. Mine Mk 27

\[ \text{a. Torpedo MK 14 (23)} \]

The following are on board maintenance procedures for the MK 14 (23):

1. Daily
   - Dope the air aplank
   - Turn over the propellers on all torpedoes not having oil dope

2. Weekly
   - Check air flush pressure and oil tank levels
   - Check safety pinch mechanism, depth pendulum and diaphragm and the igniter
   - Oil the gyro
   - Test vertical and horizontal rudders

3. Monthly
   - Grease the tail section
   - Clean and oil the control valves

4. Quarterly
   - Remove hand check exploder

\[ \text{b. Torpedo MK 27-4} \]

The following are on board maintenance procedures for the MK 27-4:

1. Weekly
   - Drive the torpedo a "tickle test" noting rudder throw (6° port and 10° starboard) and rate of rudder oscillation (3 per second)
   - Test steering through full range of settings and gyro 90° right and left
   - Test fathometers at all settings
   - Check grounds for 50,000 ohms resistance to ground
Question #8 cont'd

2. Bi-weekly
   A. Refill the battery with distilled water. Refill sooner if required.
   B. Charge battery every two weeks or when the specific gravity drops to 1.250, whichever occurs first.

c. Torpedo MK 28
   The following are on board maintenance procedures for the MK 28:
   1. 48-hour routine
      A. Ventilating the battery compartment for 3 minutes using low pressure dry air.
      B. Check elevators and rudders for freedom of movement.
   2. Weekly routine
      B. Give propulsion battery a freshening charge if required (every two weeks or when the gravity drops 20 points, whichever occurs first).
      C. Rotate the propeller at least one turn to check freedom.
      D. Give the torpedo a "tickle test."

D. Torpedo MK 16
   The following are on board maintenance procedures for the MK 16:
   1. The Naval monitor is kept under surveillance at all times.
   2. Weekly:
      A. Examine gyro, after, depth, after, and nav.
      B. Rotate propeller with hand and turn 10 turns in each direction.
   3. Bi-weekly - operate rudder with 600# air.

e. Torpedo MK 37
   The following are on board maintenance procedures for the MK 37:
   1. Weekly - give the torpedo a "tickle test."
   2. Bi-weekly - charge the exercise battery every two weeks or when the gravity drops 20 points, whichever occurs first. The war battery is of the dry type and requires no charging.

- continued on page 3-8A -
Question #8 continued

5. Torpedo MK 39

The only on board maintenance necessary on the MK 39 is a weekly "tickler test".

9. Mine MK 27

The only on board maintenance necessary on the MK 27 mine concerns the battery. At least a 10 volt ground must be maintained. The battery has to be charged every two weeks or when the gravity drops 20 points, whichever occurs first.
9. List all devices which may be ejected from the signal ejector and briefly describe the operating characteristics of the ordnance devices including the maximum launching depth of each (Confidential and below).

1. Submarine Emergency Identification Signal - MK3, MODS 1, 2, 3. These flares are for either day or night use and are only to be used in the signal ejector. After injection, the flare floats to the surface. On the surface and after a total of 54 seconds delay, a powder-pellet projects the flare upward about 250 feet where a parachute opens and supports a star which burns approximately 13 seconds. The signals are available in three colors - red, green, and yellow. Maximum launching depth is 285 feet.

2. Submarine Flare Signal - MK 2, MODS 0, 1, 2. These smoke floats are for day use. They are ejected from the signal ejector and rise to the surface and make smoke for about 15 seconds. They are available in red, green, yellow, and black. Maximum launching depth is 285 feet.

3. Emergency Radio Transmitting Device, AN/SRT-347. A self-contained, low-powered transmitter powered by a magnesium-silver-chloride battery which is integral with the equipment. It transmits a CW signal on a frequency of 121.5 MHz (VHF International Distress Frequency) at a power of 0.75 watts for about three hours indicating that a submarine has been sunk. It can be launched from a maximum depth of 1000 feet.

4. Evasion Devices
   a. False Target Can MK 2, MOD 0. A submarine-ejected instrument used to confuse and disrupt enemy underwater echo-ranging. It can contain nine metal wedges filled with a lithium hydride paraffin mixture.

- continued on page 3-9a -
Question #9-4 continued

When this mixture is exposed to sea water, it generates a bubble cloud in the water. The hydrogen bubbles return an echo of the same order and magnitude as that returned by a submarine. The persistence of echo ranges from 4 to 8 minutes. These pogs can be released individually or in any desired number up to a depth of 1000 feet.

b. NAE Beacons MK 2 MOD 3 and MK 2 MOD 4

NAE beacons are expendable acoustic decoys to protect submarines against passive acoustic homing torpedoes and to interfere with sonar. They may be launched from depths down to 1000 feet. After launching they generate broadband sound (with the greater part of their acoustic energy between 5 and 30 kc), float up to about 20 feet below the surface, hover at that level, and then sink. The noise starts 10 to 25 seconds after launching, or after the time delay (up to 10 minutes), which is set in advance. The noise then continues, at full output for 18 minutes, and at gradually reducing output for approximately 12 minutes more. The beacon loses buoyancy and sinks in about 30 minutes. The MODs 3 and 4 differ in certain construction details.
CHAPTER 3
WEAPONS - PART I

This is to certify that all work within this section has been completed.

Approved:

E. M. Jones, Lt.jg., USNR

R. M. Weidman, Jr., LCDR, USN

B. Peters, LCDR, USN
CHAPTER 3

WEAPONS - Part II

(To be completed on board your submarine)

A. Practical Factors

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<th>Date</th>
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</table>

1. Satisfactorily demonstrate knowledge of ordnance safety precautions by passing an oral or written examination conducted by the Ordnance Officer.
2. Make ready a torpedo tube and fire a water slug.
3. Fire an inboard slug.
4. Supervise loading a torpedo from topside into the room, from the room into a tube.
5. Make weekly test of magazine and/or pyrotechnic flood system.
6. Load and fire signal ejector.
7. Demonstrate proper handling of small arms.
8. Conduct one test on the angle solver and position keeper.
9. Set angle solver cams for the different marks of torpedoes.
10. Under supervision of the torpedo officer, supervise all on board tests, preliminary, and final adjustments for one of each type of torpedo listed in the ships war load.
11. Supervise a battery charge for an electric torpedo.
12. Ventilate and electric torpedo while it is in a tube and another while in the torpedo room.

B. Notebook sketches to be completed.
1. Magazine and/or pyrotechnic flooding system.
   Sketch appears below.

2. Torpedo tube flood, drain, and blow systems, including impulse and poppet systems.
   Sketch appears on page 3-11A

3. For water ejection tubes, in place of poppet system in above sketch, substitute the hydraulic ejection system.
   The drago does not have water ejection tubes.

Magazine And Pyrotechnic Flooding System
Torpedo Tube Flood, Drain, Blow And Poppet Systems

Hammer Valve
High Pressure Air Line

Impulse Flask
Charging Manifold

Stop Valve

Hammer Valve
Check Valve

Impulse Flask

225# Air

Stop Valve

Blow And Vent Manifold

Vent to Bilges

Impulse Flask Drain Manifold

Firing Valve

Poppet Valve

Emergency Stop
To Poppet Drain Tank

Breach Door

Torpedo Tube

Muzzle

To Blow And Vent Manifold

Tube Drain Manifold

WRT Tank

3-11A
CHAPTER 4

TACTICS - Part I

(To be completed at Submarine School)

References:

NWP 23
NWIP 23-8
NWIP 23-2
NWIP 23-9
NWIP 23-10
Submarine School Fire Control and Tactics Manual

A. Written Notebook Requirements and Sketches:

1. Illustrate for a guppy submarine by means of graphs:
   
   a. Submerged speed on the battery versus endurance.
b. Submerged acceleration and deceleration rates.

![Graph showing submerged acceleration and deceleration rates.]

- **Acceleration Guppy II**
- **Deceleration Guppy II**

Minutes

0 1 2 3 4 5

Speed (Knots)

0 3 6 9 12 15 18

c. Submerged turning rates at various speeds from 3 knots to full speed with full rudder.

![Graph showing submerged turning rates.]

- **Turning Rate Guppy II**

Degrees Per Second

0 1 1 1/2 2 2 1/2

Speed (Knots)

0 3 6 9 12 15 18
d. Representative values of tactical diameter, advance, and transfer for full rudder submerged.

e. Approximate rates of ascent and descent at 4.8 and 12 knots speeds when using nominal dive angles.
f. Cavitation threshold versus depth.
2. By means of a sketch, illustrate the following, giving symbols:

a. Angle on the bow. \( \text{Ab} \)

b. Lead angle. \( \text{LA} \)

c. Track angle. \( \mathbf{I} \)

d. Torpedo track angle. \( \text{Ib} \)

e. Distance to the track. \( \text{DT} \)

f. Normal approach course. \( \text{NAC} \)

g. Normal course. \( \text{NC} \)

h. Reach. \( \mathbf{M} \)

i. Torpedo turning radius. \( \mathbf{Z} \)

j. Torpedo run difference. \( \text{uf} \)
3. By means of a simple sketch, show deflection angle for a zero gyro MK 14 torpedo shot.

4. On a maneuvering board sheet, solve a problem of your own making for the firing bearing to be used for a zero gyro shot with a MK 14 torpedo. Given: St, Br, Ab. Show all work.

Maneuvering board solution attached to page 4-6A
Question: #4

St = 10 knots
Br = 060
Ab = P50.

Finding Bearing = 012.5°
5. Show by means of a sketch of target and submarine the following values for a curved fire MK 14 torpedo shot:

a. Relative bearing ($Br$)
b. Deflection angle ($DA$)
c. Correction angle ($CA$)
d. Torpedo track angle ($Tv$)
e. Intercept point
f. Gyro angle ($G$)
g. Pseudo torpedo run ($Us$)

6. Discuss all the advantages of straight fire over curved fire torpedo shots.

The use of gyro or small gyro angles cause errors in estimated torpedo run to have no practical effect on the accuracy of the periscope bearing or gyro angles. Therefore, shooting with zero gyro will modify range errors.

Straight fire problems can more easily be solved mentally using seeding (rate) computers or other devices in event of failure of the TDC.

The greatest advantage of straight fire is that errors in torpedo run will have minimal effect on hit probability.
7. List the members of the fire control party with a complete description of the duties of each. Include diagram of flow of information and chain of responsibility.

NOTE 1: When the DRT is used exclusively for fire control purposes, its employment is controlled directly by the fire control coordinator in the alternate position shown at the left.

NOTE 2: Represents the flow of range and other sonar information when active sonar is used for fire control purposes.

The Fire Control Party

Approach Officer
1. Tactical maneuvers
2. Periscope information
3. Control emissions of radar, UQC, active sonar, and fathometer
4. Brief fire control parties on tactical situation
5. Determine and direct plan of attack and evasion
6. Designate types, number, and manner of weapons to be employed.

-continued on page 4-8A-
Assistant to Approach Officer

1. Maintain a display of pertinent summary tactical and navigational information to produce tactical assistance to the Approach Officer during all phases of the approach and attack.
2. Supervise the employment and monitor the tactical or command sonars.
3. Supervise the operation of the firing panel, insuring that weapon settings are made properly and checked that the tubes are ready when required and that the salvo is launched properly and with appropriate spread applied.
4. Supervise the employment of radar and ECM in accordance with orders of the approach officer.
5. Supervise communications during coordinated operations.

Fire Control Coordinator

1. Be responsible that the best possible fire control solution is obtained through appropriate consideration of all usable information available.
2. Designate search areas, targets, and specify information required of the fire control sonars.
3. Keep the approach officer advised of the status, size, and contacts of the best solution and its evaluated reliability, and the extent to which the tactical employment of the submarine is interfering with obtaining a reliable solution.
4. Keep the plot coordinates, appraisal of ownership, and maneuvers.
5. Supervise the operation of the TDC (PK) to ensure that the best solution is set prior to firing and that firing bearings are properly matched.
6. Insure that all sources of target information are kept advised of the "assumed" target speed.

continued on page 4-88
Question #7 continued

Plot Coordinator
1. Supervise all plots under his visual control.
2. Determine best solution for target course, speed, range and zig-zag time.
3. Pass to fire control coordinator, evaluated solution elements and bearing rate, furnish appraisal of reliability of information furnished.

Sonar Supervisor
1. Indicate targets to sonar operators under direct control in accordance with direction of fire control coordinator.
2. Assist sonar operators in target detection and classification.
3. Monitor performance of sonar operators, and advise fire control coordinator of own ship's condition or evolutions which may be penalizing sonar performance.
4. Insure that sonar are operated in the optimum mode according to target signal strength and own submarine tactical maneuvers: ATF, GTT, W, and other trains, etc.
5. Insure that timely information is obtained and furnished on target zig-zag, turn, course, speed, changes, etc.

Firing Panel Operator
1. Operate Firing and Torpedo battery instructions in accordance to weapons input, check and preparation of the tubes for firing.
2. Set and monitor controlled weapons settings and check transmission.
3. Check firing panel ordered and ready lights.
4. In MK 101 FCS post tube order, spread unit, spread order and firing interval (when firing is automatic).
5. Close firing key on order "Shoot" from ATDC operator (or person designated in MK 101 FCS installation).

ATDC Operator
1. Operate the ATDC in accordance with prescribed techniques, and under the direction of the fire control coordinator.

continued on page 4-8C
Question #7 continued

ATDC Operator
1. Calculate and set tactical data
2. Calculate and set spreads in accordance with the orders of the approach officer and current doctrine.
3. Assist the TDC operator.

Navigational Plotter (Fire Control Plot)
1. Conduct navigational plot
2. When only bearings are available, make a "strip" solution for target course, speed, and range.

MK 7 Analyzer Operator
1. Operate the analyzer in the proper modes so as to furnish the most reliable and rapid solution.

Plotter
1. Perform functions of assigned plot to provide the best possible information to the rest of the fire control party.

Navigational Plotter (Tactical Plot)
1. When multiple targets are encountered, keep a plot of targets and screening vessels as designated by the approach officer.
2. Keep a plot of other friendly submarines in coordinated attacks.
3. Assist other plotters in obtaining the fire control solution.
8. Graphically demonstrate the following types of plots, noting the manner in which target zigs may be detected. Discuss the advantages and limitations of each plotting method.

a. The periscope/radar plot.

The periscope/radar plot is simple, accurate, and provides good information. However, its use requires the use of radar (SS or ST). This emission may be detected by enemy ECM equipment. Since this is dangerous, the radar ranges are seldom obtained.
b. The periscope stadiometer plot.

The periscope stadiometer plot provides fairly accurate target data without the necessity of using radar. However, the accuracy of the information is only as good as the ability of the approach officer to determine the range of the target using the stadiometer. The plot has large range errors at times because of this.
c. The sonar strip plot.

The sonar strip plot receives target bearings from sonar, and the plotter draws lines corresponding to these bearings from own ship's position on the D.R.T. Using these bearings and an assumed speed of the target, the plotter solves for target course by placing strips over the projected bearings in such a manner as to have three or more bearings intersect the speed marks on the strip exactly. The range of the target is obtained by measuring the distance from own ship's position to the point where the strips intersect the bearing lines. The accuracy of the plot depends upon the correctness of the assumed speed and the timing of the plotted bearings.
d. The time bearing plot.

Assuming a constant speed, range has the following general effects on the T/B plot:

- **Medium to Long Range**
- **Close-in to Medium Range**
- **Overhead**

The time bearing plot (Bernard Plot) furnishes the following information:
1. Paired bearings for the other plots, requiring accurate bearings
2. Bearing rate, focus on the relative motion plot and focused with the bearing rate computer to find range
3. Approximate ABR information
The relative motion plot (Synch Plot) is a plot of bearings (vessel bearings) and bearing rates. The bearing rate circles are superimposed on a standard maneuvering board. Bearings and bearing rates at these bearings are obtained from the time bearing plot and plotted on the relative motion plot to obtain a relative motion line which is combined with own ship's vector and assumed target speed to obtain target course. The relative motion line can be transposed to pass through the calculated CPA range. This line gives target range at any bearing.
The expanded time bearing plot is used primarily for low bearing rates. From these low bearing rate accurate information can be obtained and the same information is obtained as from the time bearing plot, namely, good information for the strip plot, and the relative motion plot. By using an enlarged scale, zigos are readily apparent on the expanded time bearing plot.
9. Discuss in detail the significance of the change in true bearing of the target in approach tactics. How may the submarine control this change? What changes, if any, are desirable?

Three conditions of true bearing may exist when the submarine is closing the target and each of these conditions give the approach officer some significant facts about the approach:

1. True bearing is drawing towards the bow - the submarine is losing true bearing and the target will pass ahead.
2. True bearing is drawing towards the stern - the submarine is gaining true bearing and the target will pass astern.
3. True bearing is remaining constant - the submarine and the target are on a collision course.

The submarine has a certain amount of control over the change of true bearing, depending upon the target speed and the target course (Ab). Within the limits determined by St and St the submarine may control the rate of change of true bearing by changing own speed and lead angle. When the submarine and target are both steady on their respective courses, a change of true bearing will cause a proportional change in Ab and lead angle.

The optimum tactics by a submarine, particularly early in the approach, is to maintain a steady bearing (of nearly a steady bearing) to insure a collision course and close the target to effective weapons range.
10. Describe the Type IV and Type II periscopes giving all significant data as to capabilities, limitations, and depths of use.

<table>
<thead>
<tr>
<th></th>
<th>Type IV</th>
<th>Type II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnification HP</td>
<td>6.0 X</td>
<td>6.0 X</td>
</tr>
<tr>
<td>Magnification LP</td>
<td>1.5 X</td>
<td>1.5 X</td>
</tr>
<tr>
<td>Max. elevation of LOS</td>
<td>45°</td>
<td>74.5°</td>
</tr>
<tr>
<td>Max. depression of LOS</td>
<td>10°</td>
<td>10°</td>
</tr>
<tr>
<td>True field HP</td>
<td>90°</td>
<td>90°</td>
</tr>
<tr>
<td>True field LP</td>
<td>32°</td>
<td>32°</td>
</tr>
<tr>
<td>Ranging devices</td>
<td>Radar and Telemeter scale</td>
<td>Stadiometer and Telemeter scale</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Type II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Diameter of tapered section</td>
<td>3.75”</td>
</tr>
<tr>
<td>Max. elevation of edge of field above horizon</td>
<td>49° HP</td>
</tr>
<tr>
<td>Optical length</td>
<td>36 feet</td>
</tr>
</tbody>
</table>

The Type IV periscope is normally installed in the forward position and is referred to as No. 1 periscope. The Type II periscope is normally installed in the after position, and is referred to as No. 2 periscope.

The narrow tapering of the Type II periscope reduces the amount of light entering, and there are lighting conditions when a target may not be seen with the Type II periscope when it may be seen with the Type III periscope.

The Type II periscope allows the submarine to operate four to five feet deeper than when using the Type I periscope giving the submarine a safety factor of additional depth plus making less periscope wake due to its narrower upper portion.
11. Describe the methods of determining masthead height and target length. What is the telemeter? Stadimeter?

There are basically three methods for determining masthead height:

1. Intelligence Information
2. Estimate
   Generally the estimate is based on counting the number of decks the bridge of the target is above the main deck, approximating the number of decks the freeboard represents, and adding them together and multiplying this total by 8. The figure obtained represents the distance in feet from the waterline to the bridge. Multiplying this figure by 2.1 (the average ratio of masthead height to bridge height) gives a fair estimate of masthead height in feet.
3. Radar-Stadimeter check
   This method gives accurate masthead height, but has the great disadvantage of emitting electromagnetic radiation which can be detected by the target. In his ECM gear, the basic method is as follows:
   1. Take a radar range with No. 1 periscope and set this range in the TDC.
   2. Immediately follow with a stadimeter range from No. 2 periscope.
   3. On the world range mark the TDC operator, calculate the corrected range.
   4. The periscope assistant works the stadimeter scale backwards and comes up with the accurate masthead height.

The telemeter is a scale etched on the lens of the periscope vertically and horizontally. Each division represents 1/10 of an inch in high power and 4 feet in low power. Range and target length may be determined reading the telemeter.

The stadimeter is a mechanical-optical device in No. 2 periscope to determine range by splitting the target image and placing the target masthead on his waterline. Range is then read on a circular scale on the periscope opposite the target masthead height.
12. How does a submarine maneuver to minimize detection during an approach and attack from passive (BQR-4) and active (SQS-4) sonar?

**Passive**

The below sketch illustrates the thermal structure found 75% of the time in the ocean. It can readily be seen that the best areas for a submarine to maneuver to avoid detection by a passive (BQR-4) sonar is below the layer depth.

Sound Patterns and How They Are Affected by Layer Depth

Since the best place for a detecting submarine with BQR-4 sonar is above the layer, the best place for a submarine to avoid detection is below the layer. Two things must always be kept in mind by the submarine trying to avoid detection:

1. Do not cavitate
2. Never present a beam, except once, sound is generated with the greatest energy from the beam. Below are some typical sound patterns for a submarine.

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- Continued on page 4-18A

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Question #12 Continued

The below graphs and sketches based on the SQS-4 sonar are all used to determine the best tactics to be used to minimize detection during an approach and attack against an active SQS-4.

Since reflectivity has the greatest effect when a submarine is at surface depth or when presenting a beam aspect, the submarine attempting to avoid detection should be operated deep and present a shallow aspect to the target. A general knowledge of the information presented by these graphs and sketches is necessary for the approach officer to determine exactly how he will maneuver for this particular situation.
13. There are three main phases to any approach and attack, i.e., contact, approach, and attack. Define each of these phases.

1. Contact Phase: The period from the time of acquisition of a target by the submarine, until the direction of target motion (right or left in relation to the line of sight) is determined.
2. Approach Phase: The period during which the submarine maneuvers with the object of closing to effective weapon range. This phase extends from the time the direction of target motion is established until the submarine arrives within effective range.
3. Attack Phase: The period during which the submarine maneuvers to gain the optimum firing position, compatible with the tactical situation, and weapons to be used, and to deliver the most effective salvos of torpedoes. This phase extends from the time the submarine arrives within effective weapon range until the salvo is launched.

14. What is the minimum allowance of torpedoes for a Guppy type submarine? (COMSUBBLANTINST 08000.2)

   a. During peace-time operations?
      b. For war?
         a. 8 MK 14-3A
            6 MK 27-4
            2 MK 28
         b. 12 MK 14-3A
            8 MK 27-4
            4 MK 28
15. What is the optimum firing point and what are the correct procedures for each of the following attacks? (List the considerations underlying their selection.)

a. Periscope.

In the following discussion a surfaced target and high speed straight running torpedoes are assumed. Based upon these assumptions, the theoretical optimum firing point is reached when the following conditions are met:

1. Torpedo near zero-gyro near zero reduce the effect of errors in range.

2. Optimum track angles—optimum track angles are angles at which errors in target course will have least change in deflection angle. It is equal to 90° plus maximum deflection angle. This in effect will always present the largest target length to the torpedo.

3. Torpedo run such that the last torpedo in the salvo will have just had time to arm and reach running depth prior to hitting. A poor solution will have a lesser effect on a short torpedo run than on a long torpedo run. For example, the distance that the torpedo will be offset from NDT for a long run will be greater than the effect from NDT for a short run. A torpedo run that is too short could cause the torpedo to reach its impact point before arming and/or before reaching running depth.
b. Bearings only.

In the bearings only attack, the target will be a completely submerged submarine, and the MK 27-4 torpedoes will be the weapon assumed to be used. With these assumptions the optimum firing point is reached when the following conditions are met:

1. Target range less than 2500 yards. The target range is a function of the enabling ranges, which are between 600 and 3100 yards.
2. AB at time of firing equal to 60°. The MK 27-4 is a relatively slow torpedo, and target track angles develop. An AB of 60° at time of firing and a range of about 2500 yards will produce a track angle of about 98°.

c. Periscope with secondary fire control system.

Generally, the optimum firing point for this problem is the same as for the normal periscope attack, with the exception that greater stress should be placed on 1) gyro zero, 2) optimum track angle and 3) as short a torpedo run as possible to reduce the effects of not being a machine to refine and generate the solution.

1. Gyro zero—straight fire solutions are much more accurate than curved fire solutions.
2. Optimum track angles—gives the torpedo the largest effective target length.
3. Short torpedo run—reduces the effects of all errors.
16. Discuss types of spread for a MK 16 type torpedo, their advantages and disadvantages, and upon what occasions each would be used.

For torpedo runs less than 2000 yards the standard MK 14-3A spread doctrine applies, with the exception of the enabling run which must be set so that the torpedoes do not endanger the firing submarine.

If ranges are not accurately known use standard MK 14-3A spread doctrine. Fire at least four torpedoes for ranges beyond 2000 yards for a sharp track or a closing target, and 4000 yards for a broad track. However if ranges are known within ±100 yards these general types of spread can be used to a greater advantage because they take into account the design advantages of the MK 16 over the MK 14-3A, namely:

1. Influence - contact exploder
2. Longer Range
3. Circle right, circle left feature after enabling

These general types of spread are illustrated on page 4-22A.

The very low hit probability and high noise level of the MK 16 type torpedos generally limit the use of these torpedos to torpedo runs of less than 8000 yards. Every effort should be made to fire at minimum allowable range. Stern aspect shots with the MK 16 are very desirable because of its high noise level.

- continued on page 4-22A -
Question #16 continued

MK 16 torpedo general spread doctrine:

**Situation I**
- $\theta = 30^\circ$ to $150^\circ$
- Torpedo run 2000 to 8000 yards
- **Advantage**
  - If torpedo misses, it will circle in the direction of target motion for a second attack.
- **Disadvantage**
  - Lose the effect of MOT or best shot first.

**Situation II**
- $\theta$ less than $30^\circ$
- TR 2000 to 4000 yds
- **Advantage**
  - Takes into account errors in CE for a greater coverage
- **Disadvantage**
  - If solution is correct, torpedo #4 will completely miss.

**Situation III**
- $\theta$ greater than $150^\circ$
- TR 2000 to 8000 yds
- **Advantage**
  - Takes into account errors in CE and range to give a higher hit probability.
- **Disadvantage**
  - Lose the effect of MOT or best shot first.

Units 1 and 2 circle towards target motion. Units 3 and 4 circle away.

Firing Order = AFT-FWD

Angular Spread based on 150% coverage

Units 1 and 2 circle towards target motion. Units 3 and 4 circle away.
17. For torpedo spreads, discuss the fundamental theories upon which the various firing sequences are based, i.e., MOT-AFT-FWD, etc.

Two basic concepts are considered for each type of spread. These are the possibility of target tracking and possibility of non-coincidence of the closing. From these concepts, the MOT-AFT-FWD doctrine was developed as the last order of firing torpedoes. This doctrine puts the best shot in the water first and the AFT-FWD gives good divergence for the remaining shots. The FWD-AFT doctrine is desirable against high-speed targets with a broad track at short range, which gives the target great speed across the line of sight. Therefore, in order to keep the rate of change of gyros at a minimum, the increasing matched gyros at the instant of firing, the FWD-AFT doctrine developed. The third general sequence is the AFT-FWD doctrine. The AFT-FWD doctrine is used for long torpedoes runs (in excess of 2500 yards). Firing AFT-FWD gives the greatest divergence, and is therefore desirable for the long torpedo run salvo.

18. For straight running torpedoes, what are the factors which must be considered in determining the number of torpedoes to be fired in a salvo and amount of spread coverage to be applied.

To properly determine the amount of spread coverage and the number of torpedoes to be fired, the following factors must be considered by the approach officer:

1. Errors caused by route or evasive maneuvers of the target prior to, during, and after the torpedo is launched. These are functions of torpedo run. It is, therefore, characteristics of the target, and ratio of torpedo speed to target speed.
2. Errors in firing data, and torpedo performance.
3. How many torpedoes are desired to hit the target.
19. Describe in general terms the difference between electric and spindle set torpedoes and the capabilities of the MK 106 Fire Control system.

The spindle set torpedo required a mechanical connection with the torpedo tube so that current information from the fire control solution can be relayed to the torpedo. As torpedoes became more sophisticated more inputs were required. As the number of spindles increased the number of holes in the torpedo tube increased and so did the complexity of mechanical arrangements necessary to relay information to the spindles and extract the spindle at the time of firing. To eliminate some of these problems the electric set torpedo was developed which can handle a great many inputs without the need for spindles and information can be entered right up until firing.

It fully took advantage of the electric set torpedoes the MK 4 TDC was modified by the MK 106 Fire Control system to obtain the capability of inserting electrical inputs into the torpedoes from the respective torpedo control rooms until just prior to the torpedo leaving the tube.

20. Discuss the advantages of the FCS MK 101 over the FCS MK 106.

The MK 101 and the MK 106 FCS perform the same functions to solve the fire control problems, but the MK 101 system has refinements which can be considered as advantages. These advantages lie mainly from the firing panel and the angle solver. These advantages are:

1. Automatically shifts the spread order from right to left or vice versa.
2. Automatically applies corrections to torpedo tactical data eliminates calcs.
3. Spread is automatically solved and applied when required. Data is inserted into the machine.
4. Firing order can be preset.
5. Tube order can be preset.
21. Describe the operation of the MK 7 analyzer including your ideas on best operational techniques.

The MK 7 analyzer is an electro-mechanical navigational plottor. It receives inputs of own ship's motion, and ranges and bearings of bearings and a range estimate and displays the solution of target course and speed. The accuracy of the solution is dependent upon the bearing change involved. The greater the change the more accurate the solution.

There are two types of problems that the MK 7 analyzer solves:

1. The end point.
   The end point type of solution requires a range and a bearing. Two observations are required and a DT of about 1/12 minute is required for a reliable solution. The "drop last" feature can be utilized to increase DT and refine the solution.

2. Bearings only.
   The bearings only type of solution is used when only bearings of the target are available. Bearing changes of at least 4° to 5° are required for a reliable solution. After the initial solution based on these bearings is obtained, the "drop last" feature can be utilized to refine the solution.

When using the MK 7 analyzer, it should be remembered that it is no miracle device. It is only another method for solving target course, speed, and range depending on the constants being used, and equal weight should be placed upon other sources of information.
22. Discuss the TDC fire control method employed when conducting a self-propelled type mine plant.

The control of a self-propelled mine involves a fixed point on the bottom (used as the target) and a mine vehicle that can be made to run on a preset gyro angle, like a torpedo to a distance which can be preset at which the mine will stop and sink to the bottom. In shooting a mine the set and drift of the current must be considered, since the target (the bottom) and the submarine are not affected by identical external forces as is usually the case when the submarine and the target are underway. In solving the problem the motion produced by the firing submarine enters into the problem in the usual way. The set and drift of the current are reversed and entered as c and s. With these entries, the components of current will be included in the target information sent to the angle solver. All settings of the TDC are made in the usual manner. The gyro angle and torpedoes run obtained will be correct to hit the fixed point above the bottom used as the target.

23. Work a maneuvering board problem solving for target course, speed, and range using bearings only information. (Case XI)

Maneuvering board solution attached to page 4-26 A
Question #23

$C_0 = 0 \degree 0$
$S_0 = 4 \text{ knots}$
$C_0 = 14 \degree$
$S_0 = 6 \text{ knots}$

Relative Motion 1

At time $t = 0.83$, $S_1 = 9.4 \text{ knots}$

Relative Motion 2

Transfer

Relative Speed = 8 \text{ knots}

$S_1 = 0.83$

Given any two corresponding quantities, solve for third by laying rule through points on proper scales and read intersection on third scale.
24. Describe in detail the use of the bearing rate computer under the following conditions:

a. In conjunction with the relative motion plot to solve for minimum range.

From the relative motion line extended obtain the maximum bearing rate (at CPA). From the target and own ship's speed vectors obtain relative speed. Plotting relative speed opposite maximum bearing rate read CPA range opposite 90° angle on the bow. Plot relative motion range line parallel to the relative motion bearing rate line at computed CPA range at any convenient range scale. For any given bearing the range can then be read at the intersection of the bearing and the range line previously constructed.

b. By the fire control coordinator to determine the range using course, speed and bearing rate received from the plot coordinator.

Knowing target course (AB), target speed, and bearing rate, range is obtained by resolving target's component and own ship's component across the line of sight and adding these algebraically. The value placed opposite observed bearing rate will indicate range opposite angle on the bow of 90°.
c. By the fire control coordinator to sample the range using component difference and bearing rate difference techniques.

In obtaining an initial range by range sampling, "six points" are taken prior to and after a course and/or speed change selected to provide a significant bearing rate change. Add algebraically the bearing rate and own ship's components across the line of sight. These resultant values are placed opposite each other on the bearing rate computer and range is read opposite angle on the bow of the target during both periods of observation.

d. In secondary fire control to determine the deflection angle for a MK 27-4 torpedo.

The desired deflection angle for a MK 27-4 torpedo is obtained by computing target's component across the line of sight by using target's speed and angle on the bow. But 90° angle on the bow opposite torpedo speed (14.1 knots for a warshot). Opposite target's component across the line of sight read deflection angle on the angle on the bow scale.
25. Define "break" (point of maximum rate of change of bearing rate) and "flat" of the time bearing plot. What is the significance of each?

The "break" is that portion of the time bearing plot from 39° relative angle on the bow to 70° relative angle on the bow. As the relative angle on the bow reaches 30° the bearing rate increases. It is then approximately 1/4 of the maximum. The increase in curvature is visually apparent. The rate of change of bearing rate continues to increase to the maximum where the relative angle on the bow is 45°. This is the point of maximum curvature and approximately 1/2 of the maximum value encountered.

- continued on page 4-29A -

26. Discuss two methods by which the speed of a surfaced target can be obtained by one periscope observation.

Target speed can be obtained by observing the distance from the stem to the crest of the second bow wave and using the formula "target speed equals 1/3 the square root of the distance from the stem to the second bow wave."

Normally target speed is estimated by utilizing such information as type of target, size of bow wave, type of operation, that the target is engaged in, and smoke coming out of the stack if visible.
Question #25 continued

From this point the rate of change of bearing rate will decrease until it becomes nearly steady at a maximum value. This occurs at relative angle to the bow of 70° and terminates the "break". From relative angle to the bow of 70° to 110°, the bearing rate is maximum and nearly constant and constitutes the "flat". From relative angle to the bow of 110° the bearing rate decreases.

The "break" gives warning of the approaching "flat" and the "flat" gives relative angle on the bow information which is reasonably accurate.
27. What is the "snap-shot" procedure for firing a MK 27-4 torpedo, when target is initially detected at close range (approx. 2000 yards)?

When sonar detects the target the conning officer will head towards or away from the target bearing or nearly so, and will pass the word over the TMC to the torpedo room which will be firing "flash the ready tube and open the outer doors". The QM logs target bearings on a recording sheet and the conning officer determines the bearing rate from this record and prepared to shoot torpedoes in one of the following manners:

1. Snap-That One-Two Punch
   a. If the bearing rate is 10°/minute or less only one torpedo will be fired. A gyro angle of zero is set in a torpedo with a preset end-time range of 1200 yards.
   b. If the bearing rate is greater than 10°/minute, two torpedoes will be fired with a 30-second interval. A gyro angle is set on both torpedoes in the direction of target motion if 37° plus observed bearing rate in degrees per minute, if firing forward; if 57° plus observed bearing rate if firing aft.
   c. With appropriate gyro angle set, target bearing 000, 150, or 30°, relative, and the 30-second armament time elapsed, the conning officer directs the appropriate torpedo room to fire using the "silent-fire" method. Both torpedoes are set at "above limits". The first torpedo fired has a delay of 3000 yards and the second (fired after 30-second interval) has a delay of 2000 yards.

--continued on page 4-30A--
2. Snap-shot Round House
   a. If the bearing rate is 15 minutes or less and the gyro angle of zero is ordered.
   b. If the bearing rate is greater than 15 minutes, set the gyro angle in the direction of target motion of 30° plus the observed bearing rate, 90° plus observed bearing rate if firing aft.
   c. To take the appropriate gyro angle set, target bearing 000°, 150°, or 270° relative, and the 30-second warm-up time elapsed, the incoming officer will direct the appropriate torpedo room to fire using the "silent fire" method. Only one torpedo is fired.
   Navigation is set at "above limits." and the enabling course is set at 1700 yards.

After using either of the above procedures, the incoming officer initiates normal approach tactics to close the target in case the doctrine fails to produce a hit. The incoming officer must be ready to fire the other next if necessary. When firing aft, the firing bearing of 150° or 270° must be used to keep the target out of the baffles.
28. In order to work a curved fire maneuvering board problem; what information is required, and from what member of the Fire Control Party is it obtained? Work the following problem which requires finding $U_f$ and solve for $Gr$:

Bow tube shot
B 170° T
R 2100 yds
Co 210° T
Ab P 50
Firing Br 300°
St 12
So 2

The following information is required to work a curved fire maneuvering board:

1. Relative target bearing - obtained from the periscope assistant
2. Own ship's course - obtained from the gyro repeater
3. Own ship's speed - obtained from the underwate log
4. Target bearing - obtained from the MK 4 bearing unit
5. Angle on the bow - obtained from the approach officer
6. Target course - obtained from the Sonar Strips Plot, Nav Plot or Relative Motion Plot
7. Target speed - obtained from the Nav Plot, sonar turn count, periscope observation, or Sonar Strips Plot
8. Firing bearing - given by the approach officer
9. Pseudo torpedoes run - obtained from Nav Plot or solved from the curved fire maneuvering board
Question #29
R = 120°
R = 2100 yds.
C0 = 210°
Ab = 90°
Firing bearing = 300°
St = 12 knots
So = 2 knots
Find: Gr

Speed Scale = 10:1
Range Scale = 1000 yards/division

Firing Sheet
MK 14-3A High Power
& MK 23

Maximum Gyro Angle Limits

MANEUVERING BOARD
Price 75 cents (per pad of 50)
29. Discuss the various types of power supply to the fire control system MK 106. Indicate the various uses the system may still have when each of these power courses is interrupted.

The MK 106 system installation required a power supply of 120 volt, 3 phase, 400 cycle AC power. It also used 115 volt, 60 cycle, and 115 volt DC power. The AC power supplied the heating elements and the synchronous while the DC power generated the problem in the TDC.

Loss of AC power to the TDC in the MK 106 system renders the angle solver inoperative. If 400 cycle AC power is lost there is no recourse except to fire a disposable set weapon. Loss of AC power to the MK 7 analyzer does not affect the remainder of the system since the analyzer is an independent unit. If AC power is lost the DC power will run the time clock and the position keepers may be used as an E S WAS, all inputs being made manually.

Loss of DC power eliminates the generator feature but allows the problem to be solved for a static solution. Firing is then accomplished using the constant or continuous bearing method.
30. Discuss the tactical situations in which sub/sub, sub/air and sub/surface coordination may increase the effectiveness of:

a. ASW Operations.

The most utilized method of sub/sub coordinated attack is the use of one attack type submarine and one SSK type submarine. The SSK goes deep and listens with QHR-4 sonar while the attack submarine proceeds at a shallower depth to intercept the enemy submarine. When the SSK makes contact, it vectors the attack submarine to within sonar striking range. The attack submarine is then aided in its solution by getting a solution from the SSK. By use of torpedoes such as the MK27 and the MK39 wire-guided the submarine is able to attack early.

The sub/air coordinated attack plan is similar except that the SSK vectors the aircraft to strike at the submarine while on the surface. The SSK may work with aircraft and vector aircraft using sonar information. Communication from below periscope depth have not proved very satisfactory.

The sub/surface coordinated attack is accomplished today using SSK's as sentries in an area and submarines are stationed at critical points on the periphery of the area. When contact is made the SSK surfaces and identifies the HUK group of its position, course and speed. The SSK avoids being attacked by remaining within its harver area. The nuclear-powered submarine brings into existence the possibility of having submerged sonar platforms in the van of the HUK screen.

The sub/sur coordinated tasks in task force operations consist of stationsing two or three submarine attack groups in designated areas. These stations line the periphery of the task force's trade or attack area. The submarine attack groups act as a vanguard or deterrent to interference by enemy surface units to the mission of the task force. A sub/sur attack when being used as an integral part of a task force is designed with the aircraft, surface, and the submarine attack groups. When an aircraft makes contact it communicates with the submarine giving position of "mark center" and time when contact becomes "sinkable." However, this necessitates that the submarines remain on the surface or at periscope depth to be able to communicate, neither one of which is desirable from the submarine point of view.

The sub/sur coordination in similar except that radar contact is gained by a surface unit and the submarine is vectored to intercept.

c. Submarine Patrol Operations.

The pamphlet "Submarine Task Force Tactical Instructions' has plans covering different types of sub/sur attack units. These plans are designed for two or three submarine attack units. Each plan is laid out with either section in bearing from center to target or grid. Some plans cover different depths and an OFC. Sub/sur and sub/sur coordinated attack is used as it was in the task force problem. That is the submarine having been assigned an area is vectored to the attack by aircraft to destroy vessels. The submarine approaches with its own mission the subject's approach works equally as well. If the submarine makes initial contact, the aircraft or surface vessel is vectored in. The submarine viewed as a weapon, when the enemy is within its range. Otherwise, the faster aircraft or destroyer is vectored to the attack.

4-34
31. Describe how a Regulus I missile is launched and guided.

The Regulus I missile is stowed in its storage until all preliminary checks have been completed. It is then run out on its 35-foot rail type launcher.

The launching phase consists of the time elapsed between the firing of the booster rockets, mounted on the side of the missile, and the jettisoning of the boosters after they are expended. There is no guidance control over the missile during the launching phase.

During the climb phase, the missile's initial climb angle is reduced by preset stabilizing inputs. It levels off on a constant heading when it reaches its preset flying altitude.

The mid-course guidance phase starts when the missile has left the guidance tower. The guidance tower takes control using the Torrence guidance system. The Torrence guidance system uses pulse coded radar signals to control the missile laterally by activating the missile's response equipment. Control may be exercised by the launching submarine and passed to the guidance submarine along the flight path of the missile. Guidance submarines may control the missile from periscope depth.

When the missile arrives at the target, the guidance submarine gives the missile a "home" command which activates the missile terminal controller. The terminal controller takes control and guides the missile in a vertical dive which it maintains until it hits the target.
CHAPTER 4

TACTICS - PART I

This is to certify that all work within this section has been completed.

Approved:

R.M. Weidman Jr., LCDR, USN

E.Peters, LCDR, USN
CHAPTER 4
TACTICS - Part II
(To be completed on board your submarine)

A. Practical Factors

<table>
<thead>
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<th>Date</th>
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<th>of Examiner</th>
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<tr>
<td>5-28-59</td>
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<td></td>
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</tr>
</tbody>
</table>

1. As a member of the approach party, satisfactorily acting as:
   a. TDC or PK Operator
   b. Assistant TDC Operator
   c. Ship Plotter
   d. Time Bearing Plotter
   e. Relative Motion Plotter
   f. Plot Coordinator
   g. Fire Control Coordinator
   h. MK 7 Analyzer Operator (if installed)

2. As FFC or Plot Coordinator make two SS vs SS type (Sonar only) approaches:
   a. Hit Yes X No ___ Detected Yes ___ No X ___
   b. Hit Yes X No ___ Detected Yes ___ No X ___

3. As Approach Officer make two periscope approaches:
   a. Hit Yes X No ___ Detected Yes ___ No X ___
      Number periscope observations 15
      Average periscope exposure time 10 secs
   b. Hit Yes X No ___ Detected Yes ___ No X ___
      Number periscope observations 10
      Average periscope exposure time 10 secs

4. Fire one torpedo as Approach Officer for a hit.
   See page 4-36A
STADIMETER APPROACH

DATE: 28 May 1959
EXERCISE: S-7-T
SUBMARINE: USS Orion (AS-18)

1. Target(s) (Type & No.)
   USS Orion (AS-18)

2. Screen(s) (Type & No.)
   None

3. Weapons (Type & No.)
   MK14-3A Reg No. 91996

4. Detected prior firing: YES ( ) NO (X); Min Prior Firing:

5. Analysis: Weapon Hit ( ) Embarked ( ) Missed ( ) Erratic ( )
   a. Distance from MT: 0 Yards.
   b. Solution Errors: Oi 7°; St 1 Kts; R ---- Yds.

[Signature]

(date) 28 May 59

CONFIDENTIAL
6. Approach techniques requiring more training (CO COMMENTS).
   a. Aggressiveness (Speed, Lead Angle).
   b. Tactics to prevent detection (Air, Surface).
   c. Periscope observations (Frequency, Duration, Amount).
   d. Passive ranging (Stadimeter, Telemeter).
   e. Maneuvering during approach phase (Course, Speed, Depth).
   f. Maneuvering during attack phase (Course, Speed, Depth).
   g. Screen penetration.
   h. Interpretation and use of available information (Sonar, Radar, ECM, Periscope).
   i. Use of information sources (Sonar, Radar, ECM, Periscope).
   j. Decision of when to fire.
   k. Dissemination of information and intentions.
   l. Weapon knowledge.

   m. Other: Periscope exposure too frequent—averaged one look every 1.3 min during a 35 min approach. Average exposure time 10 sec.

   n. Weakest techniques: Called angles on the bow were fair to good, except when sea conditions warrant slow for all exposures.

7. Grade assigned: Good

   [Signature]

   (Commanding Officer's Signature)
A 313 B 13 H MOT APT3-15 J 334
Ct St Mot SJG 2AS Plan Base Course

Target data message for firing run.
CHAPTER 5

OPERATIONS (COMMUNICATIONS) - Part I

(To be completed at Submarine School)

References:

Force and Squadron Commanders Instruction Series 1000 and 2000.
NWIP 16-1, Chapters 1-8 and 13.
Ship's Communications Orders/Instructions.
NWP 16.
ATP 1, Chapter 20.
RPS 4.

A. Written Notebook Requirements and Sketches

1. List standard submarine communications radio transmitters and receivers. Indicate frequency coverage, power supply, power output of transmitters, and indicate which equipments have remote control stations:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TBL</td>
<td>300 to 1800 KC</td>
<td>220 V DC</td>
<td>50 Watts (voice)</td>
<td>Canning Tower</td>
<td></td>
</tr>
<tr>
<td>TCZ</td>
<td>2000 to 18000 KC</td>
<td>120 V 60-AC</td>
<td>90 Watts</td>
<td>Canning Tower</td>
<td></td>
</tr>
<tr>
<td>TED</td>
<td>225 to 4000 MC</td>
<td>120 V 60-AC</td>
<td>9 to 15 Watts</td>
<td>Canning Tower</td>
<td></td>
</tr>
<tr>
<td>TCS</td>
<td>1500 to 120000 KC</td>
<td>120 V 60-AC</td>
<td>20 Watts (voice)</td>
<td>Canning Tower</td>
<td></td>
</tr>
<tr>
<td>SRTI</td>
<td>200 to 26000 KC</td>
<td>400 V 60-AC</td>
<td>100 Watts</td>
<td>Canning Tower</td>
<td></td>
</tr>
<tr>
<td>RAK</td>
<td>15 to 6000 KC</td>
<td>120 V 60-AC</td>
<td>—</td>
<td>Canning Tower</td>
<td></td>
</tr>
<tr>
<td>RBS</td>
<td>2 to 20 MC</td>
<td>120 V 60-AC</td>
<td>—</td>
<td>Canning Tower</td>
<td></td>
</tr>
<tr>
<td>RAL</td>
<td>0.3 to 23 MC</td>
<td>120 V 60-AC</td>
<td>—</td>
<td>Canning Tower</td>
<td></td>
</tr>
<tr>
<td>AN/RR-11A</td>
<td>14 to 32 MC</td>
<td>120 V 60-400 V AC</td>
<td>—</td>
<td>Canning Tower</td>
<td></td>
</tr>
<tr>
<td>AN/RR-13A</td>
<td>225 to 4000 MC</td>
<td>120 V 60-AC</td>
<td>—</td>
<td>Canning Tower</td>
<td></td>
</tr>
</tbody>
</table>
2. Discuss the selection of radio frequencies with respect to range and security.

For transmitters of the same power output, a high frequency transmitter has a shorter range but greater security than a low frequency transmitter since all transmitters are omnidirectional, the only security that can be obtained is through the use of high frequency transmitters where practicable. If the range is great, security must be sacrificed and a high powered, low frequency transmitter must be used.

3. Discuss a submarine's communication capability when submerged.

Submarines generally have whip antennas which may be raised for ease with all transmitters and receivers at periscope depth. Additionally, an antenna may be used with all radio equipment when submerged. Most submarines have the VLF loop antenna, AT-317/8KR, on a retractable mast. This antenna may be used in receiving with the RAK receiver, at periscope depth, and under good conditions below periscope depth. The UHF antenna, AN-468PB, sometimes is on a retractable mast and may be used at periscope depth with the AN/URR-13A receiver and the TED transmitter.

4. What are the minimum communication requirements for a GUPPY submarine while underway on independent transit?

1. Copy the WHISKEY submarine component of the Fleet Broadcast (odd hours 6 MT)
2. Copy the Hydrographic Forecast General Broadcast (0430Z)
3. Maintain a listening watch on the distress frequencies, 500 KC and 8364 KC.
4. Guard aircraft ALH (3253 KC)
5. After the submarine CHOPS, change guard to ALPHA ONE or ALPHA TWO frequencies as designated.

5. What special requirements apply to submarines in the movement report system?

The submarine movement report form is outlined in NUWP 16-1. If the submarine gets out of its DR position by more than two hours (four hours for surface vessels), a new message must be originated and sent as "change one" to the movement report. Departure and arrival reports are sent action to the applicable MRD and MRC and info to CONSUB LANT and COMSUBRON SIX.
6. Make up a diving message for a four hour period on course 090 degrees True, SOA 4 knots in accordance with instructions for the New London area.

\[
\begin{align*}
BT & \text{ SIRAGO DIVING ONE TWO ZERO ZERO 0 0 ONE} \\
& \text{ SIX THREE ZERO 0 ZERO NINE ZERO 0 ZERO} \\
& \text{ FOUR BT}
\end{align*}
\]

7. What action is initiated by the action addee of your diving message if you fail to send a surfacing message?

Whenever a submarine periodic check report is overdue or where other indications of a submarine's presence are received, the action addee on the diving message shall immediately contact the appropriate COMSUBSPACATAGRU. He shall further keep the CSGT, continuously informed of the steps being taken to contact and locate each submarine. \( \text{continued on page 5-3A} \)

8. Discuss briefly "moving haven" and "submarine patrol zone".

The "moving haven" is a rectangular area surrounding the submarine while it is in transit and moves at the submarine's SOA as established in the movement report. All other units are informed of the movements, and are instructed not to attack any submarine in that area. The moving haven extends 5 miles ahead, 100 miles behind, and 5 miles to either side, and is intended to protect the submarine from attack by friendly forces while in transit.

The "submarine patrol zone" is an area of any size or shape designed to protect the submarine from attack by friendly forces while in transit. All units are informed of the patrol zone.

9. Discuss the stowage requirements for Confidential and Secret publications when issued to you.

Confidential: Cabinet locked with a steel bar, and deadlock securing system, installed in such a manner that when secured it will prevent opening of the cabinet doors with the plungers lock in the open position. The cabinet must be of such weight, construction or installation as to minimize the possibility of physical removal.

Secret: Safe, cabinet or safe: File having combination locks of not less than three tumblers and of such weight bars, construction or installation as to minimize the possibility of physical removal as in metal file cabinets which are secured by a steel lock bar. The cabinet fastening for which are permanently attached to the cabinet and are approved manipulation proof. These combination dial type padlocks, provided an hourly guard who is armed and maintained over the area in which the cabinet is stored.
Question #7 continued:
The CSRTG will proceed to the scene of action by the most effective means, assume on-the-scene command of the search and rescue operation, and carry out duties as described in COMSUBLANT OP-PLAN 37-54. He will keep COMSUBLANT informed.

Event SUBMISS will be executed whenever:

a. The safety of a submarine is in doubt.

b. The check-in message is one hour overdue.

Event SUBSUNK will be executed whenever:

a. A submarine fails to surface promptly following a known accident.

b. There is reason to suspect that a submarine has suffered a casualty and required assistance.

c. The check-in message is two hours overdue.
10. Discuss a typical ship's emergency destruction bill. List the order of destruction of classified matter.

Ship destruction normally comes as a result of abandoning ship in uncertain waters or when danger of capture of the complete ship destruction normally involves two separate phases, first the destruction of equipment and publications, and second, the actual destruction of the ship. Usually, under which the decision to destroy a ship is made very greatly and requires that personnel concerned with destruction of equipment and ships exercise individual initiative.

The order of destruction of classified matter is as follows:
1. Communications and crypto publications
2. Intelligence publications
3. Fire control and electronic equipment and counter devices
4. Weapons and components

The destruction of the ship's machinery and finally the hull itself comes after the destruction of classified matter.

11. Describe the proper procedure, step by step, for burning superseded classified RPS publications.

1. Collect the superseded publications
2. Make out a destruction report (for both registered and non-registered publications)
3. Check authority to destroy: Insure that CSSRM and the general message file are up to date.
4. Check publications against destruction report (title and register number)
5. Put publications in burned bag and proceed to incinerator
6. Check publications against destruction report before burning
7. Burn publications completely
8. Custodian and witnessing officers both sign destruction report at the incinerator
9. Delete publications from RPS-10A, Mark RPS 17 cards
10. Have Commanding Officer sign destruction report. Place a duplicate copy in the chronological file.

The custodian and the witnessing officers are jointly and equally responsible for the proper destruction of publications authorized for destruction.
CHAPTER 5

OPERATIONS (COMMUNICATIONS) - PART I

This is to certify that all work within this section has been completed.

Approved:

A.W. COMER, LT., USN

R.M. Weidman, Jr., LCDR, USN

B. Peters, LCDR, USN
### CHAPTER 5

**OPERATIONS (ELECTRONICS) - Part II**

(To be completed at Submarine School)

**References:**

- Type Commanders Instructions, series 3000 and 9000.
- NavPers 250-371, Noise Survey and Repair for Submarine Noise Reduction.
- NavShips 900-069, Use of the Submarine Bathythermograph Observations.
- Manufacturer's Instruction Books.
- NavShips 91855, Submarine Sonar Operators' Manual.
- NWIP 33-1 and 33-2.
- NWP 33, Chapter 6.

#### A. Radar - Written Notebook Requirements and Sketches

1. List Standard Submarine radar equipment giving purpose, range capabilities, antenna description, and power sources.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AN/PS-1</td>
<td>Torpedo Fire Control</td>
<td>8890 MC</td>
<td>80 miles</td>
<td>Mast in Sail</td>
<td>115 V-60 single phase AC</td>
</tr>
<tr>
<td></td>
<td>Air Control</td>
<td>1350 MC</td>
<td>75 miles</td>
<td>15x5 foot</td>
<td></td>
</tr>
<tr>
<td>AN/PS-2</td>
<td>Air Search</td>
<td>6275 MC</td>
<td>40 miles</td>
<td>Mast in Sail</td>
<td>250 V-60 single phase AC</td>
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<tr>
<td>AN/PS-3</td>
<td>(Height Finding)</td>
<td>6575 MC</td>
<td>70,000 feet</td>
<td>Mast in Sail</td>
<td>115 V-60 single phase AC</td>
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<td>AN/PS-4</td>
<td>Surface Search</td>
<td>3400 MC</td>
<td>15 miles</td>
<td>Mast in Sail</td>
<td>115 V-60 single phase AC</td>
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<tr>
<td></td>
<td>Air Search</td>
<td>3700 MC</td>
<td>10,000 feet</td>
<td>Mast in Sail</td>
<td>115 V-60 single phase AC</td>
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<tr>
<td>SU-3</td>
<td>Air Search</td>
<td>3400 to</td>
<td>15 miles</td>
<td>Mast in Sail</td>
<td>115 V-60 single phase AC</td>
</tr>
<tr>
<td></td>
<td>Height Finding</td>
<td>3700 MC</td>
<td>80 miles</td>
<td>Mast in Sail</td>
<td>115 V-60 single phase AC</td>
</tr>
<tr>
<td></td>
<td>Surface Search</td>
<td>8740 to</td>
<td></td>
<td>Mast in Sail</td>
<td>Wave Guide</td>
</tr>
<tr>
<td>SS-2</td>
<td>Torpedo Fire Control</td>
<td>8890 MC</td>
<td>80 miles</td>
<td>Mast in Sail</td>
<td>115 V-60 single phase AC</td>
</tr>
<tr>
<td>ST</td>
<td>(Ranges Only)</td>
<td>8890 MC</td>
<td>10 miles</td>
<td>#1 Periscope</td>
<td>115 V-60 single phase AC</td>
</tr>
</tbody>
</table>
2. Make out a "rent report" on each radar equipment listed on the previous page.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Freq (Mc)</th>
<th>PRF (cycles/sec)</th>
<th>Pulse Width (usec)</th>
<th>Antenna RPM</th>
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</thead>
<tbody>
<tr>
<td>AN/BPS-1</td>
<td>RENT</td>
<td>8815</td>
<td>600</td>
<td>10 POINT 5</td>
</tr>
<tr>
<td>AN/BPS-2</td>
<td>RENT</td>
<td>1300</td>
<td>600</td>
<td>1 POINT 0</td>
</tr>
<tr>
<td>AN/BPS-3</td>
<td>RENT</td>
<td>6325</td>
<td>635</td>
<td>1 POINT 3</td>
</tr>
<tr>
<td>AN/BPS-4</td>
<td>RENT</td>
<td>3550</td>
<td>400</td>
<td>1 POINT 0</td>
</tr>
<tr>
<td>SV-3</td>
<td>RENT</td>
<td>3550</td>
<td>400</td>
<td>1 POINT 0</td>
</tr>
<tr>
<td>SV-6</td>
<td>RENT</td>
<td>3550</td>
<td>400</td>
<td>1 POINT 0</td>
</tr>
<tr>
<td>SS-2</td>
<td>RENT</td>
<td>8815</td>
<td>600</td>
<td>10 POINT 5</td>
</tr>
<tr>
<td>ST</td>
<td>RENT</td>
<td>8815</td>
<td>600</td>
<td>10 POINT 5</td>
</tr>
</tbody>
</table>

I do not care "stroke".
Any unknown or unassessed portion in text as UNKNOWN

3. Discuss operation of each radar with reference to security from detection, keel depth at which it can be used effectively.

Radar of higher frequency are more secure than radars of lower frequency because the higher frequency radars generally carry greater and can be detected at greater ranges by enemy ECM equipment. Therefore the AN/BPS-1, SS-2, and ST radars are more secure than the AN/BPS-3 radar which is more secure than the AN/BPS-4, SV-3, and SV-6 radars which are more secure than the AN/BPS-2 radar. However in one way it must be assumed that an enemy will be able to pick up all frequencies with equal ease. The fact that the ST does not sweep but tracks with periscope provides some added security to this equipment.

The ST radar may be used at a keel depth of about 60 feet. The AN/BPS-1, AN/BPS-4, and the SV-3 radar may be used down to a keel depth of about 54 feet. The AN/BPS-2 and SS-2 radars may be used while the submarine is broached at a keel depth of about 40 feet depending upon the sea conditions. The AN/BPS-2 and the SS-6 can only be used when the submarine is on the surface.
4. Discuss the use of radar "ring time" and how "ring time" is determined.

Ringtime is a relative indication of radar system sensitivity. It is a measure of transmitter power output and receiver sensitivity and is useful as a day-to-day indication of radar performance, especially useful for tuning equipment at sea where it is difficult to tune the radar on targets at considerable range. Any consistent decrease in ringtime indicates that some component of the radar is beginning to lose its designed effectiveness, and corrective action is necessary.

Ringtime is measured by transmitting a radar pulse into the dummy antenna, where a portion of the transmitted pulse will ring within the cavity. This ringing signal is fed back into the wave guide and on into the receiver during the receiving cycle of the radar. The result is a visible indication of receiver saturation on the scope, and its duration in yards is measured by using the radar ranging circuits.

5. What radar search procedure is used during periods of low visibility.

The 55 radar is used in the normal manner with the exception that the PPI scope is used in the expanded center mode, which allows contacts nearby to be spread out so that they have good discrimination at ranges into 250 yards. Contacts are reported as usual. When making headings the search is mainly directed forward. The radar operator searches on all ranges.
6. How is flooding through wave guides prevented?

The SS radar wave guide has a quick closing valve that can be shut to close off the wave guide. This quick closing valve is located inside theopping tower and is turned with a wrench that is located near it.

The ST radar has no flooding problem because the wave guide is within #4 periscope and the outboard end is covered by a glass window.
B. Sonar - Written Notebook Requirements

1. List standard submarine sonar equipment giving purpose, general characteristics, transducer or hydrophone location, and any special uses such as torpedo detection and/or mine detection.

<table>
<thead>
<tr>
<th>Equip.</th>
<th>Purpose</th>
<th>Characteristics</th>
<th>Trans. or Hyd. Loc.</th>
<th>Special Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AN/BQR-2B</td>
<td>Listening Sonar</td>
<td>7 to 10 Kc (Recorder and Azimuth Indicator) 15 to 15 Kc (Listening)</td>
<td>Hydrophone Array Chin Mount</td>
<td>Torpedo Detection AIP, 6TT, MTB</td>
</tr>
<tr>
<td>2. AN/BQR-3A</td>
<td>Listening Sonar</td>
<td>5 to 20 Kc</td>
<td>Line Hydrophone, AIP, MTB, 6TT, Scan, and Relative (Hand)</td>
<td>BDI Meter</td>
</tr>
<tr>
<td>3. AN/BQR-4A</td>
<td>Listening Sonar</td>
<td>1.5 to 5 Kc</td>
<td>Hydrophone Array, Around Bow</td>
<td>Long Range Search Torpedo Detection</td>
</tr>
<tr>
<td>4. AN/BQS-2</td>
<td>Echo Ranging Scanning</td>
<td>31.5 Kc</td>
<td>Transducers Topside and Bottomside Forward</td>
<td>Mine Detection Torpedo Detection Auto Ping, Record Navigation</td>
</tr>
<tr>
<td>5. JT</td>
<td>Listening Sonar</td>
<td>4000 Yards (Passive) 4000 Yards (Active)</td>
<td>Line Hydrophone, Topside Forward</td>
<td>Torpedo Detection Frequency Search (8 to 14 Kc)</td>
</tr>
<tr>
<td>6. QHB-1</td>
<td>Scanning Sonar</td>
<td>24 to 27 Kc</td>
<td>Fixed Bottomside Transducer</td>
<td>Torpedo Detection Mine Detection EW Communication Maintenance Close Contact Ability</td>
</tr>
</tbody>
</table>

---continued on page 5-9---

2. Discuss the relative capabilities of the sonar equipments with regard to detection range, bearing accuracy, and use during evasion against a pinging ASW vessel.

The relative capabilities of the sonar equipments are listed below:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Detection Range</th>
<th>Bearing Accuracy</th>
<th>Use during evasion against a pinging ASW vessel</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN/BQR-2B</td>
<td>36,000 Yards</td>
<td>± 0.1°</td>
<td>Excellent Sonar for control, sonar</td>
</tr>
<tr>
<td>AN/BQR-3A</td>
<td>14,000 Yards</td>
<td>± 0.1°</td>
<td>Excellent Sonar for control, sonar</td>
</tr>
<tr>
<td>AN/BQR-4A</td>
<td>75,000 Yards</td>
<td>± 3.0°</td>
<td>Excellent for early warning, not for control purposes</td>
</tr>
<tr>
<td>AN/BQS-2</td>
<td>1400 Yards (active)</td>
<td>± 1.0°</td>
<td>Excellent for general information in passive mode</td>
</tr>
<tr>
<td>JT</td>
<td>10,000 Yards</td>
<td>± 0.5°</td>
<td>Excellent for general information, not normally used Results are only fair, gives early warning only</td>
</tr>
<tr>
<td>QHB-1</td>
<td>1500 Yards (active)</td>
<td>± 0.5°</td>
<td>Excellent for general information in passive mode</td>
</tr>
<tr>
<td>AN/HQC</td>
<td>75,000 Yards (passive)</td>
<td>No bearings</td>
<td>Excellent for general information in passive mode</td>
</tr>
<tr>
<td>AN/BQS-4A</td>
<td>12,000 Yards</td>
<td>± 1.0°</td>
<td>Excellent for general information in passive mode</td>
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<td><strong>B.1. Continued</strong></td>
<td><strong>Equip.</strong></td>
<td><strong>Purpose</strong></td>
<td><strong>General Characteristics</strong></td>
</tr>
<tr>
<td>7. AN/UGN-1</td>
<td>Primary Submarine Fathometer</td>
<td>Freq. 12 KC Max. depth indicated: 6000 fathoms Auto Ping, Single Ping 500 watts to transducer</td>
<td>Fixed Bottomside Transducer</td>
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<tr>
<td>8. AN/BSH-2</td>
<td>Bathythermograph</td>
<td>Sound Vel. 4600-5100 f.p.s.</td>
<td>Fixed Sensing Element</td>
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<tr>
<td>9. OMA</td>
<td>Cavitation Indicator GI Cb12 KC</td>
<td>Noise Level Monitor NLM 150 to 3500 cps</td>
<td>Fixed Topside Hydrophones (4 NLM and 1 CI)</td>
</tr>
<tr>
<td>10. AN/BQC-1A</td>
<td>Underwater Communications (Emergency)</td>
<td>Battery Powered</td>
<td>Omnidirectional Emergency Underwater Transducers (2)</td>
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<tr>
<td>11. AN/UQC-1</td>
<td>Telephone</td>
<td>Freq. 500 KC (CW)</td>
<td>Omnidirectional undersea and Bottomside Transducers</td>
</tr>
<tr>
<td>12. AN/BQN-1</td>
<td>Submarine Fathometer</td>
<td>Frequency 12.4 KC</td>
<td>Fixed Topside and Range Scales: 30', 300', 1200'</td>
</tr>
</tbody>
</table>
3. Discuss BQS-2 with regard to its capabilities and limitations as a passive sonar and as an active sonar.

**Passive:** In the listen mode, no pulses are transmitted but any object in the area producing noise in the 30 to 33 KC frequency range will be indicated on the PPI scope by a spike at the proper bearing. Signals are also applied to the look-down mode of display. Range information is not available. Detection range of 4000 yards with sea state 2 is about an average detection range. This mode is used for area tracking, screen penetration, and target detection.

**Active:** Mode available in the active mode on 31.5 KC are as follows:

1. **Single Ping:** The single ping mode of operation provides A-scope indication (12°), PPI (40°), and all available indications of echo ranging information obtained by directional single ping transmissions. The ship's magnetic compass is the same as in the listen mode but is immediately following a single ping transmission. A magnetic recorder records the output during the receiving period. After the receiving period, the recorder "plays back" the information at about 10 times the recording speed on the A-scope indicator, until stopped by a preset timer or by the stop button. The playback cycle may be repeated. This mode can be used for indicating range for fire control purposes.

-continued on page 5-10A-

4. Describe the passive sonar search plans used when hovering and when underway submerged at 3 knots.

The normal search plan used when hovering and when underway submerged at 3 knots is the progressive search. In this method, the sonar operator starts a dihedral sweep at the stern, sweeps forward 60° and then, at 30°, it works forward progressively until it crosses the bow. It then returns to the start and sweeps up the opposite side using the same method. Recommended rate of turn is 1° per second. Maximum turn rate should not exceed 15° per second.
Question 3 - Continued

2. Auto Ping - In the auto ping mode, the equipment functions to provide high-speed ranging, echo ranging, and listening with PPI presentation of information which will show all noise or echo-producing objects within the operating range of the equipment. In addition, an oral indication of signals received from any selected bearing is available in a headset or through a loudspeaker. Detection range of 1400 yards with sea state 2 is about an average detection range. This mode is used for minefield penetration, navigation, and small object detection.

3. Record - During the record mode of operation, the entire system is slaved to and synchronized with the sound range recorder and output signals applied to the loudspeaker or headset are also applied to the sound range recorder to produce marking of the recording paper. All other functions are similar to auto ping operation. Range scales between 300 and 4000 yards are available.
5. Discuss the necessity for and, in general, the method of submarine noise reduction.

- Noise reduction in submarines is necessary to:
  1. Reduce the possibility of detection by listening harbor.
  2. Decrease the possibility of attack by an acoustic homing weapon.
  3. Prevent noise interference with other ship's listening devices.

Noise reduction is concerned with eliminating all noise possible on the submarine. Resilient mountings are used where possible on machinery. Flexible couplings reduce noise transmission to the hull. "Sound shots" of all types are carefully eliminated. The propeller shafts and bearings are carefully inspected as possible noise sources. Limitation curves are used. An effort is made to eliminate all sources of vibration in the superstructure. Constant inspection for loose planks or lines that might transmit vibrations to the hull keeps hull noise to a minimum.

6. Describe a typical submarine's noise reduction program.

The submarine's noise reduction program is intended to eliminate noise (both airborne and structural) from the interior. Noise reduction is necessary because it improves a submarine's attack and evasion ability, plus affording good preventive maintenance.

The noise reduction officer directs and coordinates the noise reduction team which is composed of:
- 1st Lieutenant:
- Junior Officer:
- Leading Auxiliaryman
- Leading Torpedoman
- Leading Electrician's Mate

The noise reduction team takes noise level measurements on auxiliary equipment using the Type 557A Sound Level Meter. These readings should be taken at least once between overhauls and recorded on cards for comparison purposes. When the ship is in upkeep, the team should make a thorough inspection topside and below decks to locate the presence of noise sources, noisy auxiliary machinery, improperly deteriorated sound mount, improper stowage of articles causing sound shorts to the hull etc. A log of all defects found should be kept with corrective action taken. Preventive action taken within the capacity of the ship's force, necessary job orders or entries in the CSM should be submitted.
7. Discuss the use of the OMA and the noise level monitor.

The OMA is a system of permanently magnetized magnetostriiction hydrophones which convert sound into electric energy and has the following uses:

1. Measure noise projected into the water by various auxiliary equipment of the submarine. This use is called Noise Level Monitor (NLM). The usual installation consists of four NLM hydrophones, two spaced forward and rearward of the control center reading the hydrophones are all located on the amplifier unit in the forward torpedo room. The decibel meter covers a frequency range of from 150 to 3500 c.p.s. The NLM readings are taken when full load. Any indication of increase in self-noise should be carefully checked and corrective action taken immediately.

2. Measure cavitation. This use is discussed under question #11.

8. What is a "resilient" mounting?

A resilient mounting is a mounting designed to dissipate rotating or vibrating machinery so that its noise does not transmitted to the hull and out into the surrounding water. Resilient mountings serve another purpose of protecting the machinery against shocks such as depth charges. Resilient mountings are generally made of rubber but may be made of other materials such as compressed felt, etc.
9. Why should resilient mountings not be painted?

Paint on resilient mountings can be a source of sound shorts which transmit noise from the machinery to the hull by bridging the resilient mounting. Paint on resilient mountings can also deteriorate the mounting.

10. Discuss "sound shorts".

Sound shorts are bridges that transmit machinery noises to the hull and out into the surrounding water. The resulting water-borne noise can be detected at long ranges underwater. Sound shorts can be caused by deteriorated sound mountings, paint, and other materials on the resilient mountings. Improperly stowed gear that bridges the sound mountings, and loose gear within the ship.
11. Describe the operation and use of the cavitation indicator.

The cavitation indicator (C1) utilizes the same type OMA hydrophones as the NLM. These hydrophones operate on the magnetostrictive principle to convert sound energy into electrical energy. One C1 hydrophone is located aft of #4 NLM hydrophone, and measures cavitation sounds produced by own ships screws. Remote indicators are normally installed in the casing tower, and maneuvering. Each indicator has three neon lamps electrically set 5 decibels apart which indicate the volume of received energy. Light #1 indicates that the equipment is ok. Light #2 is set to flicker at the threshold of cavitation. Light #3 indicates when cavitation is extreme. The C1 hydrophone is sensitive to frequencies between 6 and 12 KC. The C1 informs the casing officer when he must slow down or go deeper to cease cavitation. It also gives the personnel in maneuvering an indication of when the screws are cavitating, which is especially useful when building up turns slowly. The C1 is usually put in operation upon submerging.
C. ECM and Electronics General - Written Notebook Requirements

1. Discuss the general characteristics of BLR-1 with respect to frequency coverage, D/F capability, signal analysis, and antennas used.

The BLR-1 is used to intercept, interpret, and analyze all types of radio and radar signals within its frequency range of 90 to 10,750 MC, covered by eight tuners which can be selected from the indicator control unit. The types of information available from the indicator control unit are: type of signal, frequency of signal, direction of signal (within D/F capability), and, in the case of radar and pulsed signals, the pulse duration and the pulse repetition frequency. The information is displayed on a cathode ray tube in three different presentations: panoramic, direction finding, and analysis (pulse duration and pulse repetition frequency). Received signals also produce an audio-frequency output available for aural monitoring, and video frequency outputs available for video analysis with auxiliary equipment.

The normal antenna installation consists of three antennas on a retractable mast in the tail. These antennas are: A5-626/BLR-1 (D/F) (2300 to 10,750 MC), A5-371/5 (1000 to 4000 MC), and the AT-693/BLR (30 to 1000 MC). Direction finding information is available on bands 6, 7, and 8 using the D/F antenna.

-continued on page 5-15A-
During the shipyard overhaul period of November 1959 to April 1960, ship No. 731 was installed which incorporated the AN/WLR-3 countermeasures receiving set with the AN/BLR-1 to combine the wide band reception of the AN/WLR-3 with the analyzing ability of the AN/BLR-1. The AS-626/BLR-1 antenna was redesignated the AS-944/BLR-1, a detector-switching unit RF-81/WLR-3 was installed immediately below the AS-944/BLR-1 and the AT-693/BLR and AS-371/AA were placed immediately below the RF-81/WLR-3.

The AN/WLR-3 function is as follows:

A pulsed signal is intercepted by either the low band (2300 to 5200 Mc) or high band (4300 to 11,000 Mc) antenna of Antenna Assembly AS-944/BLR-1. Each antenna is connected to a detector-switching unit RF-81/WLR-3 where the received signal is either switched to the AN/BLR-1 receiver for normal operation or switched to the wide band receiver, AN/WLR-3. When switched to the AN/WLR-3, the signal is detected by one of two coupled detectors (depending on whether the signal is in the high or low band) located in the detector-switching unit, RF-81/WLR-3, amplified, and delivered to a set of earphones for audio presentation. In addition, the output is connected to a panel jack for connection to the DF display of the AN/BLRT Indicator console.
2. Discuss the capabilities and limitation of the ECM equipment for general ECM search and tactical use.

Intercept search is the use of ECM equipment to detect, locate, and analyze enemy electronic radiations. The equipment can perform these functions on emissions of any electronic equipment operating within the frequency range of the intercept receiver. It affords early warning and information on enemy use of electronics.

3. What is the purpose of ground straps on electronic equipment?

Ground straps prevent personnel from accidentally shocking themselves or electronic equipment by providing a low resistance path to carry off stray currents on the equipment.

4. What is the presently approved type ground strap?

Ground straps must be good conductors. The presently approved types are solid copper straps or braided copper cable at least 1/2 inch wide. They should be as short as possible.
Tactically, the intercept search operation has four stages:
1. Search for and detection of an enemy signal.
2. Location and tracking of the source of a signal.
4. Signal evaluation.

The value of intercept search in any tactical situation is subject to the following limitations:
1. Effectiveness dependent upon operations of enemy electronic equipment.
2. Time is required for sweeping frequency bands.
3. Search equipment is subject to jamming.
4. Intercept search is subject to deception.
CHAPTER 5

OPERATIONS (ELECTRONICS) - PART II

This is to certify that all work within this section has been completed.

Approved:

A.W. Comer, Lt., USN

R.M. Weidman, Jr., LCDR, USN

B. Peters, LCDR, USN
CHAPTER - 5
OPERATIONS - Part III
(To be completed on board your submarine)

A. Sketches

1. Make a profile sketch showing all sound heads, fathometer transducer, radio, radar, and ECM antennas, including antenna lead-ins where applicable. Label all ECM antennas as to frequency coverage, indicating D/F antennas.

Profile sketch appears on page 5-17A

B. Practical Factors

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1. Satisfactorily demonstrate ability to operate the following equipment:

   a. Fathometer
   b. Sonar
      (1) Active
      (2) Passive
   c. OMA
   d. Radar
   e. ECM
   f. IFF

2. Satisfactorily demonstrate ability to make out a sonar range prediction card. (Utilize Figure of Merit equipment or Figure of Merit charts.)

3. Satisfactorily demonstrate ability to operate the following equipment:

   a. Frequency Meter
New Snarkel Antenna Installation July 1959

MF/HF AT-497/URC Snarkel Whip

UHF Stub AT 497/URC Modified
AS-522B/BPX IFF and TACAN

MF/HF AT 497/URC Snarkel Whip

AT-350/URC Port Whip
MF/HF

AS-626/BLR-1 (D/F)
2300-10,750 MCS

AS-371/I
1000-4000 MCS

AS-522/BPX IFF
30-1000 MCS

ST Radar

BLR MAST

SS Radar

Antenna Lead-ins

MF/HF Centerline Wire

MF/HF Mid-Fed Whip

Topside Transducer BQS-2

BQS-2 Cone Bottomside Transducer

Retractable BQS-2 Cone

BQR-28

Radio Rm.

Control Room

BQR-28

#10MA

OMA

#10MA

OMA

Retractable BQS-2 Cone Bottomside Transducer
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b. Radio receivers  
c. Radio transmitters  
d. Radio patch panel  

4. Satisfactorily demonstrate ability to send and receive flashing light at 5 words per minute.
CHAPTER 6
SUPPLY (STORES) Part I
(To be completed at Submarine School)

References:

Executive Department Training Pamphlet; Chap. IX
BUSANDA Manual Volume VIII, Chapter I
Fleet Commander, Type Commander, and Squadron Commander current instructions, regulations and OpPlans (Sections on Logistics)
Preface and "Procedures and Instructions" of the BuShips Individual Allowance List
NavOrd List "0"
OSO Publication 12, "What do you know about NavOrd Lists"
OSO Publication 15, "What do you know about Ordnance Identification"
OSO Publication 16, "What do you know about Ordnance Repair Parts Supply"

A. Written Notebook Requirements

1. List the primary duties of the Supply Officer of a submarine.
   Material Manager: The Supply Officer is jointly responsible with other department heads for insuring that the ship is logistically ready to carry out any operational commitment.
   Head Bookkeeper: Supervise the maintenance of all the necessary for the proper administration of supply functions aboard ship.
   Mess Officer: In charge of the proper operation of the general mess.
2. Discuss the two afloat supply systems.

There are two basic types of afloat supply systems:

- Ships with central storerooms: Material for general use is kept in storerooms under custody and inventory control of the supply officer. Stores are issued to various departments as required. Usually a supply officer is attached and is responsible for all supply functions.

- Ships without central storerooms: All stores are issued immediately to cognizant departments as they are received on board. Under this system the commanding officer is responsible for administration of supply functions.

3. Who is primarily responsible for the operation and performance of all supply functions aboard ships which operate without central storerooms? Discuss delegation of authority and delegation of responsibility for these functions.

The commanding officer is primarily responsible for the operation and performance of all supply functions aboard ships which operate without central storerooms. The commanding officer usually designates another line officer to assume the duties of supply officer, but the commanding officer cannot delegate his ultimate responsibility, and all reports leaving the ship bear the commanding officer's signature.
4. What are the Bureau of Supplies and Accounts requirements concerning Supply Department orders?

The supply officer is required to prepare written orders for the guidance of all personnel performing supply functions. When approved by the commanding officer, these orders will be promulgated and made accessible to all personnel concerned.

5. Define "repair parts", "equipage", and "consumables".

*Repair parts* are items used to replace worn out or damaged parts of machinery or equipment. *Equipage* is material which is neither consumed nor appreciably altered in use. There are two classes of equipage, those requiring custody signatures and those not requiring custody signatures.

*Consumables* are operating and maintenance materials consumed in use.

6. What is meant by "standard stock material"?

*Standard stock material* is a general term for supplies, repair parts, and equipment.
7. What are the various allowance lists carried on board a submarine? What information is contained in each?

Bureau of Ships Allowance List: The Bureau of Ships allowance list fully identifies installed equipment and spares, including a complete description, name plate data, serial rating, applicable drawing, and instruction books. In addition to a description of the repair part, the allowance list contains the identifying stock number, a reference to the applicable bureau, drawing number, the unit of issue, and the quantity of each item allowed to be carried on board. The allowance list also contains an allowance designation column for all items of equipment, equipment and repair parts.

Bureau of Ships Electronic Allowance: The Bureau of Ships electronic allowance consists of three parts.

Basic Hull Electronic Allowance (BHEA) is the official BUSHIPS allowance of major electronic equipment installed and/or authorized for an individual ship.

8. What are the responsibilities of the Supply Officer with respect to allowance list changes and general amendments?

Allowance list changes are applicable to specific ships. A change is prepared and issued by Submarine Supply Office and consists of reprinted pages embodying the changes in allowance. A change is effective upon receipt and the supply officer is responsible to see that it is entered immediately.

General amendments have been discontinued.
Ships Electronic Test Equipment Allowance (SETA) contains the allowance of test equipment for a particular ship and is included as Group 5 69-1 of the Individual Allowance List.

Electronic Maintenance Parts Allowance List (EMPAL) is a recommended listing of quantities of repair parts and tubes required to support ship's operations for 90 days.

Bureau of Ordnance Allowance Lists: the ships ordnance allowance list consists of a group of individual NAUORD lists which record the authorized allowance of repair parts, tools, and accessories to support all ordnance equipment of a particular ship.

NAUORD List 0 is an annually issued index listing every NAUORD list used in the Navy and its current revisions.

NAUORD List 00 tabulates the individual NAUORD lists assigned to a particular ship to support its installed armament and ordnance equipment.
9. Discuss material control (stock control, inventory control, and custody control) of repair parts and equipage. Include forms used and responsibility for maintenance of the records.

Stock control. Allowance lists prescribe the material that should be on board, but a system of records is required to show what material is on board, to provide for procurement action to replace material and to provide for a follow-up on the ordered material. This system of records to perform these tasks is called stock control. There are four general types of stock control records. The first three to be discussed parallel the allowance lists, and the fourth is for equipage.

Stock control is a running inventory.

**Machinery Repair Parts:** Stock records maintained on SANDA form 489 or SANDA form 488. Form 489 is inserted opposite each page of the BUSHIPS Individual Allowance List. The department head concerned is responsible for the bookkeeping. The supply officer will supervise to insure that they are being maintained properly.

**Electronic Repair Parts and Tubes:** Stock records maintained on SANDA form 488. Form 488 is a chainex type and is kept in chainex files. The electronic material officer is responsible to see that they are being used. The supply officer will supervise to see that they are being used properly.

- continued on page 6-5A -
Bureau of Ordnance Spare Parts: Stock records are maintained on SANDA forms 488 and 499. In addition, SANDA form 487 is filed with stock records to show applicable NAVORD Allowance list for groups of spare parts maintained by the gunnery officer.

EquiMage: SANDA form 306 is used for stock control. For items requiring signatures, the cognizant department head is responsible for signing for custody. EquiMage not requiring a signature can be kept on SANDA form 306, form 488 or form 499 as the head of department desires.

Inventory control: In essence inventory control is a periodic check on stock control to assure that they reflect the actual status of material on board. Inventories are required periodically for equiMage and repair parts. For equiMage in addition to a periodic inventory (during the first quarter of every fiscal year), inventories are required upon relief of department head. Repair parts are inventoried once per operating cycle usually during regular yard overhaul with the exception of electronics, repair parts, and tubes which are inventoried prior to entering the yard. On completion of an inventory the supply officer reports in writing to the commanding officer.

Custody control: Custody control is required for all items in SANDA Manual, Vol. III, paragraph 8.1405. The commanding officer may designate additional items for control. Custody control is carried out by each cognizant department head. The department head may set up a system for sub-custody using SANDA form 306.
10. What are the responsibilities of the Supply Officer and the Department Heads with regard to:

   a. Maintaining the BuShips Individual Allowance List?
      The supply officer enters all changes. Department head are responsible to find and point out deficiencies.

   b. Conducting inventories?
      Each Department head is responsible for conducting inventories. The supply officer will smooth up reports and submit them.

   c. Maintaining material control records?
      Each Department head is responsible for keeping his own Department up to date.

11. Trace the supply officer's action from the time an item of equipment requiring custody control is surveyed until a replacement item is received on board.
   1. Survey item—since it is equipment requiring custody control a formal survey is required. SAWDA form 154 is required.
   2. Make out requisition for new item. DD 1150.
   3. Make out transfer report to be signed by commanding officer. DD 1148. If the item is necessary and is usable, do not transfer until a replacement is available.
   4. Transfer item.
   5. Pick up new item.

12. What are the principal sources of identification of Navy material available to submarines?

   Navy stock lists are the principal sources of identification for Navy material. Below-listed are the lists carried by submarines:
   1. General Store
   2. Fuel, Lubricants, and Petroleum products
   3. Clothing, Textiles, and Retailed Items
   4. Ship's parts control center
   5. Electronic Supply Office (repair parts portion)
   6. Submarine Supply Office
13. What are cognizance symbols? Of the material used in submarines, which cognizance symbols denote NSA material and which denote APA?

**NSA Material**
- G - General Stores Supply Office
- P - Submarine Supply Office
- H - Ships Parts Control Center
- N - Electronics Supply Office
- W - Fuel Supply Office
- U - Clothing Supply Office
- M - Navy Subsistence
- Z - Ordnance Supply Office

**APA Material**
- S - Buships
- F - Buships
- A - Ordnance Supply Office
- J - Buord
- R - Aviation Supply Office

14. What sources of supply are available to submarines? List the "normal" sources first. What documents should be used in requisitioning from each source?

**Normal Sources**
- Submarine Engines
- Submarine Propellers
- Submarine Spares

**Other Sources in the Navy**
- Other yards and bases
- Naval Supply Centers
- Naval Supply Depots
- Other supply activities
- Supply ships
- Other ships

**Other Services, Except Air Force** - DD 1145
- Air Force - DD 1149
- Commercial Suppliers - SANDA Form 48

15. What accounting information is required on requisitions for NSA material?

1. Appropriation Number
2. Expenditure Account Number
3. Allotment Number
4. Ship's Accounting Number (For Sirius - 73085)
16. Discuss the assignment of priority to requisitions. Discuss the relationship between priority and DMR (date material required).

There are three basic categories of assigning priorities to requisitions which reflect the relative importance and urgency of need for the material requested. Types of priorities and their intended uses are listed on page 6-8A.

17. Under what conditions may material be requisitioned by message?

When air mail is not rapid enough to insure timely procurement, a request for material may be sent by message using the format in BUSANOA Manual Vol. VIII paragraph 8-1-22-6.

18. Draft a sample message requisition for an item of material.

SSS 568/6-1/57 @ DMRI 29 DEC @ SKED NOP RADAR @ 5-960-188-0858 EA 1 5960-237-6017 EA 2 5930-259-735-9 EA 2 @ S & FN 1957 ALOT 5568/2/100/57 EXP ACC #13610

This format includes requisition number, priority, date material required, item number (stock number, code or nomenclature), unit of issue, special instructions, and accounting instructions.

19. Discuss "follow-up" action on uncompleted requisitions.

The supply officer should frequently check his files of outstanding requisitions and should initiate follow-up correspondence when necessary. If the need for the material no longer exists, the requisition should be cancelled.
Question #16 continued

1. Emergency (symbol - EMERG)
   a. To prevent disruption, delay of operations, training, maneuvers, or exercises,
   b. For health and general hygiene, when extreme discomfort or serious personal hazards are an issue.

2. Scheduled (symbol - SKED)
   a. Essential material required prior to a scheduled deployment or extended overseas tours, or for overseas ship replenishment to meet scheduled sailing.
   b. Scheduled overhauls (repairs, alterations, modifications, or conversions of ships).
   c. Scheduled operations.

3. Routine (symbol - ROUTE)
   a. For routine replenishment and filling of allowance.

Whenever either of the two higher priorities is assigned, the commanding officer must sign a statement in the body of the requisition justifying the priority, and the requisition must contain the date the material is required (DMR). The date requirement may also be amplified by the use of the symbols DMR1 and DMRS. DMR1 means material is required with increasing urgency after day indicated. DMRS means the need is terminated on day indicated.
Question #16 continued

On 1 January 1940, a new system of assigning the priority to requisitions was put into effect. It is designed to consider the individual unit's need for particular items as well as the relative importance within the entire naval establishment. It is based upon the ship's mission and end-usage. The system is divided into five mission categories as follows:

1. Fleet submarines
2. Fleet commanders and high priority force commanders.
3. Vital forces and type commanders
4. Lessor operational commands, shore commands, and vessels in overhaul
5. All other units

The new end-use designations, which roughly correspond to the previous priorities of EMERG, SKED, and ROUTE, range from A to D, with D being approximately equivalent to the old ROUTE priority. BUSANDA Manual Vol. VIII contains a table of mission categories versus end-use equipment designations which is used to arrive at the proper number to be placed in the priority column of the requisition. Number 10 covers the previous EMERG priority, number 15 SKED, and number 26 ROUTE for units in the mission 4 category.
20. Discuss responsibility for maintaining a full allowance of equipment and repair parts.

The supply officer with the other department heads is responsible for ensuring that the ship is at all times logistically ready to carry out its assigned missions or operations. The operating capabilities of a submarine with 100% allowance of equipment and repair parts are known, therefore it behooves all departments to keep as close to 100% allowance as possible to meet any demands on the submarine.

21. How is material in excess of allowance procured?

A requisition is made out with the following items included:
1. Signature of the commanding officer
2. Quantity of material on hand
3. State of need for material
4. Estimated cost

22. Discuss the handling of on-coming stores including receipt, checking, identification and distribution.

When material is received on board a representative of the department concerned examines the material ordered, signs the accompanying expenditure document (which he then gives to the supply officer), and takes the material. The signed expenditure document is the supply officer's receipt for material received and issued to the ordering department and is filed in the expenditure document file.
23. Discuss "special clothing". Include allowance, procurement, custody, expenditure, and accountability.

"Special clothing" is designed for providing environmental protection against various climatic conditions where standard articles of uniform are inadequate, but does not include flight, medical or ABC sleeping clothing. Allowances of special clothing are established by CNO and administered by USNVR. Within this framework, submarine type commanders prescribe allowances for submarines. Books of special clothing are usually maintained at the squadron level and issues are made to ships when required. Commanding officers are responsible for the ships' adherence to allowances for the turn in of special clothing to stocks ashore when not required, for proper use, care, and accountability of special clothing carried on board the ships. Special clothing is requisitioned by department heads on DD 756 and submitted to the supply officer. Normally, the 1st Hr. requisition is special clothing for all departments, on requisition through the CIC of the Boat who handles custody and inventory for the 1st Hr.

24. List the methods by which material is expended aboard submarines.

1. Issue

2. Transfer

3. Survey

25. Discuss transfer of material from the ship.

Material may be transferred from one ship to another or to an ashore supply activity. Prior to physical removal of the material from the ship, the commanding officer's approval for the transfer must be indicated by his signature on the transfer document (Invoice/Shipping Document DD 1142). The invoice is forwarded with the material and a receipt signature obtained on it from the receiving activity. When NSA material is transferred to an ashore activity outside of the submarine force, the invoice must be forwarded to the appropriate Navy Regional Accounts Office. In all cases involving transfer of APA material, when NSA material is transferred ashore or to another ship in the submarine force, forwarding of invoice to N200 is required.
26. What is a survey? What is its purpose?
A survey is a determination of disposition and the consequent expenditure from stock records and accounts of naval matériel. A survey is the procedure required by Navy Regulations when naval property must be:
1. condemned as a result of damage
2. acknowledged as non-existent as a result of loss or theft
3. appraised as a result of loss of utility

27. Distinguish between formal and informal surveys. Include restrictions on membership of a survey board.

Formal survey: Required for all classes of matériel or articles designated by the Bureau or office concerned or when specifically directed by the commanding officer. A formal survey is conducted by a board of one officer or three officers, not all of which can be the commanding officer, supply officer, or the officer charged with the custody of the matériel being surveyed.

Informal survey: Used in all cases when a formal survey is not required or directed by the commanding officer. Informal surveys are made by the head of department having custody of the matériel to be surveyed.

28. List the material for which a formal survey is required.
1. Provisions
2. Ammunition
3. Special weapons
4. Any equipment designated by the commanding officer

29. Aside from the material list in the preceding question, what matériel requires survey when lost, obsolete, or deteriorated?

Equipment which requires custody.
30. Discuss the submarine force allotment system. Include responsibility of the Commanding Officer and Supply Officer; the records, files and reports involved; the "mark" (target) amount; charges against the force commander's allotment.

The present submarine force allotment system is handled on the force commander's level. The force commander is responsible to the federal government for use of the allotment. These funds get to the individual submarine via the squadron commanders. The squadrons, depending upon whether or not a tender is attached, will differ in how the funds, and how much of the funds reach the individual submarine. If there is no tender the funds are generally divided as follows:

1. A reserve held by the squadron to cover any unforeseen circumstances.
2. An amount to cover above normal situations and special circumstances.
3. The rest is divided equally to the submarines for purchases outside of SUBLANT activities. This is called the "mark" (target) amount.

If there is a tender available the funds are generally divided up as follows:

1. A reserve held by the squadron to cover any unforeseen circumstances.
2. A small amount is given to each submarine as a "mark" (target) amount for purchase of items outside of SUBLANT activities.
3. The remainder is given to the tender. Since the tender is a SUBLANT activity, the submarines can requisition material without an expenditure account being required.

- continued on page 6-12A -
Records

The primary accounting tool maintained on board is the Requisition and Obligation Record. All requisitions for stores material are logged in this record. All entries affecting the operating allotment of SUBLANT are noted in this record.

Files

There are three files that support the Requisition and Obligation Record:
1. Outstanding Requisition File
2. Expenditure Document File
3. Completed Requisition File

Reports

Each submarine makes a Status of Allotment report to the appropriate NEAO on the last day of each month. The report must arrive by the 3rd of the following month. The supply officer makes up the report and it is signed by the commanding officer. If ordinary mail service is too slow, a message report may be made.
31. How are postage stamps for official use procured?

SECNAVINST 2700.1D of 5 September 1956 ended the
use of postage stamps on official mail for naval activities.
Official mail is now stampled “Postage and Fees
Paid—Naval Department.”

32. Discuss the Supply Officer’s responsibilities upon wartime
deployment with regard to stores.

The supply officer must ensure that all supply
items are ordered promptly and must work with
department heads to maintain supply items as close
to the 100% level as possible at all times. When
past experience has indicated that in the case of
certain items (such as fuses, light bulbs, and
magnetoes), more than 100% of allowance is
needed, it is advisable to keep, additional
quantities of these items over 100% allowance aboard.
CHAPTER 6

SUPPLY (COMMISSARY) - Part II

(To be completed at Submarine School)

References:

Executive Department Training Pamphlet, Chapter IX
BUSANDA Manual, Volume VIII, Chapter 2
Fleet Commander, Force Commander and Squadron Commander
instructions, regulations, and OpPlans (sections on logistics)
Navy Subsistence Office current instructions
NRAO Cleveland instruction on ration returns

A. Written Notebook Requirements:

1. Define the following:

   a. Ration. The amount of food authorized to support one
      enlisted man for one day.

   b. Money ration allowance. A definite amount of money
      provided for the purchase of food for one man
      for one day.

   c. Commuted Ration. The term applied to rations where enlisted
      personnel are authorized to receive, under prescribed
      conditions, a money allowance in lieu of rations.

   d. Leave Ration. Rations when enlisted personnel are in a
      leave status and are entitled to a money allowance
      in lieu of rations.

2. What is the current money ration allowance for submarines? What
   factors may change this figure?

   The current money ration allowance for submarines is $1.38
   per man subsisted per day.

   Factors which may change this figure are:

   1. Ships upon commissioning receive an additional money allowance
      for the first thirty days from the date of commission.

   2. Operations north of 50° north latitude or south of 50° south latitude
      automatically entitle a general increase in the money ration allowance (15%).

   3. Submarines on special CNO operations get special money
      allowance (not a set amount).
3. Discuss briefly the responsibilities of each of the following in the operation of the general mess:

a. **Commanding Officer** - responsible for the proper administration of the general mess, sign the General Mess Operating Statement, and is personally responsible to the Government for all provisions in his possession, and for any shortage thereof, including allowance.

b. **Commissary Officer** - in charge of the general mess, ensure that the ship is supplied with provisions in sufficient quantities to meet all situations, and to prepare written orders for the guidance of personnel assigned to the commissary section of the Supply Department.

c. **Executive Officer** - responsible for detailing the messmen, and preparing the Personnel Requisition Form and Requisition Credit (SANDA FORM 27) and submitting it monthly to the commissary officer.

d. **Leading Hospital Corpsman** - inspect provisions received from commercial dealers and inspect all personnel before they report for food handling duty and at frequent intervals thereafter.

e. **Leading Commissaryman** - inspect provisions for quality, sign for custody of provisions, maintain provisions stock book, prepare subsistence report. Maintain provisions budget, take inventories, and prepare the weekly menu.

f. **Leading Steward** - in charge of the steward's and is directly responsible to the commissary officer for the cleanliness and operation of the wardroom and its associated equipment.

4. What are the requirements regarding inspections for quantity and quality of provisions received:

a. **From a government source?**

   When provisions are received on board they shall be inspected for quantity by the commissary officer and the leading commissaryman. If provisions are received after working hours, they must be inspected by the duty officer and the duty cook.

b. **From a commercial dealer?**

   When provisions are received aboard ships direct from a commercial dealer they should be inspected for quality, the same way that provisions received from a government source are inspected. They should also be inspected for quality by the hospitalman.
5. Describe the system for the sale of meals from the general mess. Conditions to be met for the sale of meals and charges for the sale of individual meals from the general mess are prescribed in BYSANDA Manual Vol. VIII. Meals may be sold on a credit basis upon written authorization of the commanding officer. Charges are made on a cash basis, and payment is received at the time the meal is received. The credit system in effect is that meals sold to each individual are maintained, and bills are paid no later than the first regularly scheduled pay day of the month following the month in which the meals were sold or upon detachment of the individual officers. A sale of meals record is maintained showing meals sold, cash value of each, and total cash involved. In addition, a cash book is maintained showing all collections and transfers of money to disbursing officers, and cash on hand. The cash involved in the sale of meals must be kept in the personal custody of the commissary officer; in the safe, the combination to which is known only to him. This cash must be verified on the last day of each accounting period by an officer on board appointed by the commanding officer, who is transferred to a disbursing officer on all vessels (00-114) showing money transferred from the safe to be forwarded with the quarterly ration return.

6. What commissary records are directly affected by price changes?

1. Provisional Ledger

7. Describe how custody control of provisions is established and maintained.

When provisions have been received, and inspection has been made, the provisions are delivered into the custody of the leading commissary, who acknowledges receipt by signing a copy of the requisition. These copies are then held by the commissary officer, and proof of custody.

8. When are provisions inventories required?

1. At the end of each fiscal quarter.
2. Change of command.
3. Relief of the commissary officer.
4. Relief of the leading commissary officer.

9. When must an inventory report be submitted with ration returns?

An inventory report must be submitted with ration returns for the inventory required upon change of command.
10. Describe the provisions ledger.

The provisions ledger is the running inventory for provisions. It contains a sheet for each item of provisions carried on board and is maintained by the leading commissioner. Each page of the ledger contains a description of the article of provisions, the stock number, and unit of issue, the quantities of all receipts and expenditures (including issues to the general mess) are recorded, and the balance on hand is adjusted accordingly. The unit price of each item of provisions carried on board is also logged in the provisions ledger.

11. Describe the general mess control record.

The general mess control record is maintained by the commissary officer as a device for controlling the cost of issues to the general mess. The leading commissioner must submit a statement showing issues to the general mess daily, and this eventually furnishes the number of rations issued each day. By dividing the daily cost by the daily rations, the average ration cost can be determined. By comparing this figure with the money ration allowance the commissary officer can determine whether provisions were over- or under-issued for that day. By applying cumulative totals for the quarter he can tell at any time whether the allowance has been over or under.

12. Describe the Record of Receipts and Expenditures.

The record of receipts and expenditures is maintained by the commissary officer and is his primary accounting record for provisions. He is used on preparing the ration return, and issued to determine the value of the stores actually consumed (cost of issues) during the accounting period. The money values of all receipts and expenditures (except issues), as determined by the receipt and expenditure documents, are recorded in this record. The record is maintained in a columnar form with a column for each type of receipt and expenditure. As the form provided by the Navy (SANDA 367) is too large, submarines are permitted to use a standard ledger or notebook for this record.
13. When and to whom are ration returns submitted?

Ration returns are submitted at the end of each fiscal quarter and are charged to the command. They are submitted to the Navy Regional Accounts Office, Cleveland, with a copy to the Navy Subsistence Office, Washington.

14. When may ration returns be merged and what administrative action is required by the ship to accomplish the merging?

The ration return for a small fractional period may be merged with the return for the preceding or subsequent period, upon written authorization of the commanding officer. This is applicable when a change of command occurs near the start of a regular accounting period. The period ending 30 June may not be merged with the period ending 30 September (July and August appropriations are involved). When merged returns are authorized, a copy of the authorization must be forwarded immediately (and also when returns are submitted) to NROA and NSO.

15. What action must be taken when:

a. Ration returns cannot be submitted on time?

(Include circumstances when the delay is foreseen in advance and when it is not foreseen)

If it is anticipated that the return cannot be submitted on time (due to the ship being at sea, for instance), a letter requesting an extension of time must be sent to the Bureau of Supplies and Accounts, with copies to NROA and NSO. When returns are late without an extension of time, a copy of the authorization letter must accompany the return to NROA, and a copy must be sent to NSO.

b. The ration return shows an overissue?

If an overissue has occurred, the commanding officer will initiate action to determine the cause. When a determination has been reached, the commanding officer will submit a letter report of the cause(s) responsible for the overissue.

16. What are the responsibilities of the Commanding Officer, Commissary Officer and leading commissaryman regarding the menu?

The weekly menu is prepared and typed by the leading commissaryman and submitted to the commanding officer on SANDA FORM 1080 (General Mess Menu). It is then submitted to the commanding officer for approval. The commissary officer should check the menu carefully to ensure that it contains a well-balanced diet and that a variety of food is being served. The commissary officer should consider the eating habits of the crew and attempt to have as attractive a menu as possible.
to the Navy Subsistence Office through the normal chain of command. When an overissue has occurred, proper corrective measures will be taken immediately to eliminate the overissue by underequipments in a corresponding value during subsequent quarters. During periods of liquidation of overequipments, care will be exercised to maintain an adequate nutritional diet. An overequipment will be carried forward until finally eliminated by corresponding underequipments unless a request for credit, completely justified, has been submitted to the Navy Subsistence Office and the credit has been extended.
17. Describe the Navy Recipe Service and the Navy Food Service.

The Navy Recipe Service is the basic source for brief and clearly defined individually numbered recipe cards for the preparation of food for use in the general messes. They are used in planning menus and provide portion control by itemizing quantities and kinds of ingredients to be used. The recipes include mixing methods, cooking times, and cooking temperatures.

The Navy Food Service is a guide of suggested menus designed to meet average requirements and operating conditions of general messes. It is distributed each month usually six to seven weeks in advance of the month for which the suggested menus are planned, for voluntary use by officers operating general messes.

18. Discuss the importance of cleanliness and sanitation in the galley, crew's mess, and pantry. What are the sanitation responsibilities of the various commissary personnel? of the hospitalman?

Cleanliness and sanitation in all mess personnel spaces, and operations, is important because bacteria and products of their growth are the most common causes of food poisoning. Bacteria may be introduced by careless food handlers, cooking utensils, and food preparation and serving spaces.

The supply officer will make daily inspections of all mess personnel spaces, and operations as well as a thorough weekly inspection. All commissary personnel should constantly keep in mind the necessity for personal cleanliness and the responsibility for maintaining all mess spaces in a condition of cleanliness at all times.

The hospitalman will make a thorough sanitation inspection of all food storage, preparation, and service spaces at least weekly, noting any evidence of deterioration, contamination, and food spoilage which might endanger health. He will make periodic inspections of dishwashing practices.
19. Describe how a commissary officer would determine the quantities of various commissary items to be loaded upon wartime deployment.

In accordance with COMSUBLANT OP-ORDER 1-58, all submarines must maintain a minimum of 45 days supply aboard at all times. Appendix I to Annex F of this OP-ORDER contains a list of basic provision items that are necessary to fulfill the minimum loading of 45 days supply. Requisitions are made up in advance to bring the level up to wartime deployment. In case of orders to deploy, the commissary officer signs these requisitions so that the ships can be loaded very rapidly for deployment.

20. What are the current required provisions levels of a deployable submarine?

Submarines are required to maintain at least 45 days provisions on board at all times. Submarine commissary officers also must have plans prepared to provision the ship for a 90-day patrol on short notice.
CHAPTER 6

SUPPLY

This is to certify that all work within this chapter has been completed.

Approved:

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CHAPTER 7

POST WORLD WAR II SUBMARINE DEVELOPMENTS

(To be completed at Submarine School)

References:

NWIP 23-7
NWP 23

A. Special Purpose Submarines - Written Notebook Requirements

1. Discuss the capabilities, limitations and include a brief description of the following type submarines, adding a brief statement as to their mission and employment:

a. SSN 571 and 575.

The SSN 571 and SSN 575 are nuclear-powered submarines designed to travel faster underwater than on the surface. Their bows are more bulbous than conventional type hulls to give them added underwater speed. They possess attack characteristics similar to those of the SSN 637 class submarines with the additional ability to sustain high speeds submerged while operating on the reactor. They have six torpedo tubes forward, two screws, large internal space due to a rearrangement of ballast tanks, and reduced fuel storage which permits three stokers and the latest and best periscope electronics fire control and torpedo handling systems. Gyro compass and an adequate oxygen supply are installed. A battery, a small diesel electric generator and asphodel are retained for propulsion in case of emergency or for reactor start-up. The SSN 571 differs from the SSN 575 chiefly in the type of reactor used. The SSN 571 utilizes a water-cooled thermal reactor and the SSN 575 utilizes a liquid sodium-cooled intermediate reactor. The SSN 575 has a slightly larger hull and greater tonnage.

The SSN 571 is capable of 28 knots for 15,000 miles on the surface, cruising at 24 knots for 70,000 miles submerged and has a test depth of 700 feet. The SSN 575 is capable of 19 knots for 15,000 miles on the surface, 23 knots for 70,000 miles submerged, and has a test depth of 700 feet.
b. SSN 578 class.

The SSN 578 Skate is a nuclear-powered submarine whose design is intended to provide a nuclear-powered attack submarine of about the size of a guppy submarine. Emphasis has been placed on small size in order to realize the advantages which go with a small submarine. This submarine has a sustained speed of at least the maximum of the existing guppy submarines and has endurance inherent in nuclear propulsion. The Skate has six torpedo tubes forward and two short torpedo tubes aft. She carries 12 reloads forward and two reloads aft. She is capable of 18 knots for approximately 2,000 full-power hours submerged and has a test depth of 700 feet.

c. SSN 593 class.

The SSN 593 class submarines are nuclear powered submarines having the "tear drop" hull form and are successors to the Skipjack which is the prototype of the new conception. They will have sail planes instead of bow planes, and are intended to be high speed, highly maneuverable attack type submarines with great endurance. The class will mount six torpedo tubes forward and have installed missile guidance systems. They will also retain a snorkel, a battery, and a diesel electric generator for charging the battery and for reactor start-ups. The SSN 593 class have a test depth of 700 feet.
d. SSN 585 class.

The SSN 585 Skipjack is a nuclear-powered submarine utilizing the basic "teardrop" hull design pioneered by Albacore, but with the addition of removing the bow planes and adding sail planes to improve maneuverability. This design is intended to produce a reactor-powered attack type submarine in which the best possible submerged characteristics are realized. It has single screw propulsion, high submerged speed, great submerged maneuverability, and endurance are emphasized in order to provide a vehicle for the employment of advanced tactical methods. A missile guidance system is installed.

The SSN 585 is capable of 16 knots on the surface, 26 knots submerged, and has a test depth of 700 feet.
e. SS 563 class.

The SS 563 " Tang" class submarines embody various improvements based on war experience to give higher submerged speed with improved submerged handling characteristics. They are deep-diving submarines with comparatively short hulls and are capable of more speed, maneuverability, and diversified employment than previous submarines. Important new characteristics include new type main engines three main engines, improved electronic gear, two tube torpedo tubes (for countermeasures only), and rearranged compartmentation that eliminates the conning tower. The SS 563 class employ the high capacity battery load on Byggøy type and the "dry mast" type mast.

The SS 563 is capable of 14.5 knots for 6,000 miles on the surface, 14.5 knots for 15,000 miles submerged, and has a test depth of 900 feet.

f. SS 580 class.

The SS 580 is a diesel-powered conventional submarine utilizing the radical underwater hull form employed in the Albacore, which will make it more maneuverable than any other conventional submarine in the fleet. The increase in submerged speed, endurance, and maneuverability are obtained through a shorter hull of greater beam, utilizing single screw propulsion.

The SS 580 has a radar missile guidance system, and six torpedo tubes fore and aft. They are capable of 17 knots, for 4,000 miles on the surface, 18.5 knots for 18,500 miles, and have a test depth of 700 feet.
g. Guppy IA

The Guppy IA is a fleet type submarine conversion with added snorkel and streamlining which increased submerged speed. They have large I or Large II batteries. Guns were removed. They were designed to improve the capabilities of the fleet type submarine. They are limited with regard to underwater speed and endurance plus having a relatively shallow test depth. The Guppy IA is capable of 18.5 knots for 7000 miles on the surface, 12 knots for 12 miles submerged, and has a test depth of 400 feet.

h. Guppy II

The Guppy II is the first major postwar improvement in the submarine program embodying greatly increased submerged speed with a proportionate increase in submerged endurance. They are conventional fleet type submarines incorporating the snorkel, streamlining, and a high capacity battery among other major changes. Most Guppy II conversions have a fixed periscope to reduce excessive periscope vibration at high submerged speeds. They are limited by having a relatively shallow test depth and must surface or snorkel to charge batteries periodically. The Guppy II is capable of 18.2 knots for 7000 miles on the surface, 13.0 knots for 9 miles submerged, and has a test depth of 400 feet.
i. Guppy IIA

The Guppy IIA is a conventional fleet type submarine converted to include an installed snorkel, streamlining, new type batteries, more electronic equipment, and one engine removed. The new batteries (Gargo II) improve submerged endurance capabilities but do not equal those of the Guppy II installation. The habitability on the Guppy IIA is improved. Long-range array type search sonars are installed on some Guppy II submarines. The Guppy IIA has limited speed and endurance and has a relatively shallow test depth. The Guppy IIA is capable of 16.5 knots for 7,000 miles on the surface, 14 knots for 13 miles submerged, and has a test depth of 400 feet.

j. SSK Type II

The SSK Type II is a conventional fleet type submarine with installed snorkel, streamlining, new type batteries, more electronic equipment, two bow torpedo tubes removed, and one engine removed. The SSK Type II has greatly improved sonar detection and attack capabilities. "Noise" reduction and habitability is emphasized. They have a long range sonar installation in the bow, streamlining and surface propulsion are similar to the Guppy IIA with good sea-keeping characteristics. It has the ability to locate and destroying ships with particular emphasis on other submarines. The SSK is restricted by its own lack of speed and endurance, shallowed test depth, and dependence upon good sonar shallusions. They are capable of 16.5 knots for 7,000 miles on the surface, 11 knots for 9.2 miles submerged, and have a test depth of 300 feet.
k. SSK Type I.

The SSK Type I is an interim fleet type submarine conversion to assist in determining SSK prototype. Major changes involved in this conversion are the installation of a long range passive sonar array in the conning tower fairwater, the incorporation of noise reduction alterations to eliminate sonar interference and to improve SSK patrol capabilities, streamlining of the superstructure, the removal of two engines and the removal of two bow torpedo tubes. Its primary mission is to destroy and destroy ships, particularly other submarines. It is designed to be of providing evadable target information to other ASW units. The SSK is limited in its endurance, speed, shallow test depth, and dependence upon good sonar conditions. They are capable of 14.5 knots for 12,000 miles on the surface, 12.5 knots for 18.5 miles submerged, and have a test depth of 300 feet.

1. Fleet Snorkel.

The fleet snorkel is essentially a conventional fleet type submarine having six torpedo tubes forward and four aft, retaining the chopper bow. In addition the fleet snorkel has a streamlined conning tower fairwater to decrease underwater turbulence and drag. It is also equipped with a snorkel to enable the submarine to operate submerged on the diesels for propulsion and battery charging to decrease the probability of visual detection.

The fleet snorkel is limited in that it must remain at periscope depth to snorkel and the high noise level while snorkeling provides the enemy with an excellent sound source for sonar detection. The fleet snorkel is capable of 18-20 knots for 8000 miles on the surface, 8 knots for 9 miles submerged, and have a test depth of 400 feet.
m. SSG (including FBM type).

The SSN is a snorkel-equipped conventional submarine capable of guided missile launching. The missiles are stowed in a special pressure compartment on the main deck. The stowage is arranged so that the missile can be completely prepared for firing while the submarine is submerged.

The mission of the SSN is to deliver guided missile attacks on enemy controlled waters. It is able to remain submerged until the launching point is reached, launch the missile within approximately ten minutes after surfacing, and with its special guidance system control the missile in flight and guide it to its target at ranges in excess of 200 miles or pass control of the missile to another submarine. The SSN is limited in that it must be accurately positioned while launching and guiding the missile and it is vulnerable to attack during the evolution.

The SSN (FBM) has the same mission and capabilities as the SSN with the additional capability of being able to carry and fire from a submerged condition up to 16 Polaris missiles from any spot a submerged submarine can reach.

- continued on page 7-8A -
The Sunny (SSN-282) class SSN's are capable of 16.7 knots for 6000 miles on the surface, 9.2 knots for 9.2 miles submerged, and have a test depth of 300 feet.

The Grayback (SSN-574) class SSN's are capable of 15 knots for 13,000 miles on the surface, 12 knots for 12 miles submerged, and have a test depth of 700 feet.

The SSN (N)(FRM) submarines will be nuclear-powered. Their designed horsepower is 15,000 shp with a surface speed of 20 knots.
n. Fleet snorkel (missile guidance).

The fleet snorkel (missile guidance) is similar to the fleet type submarine, with the additional snorkel and streamlined diving tower structure of the fleet snorkel.

The primary mission of the fleet snorkel (missile guidance) is to proceed undetected to a predetermined location in the flight path of the proposed missile shot and to assume guidance control of the missile as it passes overhead and guide it to the target. To accomplish its missile guidance capabilities this submarine has a special guidance system which may be used to guide the missile while on the surface or submerged.

The fleet snorkel (missile guidance) is limited in that it must be very accurately positioned and while guiding the missile it is vulnerable to attack. Dual control of the missile is also possible by two submarines of this type, which permits increased accuracy.

o. Radar picket.

The SSR is distinctive among conventional types due to the various radar radomes and antennas protruding from the decks. Type III and IV have the general lines of the snorkel-equipped fleet type submarine, the Type III has the ship's bow, but has the Gargoyle bridge and fantail in addition to having a 30 foot section of hull added just forward of the bridge to accommodate the air control radar. The Type III is designed as a picket (SSR) 350 feet long with a rounded bow and a streamlined sail housing all antennas except the AN/ASPS-3.

The SSR has the primary mission to extend force radar and air control range while remaining on station undetected. The SSR is valuable in waters which are unsuitable for surface ships and where the extensive detection and communication equipment on board can be used to furnish intelligence or aid own forces in offensive or defensive operations. They are capable of controlling combat air patrols, directing enemy aircraft and investigating returning strike groups, acting as geographcal reference points, proving sighting, identifying, and spotting targets, investigating returning strike groups visually, by radar, and by IFF. The main limitations of the SSR are reduced diving and submerged speeds, ability to carry few cruising torpedoes and a tendency to take a very long time submerged because of the drag from the special radio and radar antennas.

-continued on page 7-9A-
n. Fleet snorkel (missile guidance) - continued

The fleet snorkel (missile guidance) is capable of 18-20 knots for 8000 miles on the surface, 8 knots for 9 miles submerged, and has a test depth of 400 feet.

o. Radar picket - continued

The first submarine designed and built as an SSR is the Squalus (SSR-572), a Type III SSR.

The Triton (SSR(N)586) is intended to provide a nuclear-powered SSR with the best practicable radar and air control facilities. A missile guidance system is installed. She retains a conning tower, four torpedo tubes forward, and two torpedo tubes aft, and is 444 feet long.

The Type II SSR is capable of 18.0 knots for 6000 miles on the surface, 7.5 knots for 7.5 miles submerged, and has a test depth of 400 feet.

The Type III SSR is capable of 17.0 knots for 7500 miles on the surface, 9.0 knots for 9 miles submerged, and has a test depth of 300 feet.

The Type IV SSR is capable of 20 knots on the surface, 10.0 knots for 10 miles submerged, and has a test depth of 450 feet.

The Triton is capable of 27 knots on the surface, 23 knots submerged, and has a test depth of 700 feet.
Oiler (SSO).

The oiler (SSO) is a snorkel-equipped fleet-type submarine with decreased armament and a streamlined conning tower. Fairwater is the major alteration is the installation of cargo fuel tanks and associated transfer equipment.

The primary purpose of this conversion is to provide a submarine capable of supplying fuel or other vital materials to isolated beachheads or as a consolidated, readily movable base, to replenish airplanes, seaplanes, and other submarines.

The SSO can refuel seaplanes without surfacing, but when refueling a submarine, the hoisting must be performed on the surface, although during the refueling process, the two submarines can theoretically dive and maneuver. When fueling a beachhead, the oiler is limited because a fuel hose must be supplied by an outside source.

Adverse conditions of weather, sea state, and currents make it difficult for the oiler to conduct replenishment. The additional tanks result in reduced surface and submerged speeds. The SSO is capable of 15.7 knots for 600 miles on the surface and 9.3 knots for 9.0 miles underwater, and a submerged test depth of 400 feet.

Transport (ASSP).

The transport (ASSP) is a conversion of the conventional fleet-type submarine for the purpose of carrying 33 tons of cargo and 80 troops. More food, fuel, and water may be stored, and a more efficient air revitalization system is provided in addition to a carbon dioxide scrubbing system. The additional space was obtained by removing two main engines and all torpedo tubes and associated equipment. The ASSP has a snorkel.

The primary mission of the ASSP is troop transport. It can carry troops and cargo to a designated debarkation point undetected. There is sufficient oxygen carried to supply the amount needed for 40 hours, and there is enough carbon dioxide absorbent aboard to operate for 77 hours.

Because the ASSP carries no torpedoes and is equipped with only light armament, its only defense against enemy attack is to employ evasive tactics. The ASSP conversions have reduced speed.
The ASSP is capable of 15.0 knots for 10,000 miles on the surface, 8.4 knots for 8.4 miles submerged, and has a test depth of 400 feet.
r. Target (SST).

The SST is a 250-ton coastal type submarine having a streamlined hull and superstructure for minimum noise and maximum speed. It has a single screw, MK 109 fire control system, and a single bow torpedo tube capable of firing MK 27-A torpedoes.

The SST is designed for target and training purposes, and for the evaluation of our defenses against similar enemy types. It is also used to determine the capabilities and limitations of such enemy submarines. The SST has one active sonar, one passive sonar, and one surface search radar. The limitations of the SST are its inability to operate in the open ocean, limited endurance and speed, and limited offensive capabilities. The SST is capable of doing 10 knots on the surface, 10.5 knots submerged, and has a test depth of 225 feet.
CHAPTER 7

POST WORLD WAR II SUBMARINE DEVELOPMENTS

This is to certify that all work within this section has been completed.

Approved:
R.M. Weidman Jr., LCDR, USN
B. Peters, LCDR, USN
CHAPTER 8
WATCH STANDING (IN PORT) - Part I
(To be completed on board your submarine)

References:

*Standard Submarine Organization and Regulations Manual
*BuShips Manual, Chapter 62, Section III, Submarine batteries
*Type Commander's Instructions pertinent to the subject of the assignment
Navy Regulations
CG-169 (Rules of the Road)
*NWP 23
Local area harbor chart
Record of builder's trials and tests
*Effective Dispersal Plans
Booklet of general plans
FXP 1
*NWIP 23-10
*Force Regulations
*Fleet Regulations
*SOPA Instructions
Basic Force and Group OpPlans
ACP 175

A. Written Notebook Requirements:

1. Who is authorized to release messages on your ship?

All messages will be released by the signature of the commanding officer or his authorized representative. In port, the executive officer and the duty officer are authorized to release messages.
2. What is your ship's policy on visitors-foreign and US?

When visiting is authorized by SOPA, the ship shall be rigged for visitors, i.e., cleared, necessary items covered, and men from the duty section stationed in all compartments and topside stations. All latches shall be shut with the exception of ATR and FTR. The following items shall be covered from view:
1. All deep depth gages and sea pressure gages
2. Hydrolevel regulator
3. Sonar equipment and the Bathythermograph
4. Extra room radar and ECA equipment

3. What visual signals would you display when divers are working over the side? When fueling ship? What precautions should be taken?

When a diver is working over the side, the flag, "FOUR" shall be displayed where it can best be seen, so that vessels passing close by will slow down and maneuver with caution. A watch should be posted in the area where the divers are down to ensure that nothing is thrown over the side. The screws should not be turned over for any reason unless requested by the divers.

When fueling ship, the flag, "BAKER" shall be displayed where best seen. All filling and transfer line-up must be checked, and a watch with phone stationed to observe the liquidometer or expansion tank gauge on the tank being filled, and the compensating overboard discharge. The smoking lamps should be out, and no naked lights or electrical equipment or sparks permitted near a compensating connection or tank or vent from a tank or the filling connection. CO2 extinguishers should be kept handy. The filling connection to the tank being filled should be open plus all compensating water connections. When filling a fuel bellows tank, insure it is rigged as a fuel bellows tank. To shift tanks when one is full, it is necessary to first open the filling connection to the empty tank and then shift the connection to the full tank. Fueling should be secured when the liquidometer on expansion shows the presence of fuel or when fuel shows in compensating water overboard discharge.
Question #2 continued:

The visiting route shall be from ATR to the FTR and no visitors shall enter:

1. Lower flats of the engine rooms
2. Motor room
3. Battery wells
4. Storerooms, cool room or meat room
5. Pump room, radio room, freezing tower, or sonar room
6. Ship's office
7. Superstructure (all deck lockers shall be shut)

Generally, the ship's policy is not to allow foreign visitors, but if foreign visitors are allowed the above conditions will apply.

In no case will classified material be shown or discussed in any way and visitors will be expedited through the ship.
4. You are duty officer and the only officer aboard when word is received of an imminent atomic attack. What would you do:

a. If the ship cannot get underway?

The duty officer should contact the commanding officer and the executive officer and get all hands possible back aboard. Rig the ship for dive, and if this is not possible, all possible hull openings should be shut. Have the harbor warning circuit guarded on the retractable whip antenna. Dive the ship alongside if possible and rig for depth charge. Station a watch on the underwater telephone and sonar equipments. Supervise damage control monitoring and radiological monitoring.

If the ship cannot be dived alongside, order all personnel below, shut all hull openings, and secure all unnecessary rotating machinery.
b. If the ship can get underway?

The duty officer should contact the commanding officer and the executive officer and get all hands possible back aboard. Rig the ship for dive and if this is not possible, all possible hull openings should be shut. Sound the harbor warning circuit. Make all preparations to get underway. Sortie on order of SOPA. The Signal's emergency dispersed anchorage is SS-13, Tangier Island.
5. Briefly discuss the regulations for arrest, confining, and restraint of an enlisted man. What are the procedures for putting a man on report? Describe the method of conducting and identify a person who may conduct a legal search.

An enlisted man may be ordered into arrest or confinement by an order, oral or written, delivered in person or through other persons subject to the code provided probable cause is shown. When ordered into arrest or confinement prior to trial, immediate steps shall be taken to inform him of the specific wrong of which he is accused. Normally, when the offense is one tried by a Summary Court Martial the man shall not be placed in confinement.

Arrest shall mean restraint of the man by an order, not imposed as punishment for the offense, directing him to remain within certain specified limits. Confinement is physical restraint. If the man is to be confined he must be placed under guard and escorted to a place of confinement.

To place a man on report it is necessary to fill out a report slip giving the man’s name, rank, and service number; a brief statement of the offense and the names of three witnesses, if applicable. The slip is signed by the person making the report who will also inform the man placed on report of the nature of the offense. The man placed on report will surrender his liberty card to the duty officer and if restricted will sign a slip acknowledging his status. All reports will be referred to the Executive Officer.

- continued on page 8-5A -
The following are legal searches:

1. Search conducted in accordance with the authority granted by a lawful search warrant.

2. A search of an individual's person or the clothing he is wearing, and of the property in his immediate possession or control conducted as an incident of lawfully apprehending him.

3. A search under circumstances demanding immediate action to prevent the removal or disposal of property believed on reasonable grounds to be criminal goods.

4. A search made with the freely given consent of the owner in possession of the property searched.

5. A search of property which is owned or controlled by the United States.

Authority to order and/or to perform searches of individuals is delegated to the Executive officer, the legal officer, and the CPO or Duty Officer. Other officers shall neither order nor perform searches except when lawfully apprehending an individual in which case the individual must formally have been placed under arrest before the search is made. Searches must be performed with scrupulous regard for the law to prevent miscarriage of justice.
6. How would you accept custody of ship's personnel when returned under arrest by the permanent shore patrol?

Acceptance of custody of ship's personnel is gained by the duty officer when he signs for them, thus releasing the permanent shore patrol from responsibility. If the man are injured or delayed they should be examined by medical personnel. When the men are on board, they must surrender their liberty cards and they must be informed of their restriction to the ships. They will then sign slips acknowledging that they understand their status. The shore patrol report is turned over to the executive officer for further action.

7. Briefly discuss emergency personnel transfers, including the man's service record, medical record, and pay record. What is your procedure for checking out and release from responsibility for local custody items?

Generally, emergency transfers are necessary only in hospital cases, and the man may be added to any record in this manner. However, if his military record should be kept with him, this should be followed with the order for transfer at the hospital, or dispensary. If the man will be under treatment for less than seven days, there is no need to transfer the service or pay records. If the man is to return within thirty days, he should be returned to the submarine; over thirty days, he must be transferred completely for reassignment after completion of treatment.

If the transfer is not for medical purposes, a completed personnel record checkout sheet must be completed on him.

Checking out and release from responsibility for local custody items is accomplished by the use of a checkout slip signed by department heads, 1st Lt., and COB indicating that the man has checked in all gear issued him by the submarine. This slip is turned into the yeoman before the man can receive his orders and leave the submarine.
CHAPTER 8
WATCH STANDING (IN PORT) - PART I

This is to certify that all work within this section has been completed.

Approved:

[Signatures]

R. M. Weidman Jr., LCDR, USN

B. Peters, LCDR, USN
CHAPTER 8

WATCH STANDING (UNDERWAY) - Part II

(To be completed on board your submarine)

A. Written Notebook Requirements

1. List reports, according to Navy Regulations, the OOD is required to make to the commanding officer. What additional reports does your commanding officer require?

Navy Regulations requires that the OOD shall promptly report to the commanding officer, all matters which affect or which may affect the safety of the ship or personnel or ships in company. All land, shore, rocks, lighted or unlighted buoys, beacons, land, islands, rocks, lighthouses, discussing water, vessels, aircraft, or wrecks indicated, any marked changes in the barometric force, or direction of the wind, state of the sea, or indication of warnings of storms or bad weather, all changes of formation, course, or speed ordered by the OOD, or changes of course or speed made by the ships in company or by himself, alterations to equipment which may affect the safety or operations of the ship; all serious accidents; the winding of chronometers; the hours 0800, 1200, and 2000, and in general, all occurrences worthy of notice to the commanding officer shall be reported to him subject to his orders.

In addition, the commanding officer requires reports on all action taken deemed necessary to insure the safety of the ship's closest point of approach or less than 1000 yards, all contacts within 1,000 yards, and all navigational lights and aids at 1200 the OOD reports 1200 all chronometers wound and the specific gravity of the batteries.

2. Who is authorized to relieve the OOD if he believes the situation warrants it?

The commanding officer, executive officer, and the navigator, if authorized in writing by the commanding officer, may relieve the OOD if they believe the situation warrants it.
3. What is the dividing line between inland and international waters in your present area?

The dividing line between inland and international waters in your present area is a line extending from Cape Henry Light to Cape Henley Junction Light, Whistle Buoy, and thence to Cape Charles Light.

4. The gyro repeater on the bridge spins 30° from course and stops. What action should be taken by the OOD?

The OOD should immediately have control shift to the other gyro and then check the bridge gyro repeater against the repeater in the control tower, or on the auxiliary gyro, against the auxiliary gyro repeater in control. If the readings coincide, it can be assumed that the original gyro had a malfunction, and the OOD should have the auxiliary electrician check on it. If the readings still differed, the OOD should shift steering to control and steer by the right panel indication on the gyro in control. Have the auxiliary electrician check out the gyro repeater circuit. If all gyros are out, steer by the magnetic compass in the control tower. In any case, keep the commanding officer and the navigator informed of the trouble and action taken.

5. List the following tactical characteristics of your ship:

a. Surface tactical diameter using full rudder at 5, 10, and 15 knots.

<table>
<thead>
<tr>
<th>Speed</th>
<th>5 Knots</th>
<th>10 Knots</th>
<th>15 Knots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>360 yards</td>
<td>320 yards</td>
<td>297 yards</td>
</tr>
</tbody>
</table>

b. Submerged tactical diameter with full rudder at 3, 6, 9, 12 and 18 knots.

<table>
<thead>
<tr>
<th>Speed</th>
<th>3 Knots</th>
<th>6 Knots</th>
<th>9 Knots</th>
<th>12 Knots</th>
<th>18 Knots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>400 yards</td>
<td>400 yards</td>
<td>400 yards</td>
<td>400 yards</td>
<td>400 yards</td>
</tr>
</tbody>
</table>
6. List the speed in knots and number of R.P.M. your ship makes surfaced, submerged and snorkeling for all bells.

<table>
<thead>
<tr>
<th></th>
<th>Surfaced</th>
<th>Submerged</th>
<th>Snorkeling</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ahead</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4</td>
<td>5.1 Knots</td>
<td>110 RPM</td>
<td>3.3 Knots</td>
</tr>
<tr>
<td>1/2</td>
<td>9.1 Knots</td>
<td>190 RPM</td>
<td>6.7 Knots</td>
</tr>
<tr>
<td>FULL</td>
<td>11.2 Knots</td>
<td>170 RPM</td>
<td>9.7 Knots</td>
</tr>
<tr>
<td>FLANK</td>
<td>18.1 Knots</td>
<td>240 RPM</td>
<td>12.1 Knots</td>
</tr>
<tr>
<td><strong>Back</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/3</td>
<td>3.2 Knots</td>
<td>110 RPM</td>
<td>2.1 Knots</td>
</tr>
<tr>
<td>2/3</td>
<td>7.0 Knots</td>
<td>190 RPM</td>
<td>4.3 Knots</td>
</tr>
<tr>
<td>FULL</td>
<td>13.0 Knots</td>
<td>260 RPM</td>
<td>8.5 Knots</td>
</tr>
<tr>
<td>EMERG</td>
<td>18.5 Knots</td>
<td>370 RPM</td>
<td>12.0 Knots</td>
</tr>
</tbody>
</table>

7. You are diving officer and the following separate incidents occur. List the action to be taken in each case:

   a. Bow planes won't rig out.

      Upon discovering the loss of bow planes, leave them alone and control the dive with stern planes. By careful attention to the handling of the stern planes, easing of the doctor bubble early and blowing negative sea, usual good control should be maintained. Have the auxiliary electrician investigate the cause of the casualty. Notify the connning officer. Level off at ordered depth. After backing off, the bow planes may be rigged out by hand if it is still impossible to rig them out using normal power.

   b. Stern planes will not move from 20° dive in either normal or emergency power.

      Shift to hand operation to see if that will control the planes and if that works, have the auxiliary electrician check to see what was the matter in normal and emergency power and correct it. Keep the connning officer informed of the situation. If hand operation does not work, try to hold the bubble by using full rize on the bow planes, backing the screws, blow bow buoyancy and the forward group if necessary.
c. No depth is ordered.
   After reporting "green board", request depth. If none ordered
   request depth again. If none ordered or 500 feet or a safe depth
   considering the tactical situation, level off, report depth
   and request depth again.

d. Ship loses AC power immediately following the second blast
   of the diving alarm.

   Turn on DC power to TP-TR panel. Ensure that
   the XTA phones are manned since the 2MC and
   7MC will be inoperative. Use the XTA phones to order
   speed changes because the 1MB and 2MB will be
   inoperative. Continue the dive and initiate action
   to restore AC power.

8. What is the best course for surfacing or submerging a subma-
   rine in a heavy sea?

   Surface with moderate speed into or with the sea preferably
   using the snorkel induction.

   Submerging with the seas abeam is usually the easiest
   and quickest method.

9. What is a "pooping sea" and what are the inherent dangers?

   A "pooping sea" is a following sea with waves coming
   from astern or on the quarters and breaking over the ship.
   The main danger of the "pooping sea" is the danger of flooding
   the induction piping through the main induction. Use of the
   snorkel induction reduces this danger. Another danger of
   the "pooping sea" is that of taking water aboard through the
   conning tower hatch. Usually the conning tower hatch is
   shut during heavy seas to prevent this from happening.
10. When should honors be rendered between ships underway? What are the honors whistle signals?

Honors shall be rendered when ships or embarked officials or officers pass or are passed ahead (300 yards for ships) and 100 yards for (boats). Honors shall be initiated by the junior commanding officer of the forward. "Attention" shall be sounded when the four of one ship passes the bow nearest to abeam of the quarterdeck.

The honors whistle signals are:

- one blast - "Attention t'quarter"
- two blasts - "Attention to port"
- three blasts - "Hard alee"
- four blasts - "Two"
- five blasts - "Carry on"

11. What flag does a harbor pilot carry during daylight? What lights at night?

During daylight a harbor pilot carries the P (PAPA) flag. At night a harbor pilot shall display at the masthead a single white light visible all around the horizon and below that a distance of eight feet a single red light visible all around the horizon. The pilot vessel shall also display the required colored pilot lights and overtake's lights for a vessel underway when it is underway. When not engaged in piloting duties the pilot vessel shall display the lights required for similar vessels of her class and tonnage.

12. You are OOD while operating with a DD. What publication would you use to interpret the DD's flag hoist? What is the flag hoist signal for "I am operating with a submerged submarine?"

I would use ACP 175-A to interpret the DD's flag hoist.

The flag hoist signal for "I am operating with a submerged submarine" is CODE HP.
CHAPTER 8

WATCH STANDING (UNDERWAY) - PART II

This is to certify that all work within this section has been completed.

Approved:

[Signature]

R.M. Weidman Jr., LCDR, USN

[Signature]

E. Peters, LCDR, USN
CHAPTER 8

NAVIGATION AND SEAMANSHIP - Part III

(To be completed on board your submarine)

References:

HO 206
CG-169 (Rules of the Road)
Knight's Modern Seamanship
*BuShips Manual, Chapter 94, Submarine Safety
ACP-175
Ship salvage blueprints
*NWIP 23-6
*NWIP 23-10
General Information Book
*Standard Submarine Organization and Regulations Manual
*NWP 23

A. Written Notebook Requirements:

1. What are the markings of a hand lead line?

2 fathoms - 2 strips of leather
3 fathoms - 3 strips of leather
5 fathoms - white cotton rag
7 fathoms - red flannel rag
10 fathoms - piece of leather with a hole in it
13 fathoms - same as at 3 fathoms
15 fathoms - same as at 5 fathoms
17 fathoms - same as at 7 fathoms
20 fathoms - 2 knots
25 fathoms - 1 knot
30 fathoms - 3 knots
35 fathoms - 1 knot
2. Sketch and describe the method of conducting a breeches buoy exercise with another submarine; own ship receiving, own ship providing. What basic differences exist when conducting this exercise with a surface ship?

Own Ship Providing

With the receiving and providing ships on parallel courses, the sea and wind one to two points on the disengaged bow, and the receiving ship on the lee side the sending ship passes the standing part of the high line to the receiving ship which secures it to a padeye in the shears with a shackle or a pelican hook. The inhaul is then passed over to the receiving ship and led through snatch blocks secured to padeyes, usually below and in the...

---Continued on page 8-13A---
Own Ship Receiving

same vertical plane as the high line, and tended forward. The providing ship leads the high line through snatch blocks on the shears and below the shears on the superstructure and tends it aft maintaining the proper tension to keep the highlaut after the breeches buoy starts across. The inhaul-backhaul line on the providing ship is generally tended forward. The breeches buoy trolley is then placed on the high line, and secured to the inhaul-backhaul line and then controlled by the inhaul-backhaul line by both ships.

The receiving ship will usually make the approach on the providing ship when conducting this exercise (with a surface ship). Since a submarine's deck space is small and exposed, the submarine should be rigged as the receiving vessel.
3. Sketch the towing rig for your ship to tow or be towed.

Rig For Ship To Be Towed

Rig For Ship To Tow
4. What action is taken on hydrographic messages received on your ship? Where filed?

When hydrographic messages are received in Radio they are routed to the Commanding Officer, Executive Officer, and the Navigator and hence to the Quartermaster who enter the necessary corrections.

Hydrographic messages are filed in the Hydrographic Number File. Hydrographic messages are filed in a chronological field until cancelled, expired or Notice to Mariners publishes the same information.

5. Where are your ship's chart allowances found? Where are charts obtained in your local area?

The ship's chart allowances are found in 1 PCL under Group 6 chart allowances.

Normally, charts are obtained from the Hydrographic Office, Scotia, New York. If charts are needed on an immediate basis they may be obtained from the Hydrographic Office just inside Gate #2, Naval Operating Base, Norfolk, Virginia.

6. How often are the ship's chronometers checked against the standard? How often wound?

The chronometers are checked against the standard daily using the time tick as scheduled in JANAP 195E.

The chronometers are wound daily at 0800.
Question No. 5 continued:

Effective May 1959 all charts, maps, navigation publications, and other hydrographic material are to be ordered from the following address:

Commanding Officer (Code H D)
U.S. Naval Aviation Supply Depot
5801 Talbot Avenue
Philadelphia 20, Pa.

New additions to charts already held are mailed automatically.

Allocation of CONFIDENTIAL charts is determined by referring to CINCLANTFLT INST 03530.1.
7. Sketch a plan view of a submarine showing all navigational lights with their respective arcs of visibility.
CHAPTER 8

NAVIGATION AND SEAMANSHIP - PART III

This is to certify that all work within this section has been completed.

Approved:

[Signature]
R.M. Weidman Jr., LCDR, USN
5/30/59

[Signature]
B. Peters, LCDR, USN
CHAPTER 8
WATCH STANDING, NAVIGATION AND SEAMANSHIP - Part IV
(To be completed on board your submarine)

A. Practical Factors, Watch Standing in Port

<table>
<thead>
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<th>Signature</th>
<th>Date</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/1/59</td>
<td>W. W. Landgraf</td>
<td>2/24/59</td>
<td>S. F. Aronson</td>
</tr>
<tr>
<td>3/19/59</td>
<td>J. H. Hawkins</td>
<td>5/14/59</td>
<td>J. H. Hawkins</td>
</tr>
<tr>
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<td>J. H. Hawkins</td>
<td>7/2/59</td>
<td>J. H. Hawkins</td>
</tr>
<tr>
<td>7/9/59</td>
<td>J. H. Hawkins</td>
<td>9/18/59</td>
<td>R. W. Ford</td>
</tr>
<tr>
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<td>6/18/59</td>
<td>W. W. Landgraf</td>
</tr>
<tr>
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<td>10/8/59</td>
<td>W. W. Landgraf</td>
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<td>W. W. Landgraf</td>
<td>3/10/59</td>
<td>W. W. Landgraf</td>
</tr>
</tbody>
</table>

1. Rig all compartments and topside for dive.
2. Line up ventilation and start a battery charge.
3. Rig all compartments for surface.
4. Make all preparations for getting underway, get the ship underway, and connect it out to the operation area.

5. Heave in and veer anchor chain. Put out drift lead and demonstrate ability to determine when anchor is dragging.

6. Demonstrate ability to encrypt and decrypt messages in all systems held. Be officially designated as a member of the crypto board.

7. Operate the drain pump. Locate all bilge suction valves.

8. Be designated qualified by the Executive Officer to supervise a battery charge.

9. Demonstrate a thorough knowledge of emergency drills and damage control procedures.

10. Read ships orders and organization.

11. Understand procedures for handling shore part reports, job orders, incoming mail, messages and various types of visitors.

4a. Make four landings.

CONFIDENTIAL
12. Demonstrate a thorough knowledge of physical security, photographs, news releases, etc., as contained in OPNAVINST's 5510.29 and 5510.1A.

You are in all respects qualified submarine watch stander in port.

CO Signature

Date 10 September 1959
CHAPTER 8

WATCH STANDING, NAVIGATION AND SEAMANSHIP - Part V

(To be completed on board your submarine)

A. Practical Factors, Watch Standing Underway

<table>
<thead>
<tr>
<th>Date</th>
<th>Signature</th>
<th>Make a satisfactory dive while assigned the following stations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 May 57</td>
<td>MM Sanders</td>
<td>1. Air manifold.</td>
</tr>
<tr>
<td>11 May 57</td>
<td>MM Sanders</td>
<td>2. Bow planes.</td>
</tr>
<tr>
<td>11 Sept 59</td>
<td>MM Sanders</td>
<td>5. Trim manifold.</td>
</tr>
<tr>
<td>3-24-59</td>
<td>MM Sanders</td>
<td>6. Rig and secure from snorkeling.</td>
</tr>
<tr>
<td>3-24-59</td>
<td>MM Sanders</td>
<td>7. Compensate after an extended period in port.</td>
</tr>
<tr>
<td>2-15-59</td>
<td>MM Sanders</td>
<td>8. Qualify as diving officer, including casualty</td>
</tr>
<tr>
<td></td>
<td></td>
<td>drills surfaced, submerged, and snorkeling.</td>
</tr>
<tr>
<td>7-25-57</td>
<td>MM Sanders</td>
<td>9. Demonstrate a knowledge of shiphandling sufficient</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to rescue a man over board unassisted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10. Qualify as an OOD underway.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11. Pass a comprehensive Rules of the Road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>examination.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12. Send and receive flashing light at 5 words a minute.</td>
</tr>
</tbody>
</table>

You are in all respects a qualified submarine watch stander underway.

CO Signature: [Signature]
Date: [11 September 1959]
CHAPTER 8

WATCH STANDING, NAVIGATION AND SEAMANSHIP - Part VI

(To be completed on board your submarine)

A. Practical Factors, Navigation

<table>
<thead>
<tr>
<th>Date</th>
<th>Signature</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-13-57</td>
<td></td>
<td>1. Pilot the ship in and out of port.</td>
</tr>
<tr>
<td>6-12-57</td>
<td></td>
<td>2. Determine and plot danger bearings for entering or leaving port.</td>
</tr>
<tr>
<td>6-12-59</td>
<td></td>
<td>3. Lay out the track for leaving or entering port.</td>
</tr>
<tr>
<td>8-7-57</td>
<td></td>
<td>4. Act as Navigator for anchoring, using radar only.</td>
</tr>
<tr>
<td>5-31-59</td>
<td></td>
<td>5. Determine the position of the ship by each of the following: Loran, radar, and sounding.</td>
</tr>
<tr>
<td>5-31-59</td>
<td></td>
<td>6. Set DRAI for a given position.</td>
</tr>
<tr>
<td>6-24-59</td>
<td></td>
<td>7. Perform 2 complete days work in navigation.</td>
</tr>
</tbody>
</table>
CHAPTER 9

ENGINEERING (MACHINERY) - Part I

(To be completed on board your submarine)

References:

Ships Engineering Department orders.
Type Commanders Instruction pertinent to Engineering Department.
Manufacturers Instruction Book pertinent to specific equipment.
General Information Book.
Booklet of General Plans.
BuShips Manual.
Docking Plan.
NavPers 16161 - Submarine Main Propulsion Diesels.
NavPers 16160A - The Submarine.
NavPers 16163 - Submarine Refrigeration and Air Conditioning System.
NavPers 16170 - Submarine Distilling System.
NavPers 16164 - Submarine Air System.
NavPers 16166 - Trim and Drain System.
NavPers 16169 - Submarine Hydraulic Systems.

A. Written Notebook Requirements and Sketches:

1. Sketch the following systems:

a. High pressure air system including manifold.
   Sketch appears on page 9-1A

b. Main ballast tank blow system including manifold.
   Sketch appears on page 9-18

c. Service air system including manifold.
   Sketch appears on page 9-1C

d. Low pressure or engine exhaust ballast tank blow system (include notes giving working pressures and test pressures as applicable).
   Sketch appears on page 9-10

e. The snorkel induction and exhaust piping and valves outside the pressure hull (include hull induction valves).
   Sketch appears on page 9-1E

f. Ship's ventilation system inside the pressure hull.
   Sketch appears on page 9-1F

g. Fuel oil filling, transfer, and compensating water.
   Sketch appears on page 9-16

h. The lube oil storage, filling, and transfer system up to the purifier.
   Sketch appears on page 9-1H
i. The fresh water storage, filling and transfer system.

  Sketch appears on page 9-26

j. Trim and drain systems showing cross connections and manifolds.

  Sketch appears on page 9-26

k. Main hydraulic plan, manifold, and distribution system up to unit using hydraulic power (excluding vertical hoists).

  Sketch appears on page 9-26

l. Hydraulic system for normal bow plane rigging and tilting including windlass and capstan. (Indicate source of hydraulic power for emergency and hand.)

  Sketch appears on page 9-26

m. Hydraulic system for normal stern plane tilting. (Indicate source of hydraulic power for emergency and hand.)

  Sketch appears on page 9-26

n. Hydraulic system for normal steering. (Indicate source of power for emergency and hand.)

  Sketch appears on page 9-26

o. Hydraulic system for all vertical hoists (including periscope, snorkel, and masts).

  Sketch appears on page 9-26

2. Make a block diagram of the air conditioning system.

  Sketch appears on page 9-26

3. Make a block diagram of the refrigeration system.

  Sketch appears on page 9-26

4. Briefly discuss the operation of the fuel oil filling, transfer, and compensating system. List the normal sequence of events to be followed in fueling ships.

   The fuel oil filling, transfer, and compensating system is designed to accommodate the storage, handling, and handling of fuel oil under normal and submerged operations. Fuel is stowed in normal fuel oil tanks, fuel ballast tanks, expansion tank, collecting tank, variable fuel oil tanks, and other fuel oil tanks. Expansion tank serves three important functions:

   (1) prevent oil from being blown overboard in event of a small air lock or any one of FPS's or NFT's, (2) a tank to which oily bilge water may be pumped without danger of affecting an oil slick, (3) a tank to which the oil may expand because of temperature variation.

   Expansion tank registers when a fuel tank is full when taking on fuel. Oil flowing past the sight glass in the after-engine room will also tell when the tank is full. The collecting tank is a tank which acts as a settling tank for fuel oil and registers when a fuel tank is empty if on service. Compensating water pressure comes from main engine or main motor circulating water.

   - continued on page 9-26 -
Question #4 continued:

As fuel is used from the storage tanks it is automatically replaced with saltwater from the compensating system to prevent any pressure differentials from occurring which might strain the storage tanks. This also eliminates forming bullet charges as fuel is used.

Variable fuel oil tanks and clean fuel oil tanks are not connected to the compensating system since they are entirely within the pressure hull. Fuel is blown with 225 # air from variable fuel oil tanks to the filling and transfer system. Clean fuel oil tanks are used to collect the clean fuel oil that is ready for use by the engines. Clean fuel oil is emptied into the CFOT in each engine room after all impurities have been removed by the purifiers which take a suction on collecting tanks. As soon as fuel is drawn from the top of the collecting tank, saltwater from the main engines comes into the bottom of the expansion tank, starting a pressure on the compensating system and forcing the fuel from the tank on service to collecting tanks. Thus the system is kept full of a liquid at all times. The space circulating water flows over the sides through the head top. As soon as the liquid meter in collecting tanks reads less than full, the tank on service is empty, it is then secured and the fuel transfer line of to another fuel tank is placed on service. Any saltwater entering collecting tank is pumped out by the drain pump which takes a suction on the bottoms of collecting tanks and discharges to the compensating system.

When fueling ship fuel at 20 to 40 psi enters the fuel filling and transfer line through a filling connection over the starboard after corner of the after engine room. As the fuel enters the fuel tank through the open valve on the transfer line, water is forced out through the compensating system to expansion tanks.
Stern Plane Tilting System

Hydraulic Service Act

Emergency Power

Hand and Emergency Power

Emergency Tilting Control Valve

Hand Valve

Hand Power

Normal Power

Vent and Surge Tank

Tele-Motor

Supply

Return

Control Cylinders

Electric Motor

Hydraulic Pump

5 A End

Tilting Ram

Stern Planes
Air Conditioning System
Refrigeration System

Cool Room
Freeze Box

After Battery

Control Room

Charging Connection

Cross-Connect
Discharge To
Air Conditioner #8

Cross-Connect Suction
To Air Conditioner #3

Strainer
Compressor
Condenser
Receiver
Strainer

Freez Flow
Question #4 cont'd

out the bottom of expansion tanks and then overboard through a valve in the compensating line near the fueling connection in the superstructure. When the tank being filled becomes full oil can be seen through the sight glass in the line to expansion tanks in the after engine rooms. When the tank becomes full the valves in the fuel filling and transfer line to another tank must be opened and the valves to the full tank shut.

When venting fuel tanks it is necessary to go with the bubble. The following order should be followed: expansion tanks, tank on service, collecting tanks and other fuel tanks in any order.

5. If the hydraulic pumps are all inoperative, how can you obtain hydraulic power to raise the periscope?

If the IMO pumps are inoperative and the accumulator is in the fully charged position there will be enough oil to raise one periscope. However, if the accumulator is discharged the periscopes can be raised by hand. In the forward port corner of the control room on the starboard is located a hand pump which can be used to supply pressure to raise the periscopes. When rigged for doing this pump may be used without any additional hook-up of the manifold. The use of the pumps is much slower than normal power.
Question #5 cont'd

Two other hand pumps are located in the after torpedo room. One in the after starboard side, normally used to transfer oil from storage tanks in the after torpedo room. The other is the hand pump for the other E/18 boat by the starboard.

Hydraulic pressure can also be obtained by hand charging the accumulator as follows:
1. Open the by-pass valve on the main supply manifold
2. Open the valves between the accumulator and the flanks
3. Open blower valve to bleed off air pressure in the accumulator
4. Close the accumulator fully charged, shut by-pass valve and blower valve.
5. Open valves to air flanks to restore air pressure to the accumulator.

B. Diesel Engine:

1. What type engines do you have on your submarine?
   The diesel engine on the submarine is a John N. Morse 10-18-bhp opposed piston, 2-cylinder, 10-cycle, supercharged engine with a rated horsepower of 1600 H.P. Maximum operating speed is 1720 RPM.

2. Fill in the following table as applicable:

<table>
<thead>
<tr>
<th>(ENGINE RUNNING AT 80/90)</th>
<th>NORMAL</th>
<th>MAX.</th>
<th>MIN.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGINE LUBE OIL PRESSURE</td>
<td>39</td>
<td>60</td>
<td>17</td>
</tr>
<tr>
<td>ENGINE LUBE OIL TEMPERATURE</td>
<td>154</td>
<td>180</td>
<td>100</td>
</tr>
<tr>
<td>ENGINE F.W. PRESSURE</td>
<td>14</td>
<td>29</td>
<td>-</td>
</tr>
<tr>
<td>ENGINE F.W. TEMPERATURE</td>
<td>150</td>
<td>170</td>
<td>-</td>
</tr>
<tr>
<td>ENGINE S.W. PRESSURE</td>
<td>14</td>
<td>29</td>
<td>9</td>
</tr>
<tr>
<td>FUEL OIL PRESSURE WHEN SNORKELING 80/90</td>
<td>25</td>
<td>35</td>
<td>5</td>
</tr>
</tbody>
</table>

3. Discuss the effects of snorkeling on engine blower temperatures. What is the danger from excessive blower temperature?

During snorkel operation, the scavenging air blowers operate under much worse than normal conditions. The blowers must provide air to the engines from the reduced pressure inside the ship, thus causing the blowers to work harder. At the same time, the blower is discharging to greater back pressure than normal due to the extra back pressure encountered when snorkeling. The combination may cause the blower to overheat.

- continued on page 9-5 -
Question #3 cont'd

The blower lobes are designed to clear others by a very few thousandths of an inch. If the blower head up excessively, the lobes may expand enough to phase or fly apart.

4. List and state the function of the snorkel safety devices.

The large snorkel safety circuit has three safety cutouts. These are the high vacuum cutout, the high back pressure cutout, and the low RPM cutout. The operation of each of these is as follows:

a. The high vacuum cutout is actually four contact makers, two located over the silencers on number two engine and two located over the silencers on number four engine. Each contact maker has an adjustable length rod extending to a bellows. The bellows operates on a decreased pressure. The vacuum is recorded within each engine room and the adjustable rod circuit to operate the circuit at 6" of vacuum.

b. The high back pressure cutout switches are also actually four contact makers, two located over the silencers on number two engine and two located over the silencers on number four engine. Adjustable length rods and bellows are used. These bellows have tubing running to the back drain line which in turn runs to the exhaust headers. The high back pressure bellows open the safety circuit at about 34" pressure.

---continued on page 9-5A---

5. Fill in the following table as applicable:

<table>
<thead>
<tr>
<th></th>
<th>Fuel consumption</th>
<th>Lube Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gal/Mile</td>
<td>Gal/Hr</td>
</tr>
<tr>
<td>Per engine at 80/90</td>
<td>7.22</td>
<td>70</td>
</tr>
<tr>
<td>Per engine at 100%</td>
<td>7.50</td>
<td>90</td>
</tr>
<tr>
<td>Per engine snorkeling at 80/90</td>
<td>8.43</td>
<td>70</td>
</tr>
</tbody>
</table>

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Location #4 continued:

The low RPM cutout switches operate off of the fresh water pump discharge pressure on each engine. When the engine RPM drops below 420 RPM, the reduced discharge pressure opens the switch. However, both engines must drop below 420 RPM before the safety device operates since the switches are in parallel.

The above safety devices are electrically in series so that if any of the limiting factors are exceeded, the safety circuit will be opened to deenergize solenoids controlling the opening of the main snorkel exhaust valve and fuel to the engines. The voltage supply is 115-V DC from the port or starboard feeders.

The head valve itself is a safety device because it shuts whenever electrodes on the head valves are shorted by contact with seawater. In the event of AC power failure the head valve will automatically shut.

The fact that the main snorkel exhaust and the engine room snorkel exhausts cannot be opened, but only shut, by the control scope prevents premature opening of these valves when starting the engines.

A thermo switch is installed in each scavenging air blower header to give warning of high temperature. These switches activate at 160°F and cut off the same red warning light, flasher and horn as the lubricating oil and circulating water alarms.

**Engine Room Snorkel Safety Circuit**

![Diagram of Engine Room Snorkel Safety Circuit]
6. Describe lube oil tests used on your ship. What action is taken when lube oil fails to meet required specifications?

Lube oil from the pumps is tested quarterly on the tender. Normally, the only on-board test consists of using the Viscometer to determine the viscosity by measuring the time required for a steel ball to drop the length of a tube filled with the oil to be tested. This is measured against the standard to determine the viscosity.

If lube oil fails to meet the required specifications, it must be replaced by new oil.

C. Auxiliary Equipments:

1. Briefly describe and state the principles of operation of the following:

   a. Fresh water distilling units (include capacity).

   The Sirocco has two Model AAA-1 vapor compression distilling units and auxiliary equipment which may be operated simultaneously or separately. Each unit is capable of delivering 1,000 gallons of distilled water per day, producing 450-500 gallons of distilled water per year from about 70 gallons of normal sea water or brackish water. All power is Electrical.

   Water to be distilled is supplied to the evaporator through a heat exchanger, where it is preheated by condensate and brine, and finally brought to the evaporating stage by electric heating units. By this method, the exchange of heat from condensate and brine to the preheating feed, a comparatively small amount of additional heat is required for evaporating. The vapor is further compressed to 35 psi and condensed in the steam chest. This condensation is due to the temperature difference between the feed water (which is preheated and boiling at atmospheric pressure) and the surrounding compressed steam of higher temperature.

   b. High pressure air compressors (include capacity).

   The Sirocco has two Wardie-type high pressure air compressors located in the F.E.K. Each has a rated capacity of 60 cubic feet per minute at 3,000 psi pressure, which is equivalent to 68 cubic feet per minute of free air. Each unit has two tandem, differentially compounded cylinders arranged to give four stages of compression with cooling after each stage. Since the volume of air passing through the compressors is reduced over 200 times, the water vapor must be removed because moisture in the air tends to erode valve discs and seats when it is throttled through controlling devices. To remove the condensation, each compressor discharges through a filter, and then to an air and water separator which must be drained periodically.
c. Lube oil purifiers.

The two lube oil purifiers on the rig are Sharples centrifuge purifiers rigged as a clarifier to separate solids from the oil. Oil brought into the purifier is spun at a high rate which causes the heavier particles to move outward and the lighter particles to stay in the center. Impurities are held in the bowl at the top. These impurities must be scraped from the bowl periodically. The unit is rotated by a belt driven by an electric motor. The capacity of the lube oil purifier is 450 gallons per hour. The purifier bowl rotates at approximately 15,000 RPM.

d. Fuel oil purifiers.

The two fuel oil purifiers on the rig are Sharples centrifuges rigged as separators to separate water and solids from the fuel oil. Centrifuging the bowl is spun at a high rate. A special ring around allows clean oil to spin out one port while the heavier water is forced out another. The impurities remain in the bowl and must be scraped out by hand. The fuel oil purifier must be primed with water before operating to prevent oil from flowing out the water discharge. The unit is rotated by a belt driven by an electric motor. The capacity of the fuel oil purifier is 450 gallons per hour.

e. Shaft thrust bearings.

The rig's shaft thrust bearings are Kingery segmented pivot wedge type. This bearing consists of several pivot segments or shoes against which the thrust collar rotates. A head or center axial motion of the shaft to which the thrust collar is secured is restrained by the action of the thrust shoes against the thrust collar. The shoes and collar, enclosed in a housing, are immersed in oil. As the shaft rotates the wedges assume an inclined position with respect to the collar; a wedge-shaped flow of oil is formed which prevents the two surfaces from coming in contact. The thrust bearings are located at the forward end of main motors one and two and absorb the thrust for both ahead and astern shaft rotation.
f. Stern tube and strut bearings (include drydock maintenance).

The stern tube and strut bearings are bronze shells in halves, grooved longitudinally to accommodate strips of lignum vitae, which is the wearing material and bearing surface. The lignum vitae is cut and installed to present an end on grain to the shaft.

The stern tube is equipped with a syphon seal to prevent leaking. During drydock periods it is necessary to keep lignum vitae bearings wet. This is accomplished by running water at about 10 psi through the bearings. The wear in stern tubes and strut bearings should be measured and recorded at each docking.

D. Administration:

1. What is the purpose and who administers the submarine force alteration and improvement program on your ship?

The submarine force alteration and improvement program is under the administration of authorized equivalent to repair items established by COMSUBLANT. COMSUBLANT publishes a list of approved alterations equivalent to repair which briefly describes them, lists the applicable submarines serially, numbers them and designates them to be done by yard personnel or forces afloat. Annually on 30 September and upon completion of a yard overhaul, a pencilled letter listing completed ASI items is sent to COMSUBLANT in order that he may remove the ship from the list of ships to which the item is applicable.

2. Where are the ship's plans filed? How is it kept up to date?

How would you obtain a blueprint that your ship does not have on file?

The ships carries large scale, reduced size and microfilm plans which are filed throughout the ship. Torpedo room plans are stored in the torpedo rooms. Many of the reduced size plans, and the microfilm prints, are stored in the engineering lockers in the forward battery rooms and are also kept in lockers in the control room, maneuvering room and the four room.

The index of plans lists the title of the plan, BUSHIPS plan number, and key letters contracts, plan number, reference to a BUSHIPS plan number for any alteration, the location and type of print. Decisions are made by the ship's planning section. Blueprints not on file can be obtained from the Bureau of Yards and Docks.
3. What is a docking plan?

A docking plan is the plan of the submarine showing its hull and projecting appendages. Weight balance of the submarine is indicated so that blocks may be placed in the bottom of the dry dock to exactly accommodate the contours and weights of the submarine without damaging any of its hull bottom appurtenances. There are three position plans to be used alternately for docking to ensure painting and scraping of the complete hull.

4. List the preparations for docking and undocking.

Docking:
1. A ship entering drydock must be without list and without excessive trim. Trim in excess of one foot per 100 feet of length makes the docking operation hazardous.
2. Tugs for docking are provided by the yard commander.
3. The arrangement of blocking and shores must be in accordance with the docking plan of the ship concerned.
4. Before flooding, the docking officer shall check the blocks, paying particular attention to the following:
   a. The location of the square marks on the coping of the dock for placing the stern and stem of the ship preparatory to landing.
   b. The location of the after (prom) keel block from the square marks.
   c. The location of all floating blocks.
   d. The heights of floating block, making sure that they will clear the keel block even if the vessel has a slight list.
   e. Possible interference between any blocks and sea valves or other hull fittings.
   f. Shape and position of any cribbing necessary to support overhang at either the bow or stern.
   g. The height, shape and level of cradle blocks when prepared.
   h. The presence of any projections on the hull below the Trade Level shown on the docking plan. These should be considered not only to avoid fouling on landing but also to determine any special precautions necessary in handling the ship into dock.

Continued on page 9-9A
Question #4 continued:

1. The level of the keel blockage for the length of the keel at the ship to be docked should be checked by eye to make sure there are no excessively high blocks.

5. The docking officer will control the pumping of the dock, the landing of the vessel, the placing of the shores, and the personal inspection of the blocks.

6. The docking officer directs the handling of lines to insure the safe entrance of the vessel into the dock.

7. The docking officer shall check the draft of the ship being docked.

8. The docking officer must be present when the dock is flooded.

9. The commanding officer, if the ship being docked will insure that all equipment which for operation extends below the hull, is in the retracted or fully housed position prior to docking.

10. The propellers should not be turned over while the vessel is in drydock unless authorized by the docking officer.

11. No weight or water ballast shall be shifted, added or removed unless authorized by the docking officer.

Undocking:

1. Before flooding, the docking officer must make sure that all yard arrangements have been made including:
   a. Disposition of the ship after leaving the dock.
   b. Ships working party on the dock and detailed to lines.
   c. Yard work in condition for undocking and men stationed at newly completed underwater jobs to report any leakage.
   d. Staging and other loose objects removed from the dock and all blocks dropped down.

   continued on page 9-9B
Question #4 continued:

1. Drydock pumping plant ready for operation in case it is found necessary to stop flooding and pump down.

2. After flooding has begun, the docking officers should receive reports on any leakage in time to stop flooding and pump down.

3. The docking officer must be prepared to take steps to prevent damage to the ship should the vessel take an undue list.

4. The docking officer shall direct the handling of lines used in undocking, and through a pilot, the movement of tugs handling the vessel. The docking officer shall formally turn over the ship to the commanding officer when the extremity of the ship last to have the lock crosses the sill, being careful to have the vessel in a safe position at the time.
CHAPTER 9

ENGINEERING (MACHINERY) - PART I

This is to certify that all work within this section has been completed.

Approved:

[Signatures]

P. Eadie, II, LT, USN
R. M. Weidman, Jr., LCDR, USN
B. Peters, LCDR, USN
CHAPTER 9

ENGINEERING (ELECTRICAL) - Part II

(To be completed on board your submarine)

References:

Type Commander's pertinent instructions.
Engineering Department orders.
BuShips Manual.
BuShips Manual, Chapter 62, Part III.
General Information Book.
Applicable manufacturer's instruction books.
NavPers 16162 - Submarine Electrical Installations.

A. Batteries - Written Notebook Requirements and Sketches:

1. Briefly describe the storage battery installation on board your submarine, including the purpose and uses of the following battery auxiliaries: ventilation system up to the exhaust ventilation line, ICV panels, cooling system, agitation system, ampere hour meters, hydrogen detectors, air flow meters, ground detectors and salinity indicators.

The storage has four batteries, located in three battery wells, and having a total of 504 cells. The 504 cells are divided up as follows: Number One battery containing 126 cells in the forward battery well, 58 cells of Number Two battery located in the forward battery well, 68 cells of Number Two battery located in the battery annex under the control room, 126 cells of Number Three located in the after battery well, and 126 cells of Number Four located in the after battery well.

Each cell is an Epide MAT-43A experimental lead acid storage battery. The top section of each cell jar
Question #1 cont'd

contains battery cooling water ducts which extend into the jar about 5/12 inches. The cells are equipped with ceramic domes and are designed for open tank ventilation. The ceramic domes prevent foreign matter from entering, but allow hydrogen to escape freely. The domes act as a flash arrester to prevent sparks from entering the cells.

The fully charged specific gravity of the battery is 1.265, and a charge is normally given when the gravity drops 100 points or every four days, whichever occurs first. An equivalent cycle for the MAT-43 A is 4/100 ampere-hours.

The open tank ventilation in the forward and after battery wells has the following flow pattern; air enters through sections intakes and passes through plenums running athwartships, circulated by circulating fans longitudinally to the exhaust plenum on the opposite end of the well, and drawn from the exhaust plenum into the ship's exhaust line by the battery exhaust blowers. The movement of air in the annel is athwartships with the plenums, running longitudinally. The circulating fans are located in the corners of the wells and move the air from the corners to prevent concentrations of hydrogen from forming.
Question #1 cont'd

The exhaust lines from each battery well are equipped with recirculating dampers to permit emergency recirculation within the compartment to reduce hydrogen concentration in the case of fire or some other emergency.

The ship is equipped with two Ward Leonard/DC Scanners which act as low voltage automatic alarms and individual cell voltage scanners. The scanners are located in the forward and after battery compartments and allow individual cell voltages to be read from a centralized point by selecting the desired cell on the scanner and reading the voltage on a voltmeter on the scanner. One scanner reads the cell voltages for two batteries. The low voltage alarm feature on ship is set at 1.58 volts for the 24-hour rate and automatically adjusts to the low voltage limit for different discharge rates. The scanners are run in automatic when danger of reduced power is detected.

The battery cooling system consists of two separate but cross-connected systems, each having a capacity of 10,000 Btu per hour for each degree of temperature difference between the battery electrolyte and sea water, and is designed to permit continual battery operation at about 80°F and always under 130°F. Salt water is pumped by centrifugal circulating water pumps from sea suction lines through heat exchangers which cool the fresh distilled water and overboard through discharge lines. The fresh water is pumped through the heat exchangers by centrifugal circulating water pumps through plastic headers, through the cell basins and finally to return headers and back to the heat exchangers.

The ship has no agitation system.

Continued on page 9-12A
The Dingo has four Dangaro NX type amperes hour meters, located in the forward and after battery compartments, which measure the state of charge or discharge of the batteries. The meter consists essentially of a motor element which operates in proportion to battery current and positions a dial, through a gear train, which indicates the amperes hours removed from or remaining in the battery. The face of the meter is calibrated with two sets of numbers, red for discharge and black for charge. Two AH meters are in the forward battery compartment in the battery.

The hydrogen detectors are manufactured by England and have one meter for each of the three battery wells, which have their own venturis. The remote reading meters are located in the control room, and maneuvering room and indicate average hydrogen concentration in the well. The detectors operate on the basic that hydrogen flowing over the filament in the analysis cell (located in the venturi) conducts heat away and decreases the resistance of the filament. The analysis cell and the reference cell, which is sealed with air at atmospheric pressure, form the upper portion of a Wheatstone bridge circuit whose arms are of equal resistance when the hydrogen concentration is at 0%. As hydrogen passes over the analysis cell, an inequality of resistance results which is registered in hydrogen concentration percentage on the meters.

The Dingo has three Hans deboy air-flow meters, one for each battery well. The transmitter sending a
pressure differential created by the flow of air across a venturi in the battery exhaust line by the use of a diaphragm. The motion of the diaphragm is picked up by the transmitter relay through a gear linkage and is sent electrically to the receiver relays in the maneuvering room, where the diaphragm is registered in cm by the use of a dial and a specially calibrated card. The air-flow meters indicate the rate of air flow through the battery wells, at all times, and must be watched closely to determine that air-flow requirements within the battery wells are being maintained.

The ground detector for the diaphragms is a Westinghouse meter which measures resistance to ground in ohms from zero to 50,000, at various points in the electrical system: the meter, which is located on the port side of the maneuvering room, reads grounds for the following points: forward and astern batteries, all four main motors, all four auxiliary generators, and the D.C. auxiliary bus tie. Before starting a battery charge, each battery must have a resistance to ground of at least 50,000 ohms. The ground detector is used to determine the resistance to ground of the above pieces of electrical equipment. It solves the equation $R_g = R_v \left( \frac{V_m}{V_n} - 1 \right)$.

The diaphragm has two salinity indicators, one for the forward two batteries, and one for the after two batteries. The indicators are located in the control room, and are used to indicate the salinity content of the battery cooling water system in equivalent parts per million (E.P.M.), from zero to 10 to indicate completely pure, or inorganic, water for use in the system respectively. Each indicator measures the electrical resistance between two platinum electrodes placed in the battery cooling water line on the discharge side of the ion exchanger. A reading of zero to 1.10 E.P.M. is an acceptable water. At a reading of 1.13 to 2.61 E.P.M., the ion exchanger must be replaced. A reading above 2.61 E.P.M. indicates that the water is not acceptable and the water in the system must be drained and replaced.

9-128

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2. Discuss the battery charging procedure in use on your submarine. Include a discussion of the following:

a. Watches:

(1) Required.

(2) Duties of.

The submarine has four separate watch organizations as follows:

1. In-Port Watch—consists of at least two electricians on duty as controllermen in maneuvering and one IC electrician to take gravities, etc.

2. Regular Underway Watch—consists of two controllermen, chief logman in maneuvering, and one IC electrician in control.

3. Maneuvering Watch—consists of two controllermen, a bell sheet recorder, an XTA talker, the senior electrician, and a qualified officer in maneuvering and an electrician in control.

4. Special Action Maneuvering Watch—consists of two controllermen, a bell sheet recorder, an XTA talker, the senior electrician, or a qualified officer in maneuvering and an electrician in control.

The duties of the above watches are as follows:

1. The controllermen stand watches on thenaublick and answers bells
2. The controllermen bear and answers bell
3. The controllermen record and record applicable data on the Engineering Bell Sheet.
4. The controllermen receive and relay all orders and messages between the bridge and maneuvering.
5. The qualified officer is in overall charge of maneuvering to insure prompt and correct execution of orders.
6. The IC electrician in control, acts as a messenger for the diving relief, checks on the proper operation of the hydrogen detectors, and compiles and operates the switchboards.

Before starting a charge, the line-up must be checked by an office. No maneuvering room watch standers will have their stations unless ordered to do so and properly relieved.
b. Resistance to ground:

(1) Minimum for one battery prior to and during charge. 
   $50,000 \text{ ohms}$

(2) Minimum for two batteries in parallel prior to and during charge. 
   $25,000 \text{ ohms}$

(3) Minimum for four batteries in parallel prior to and during charge. 
   $12,500 \text{ ohms}$

(4) Minimum for two series battery groups in parallel prior to and during charge. 
   $12,500 \text{ ohms}$

c. Ventilation:
   A summary of ventilation requirements appears on page 9-14A
   (1) Requirements on stand.

   (2) Requirements on discharge.

   (3) Requirements prior to starting a charge.

   (4) Requirements during a charge.

   (5) Requirements after completion of a charge.
       Maintain air flow requirements for charging at the finishing rate for 20 minutes after the charge is completed.

   (6) Requirements during snorkel charge.

   (7) K factor. What is it used for? What is value of K surfaced? Snorkeling?

   The K factor is the hydrogen distribution factor determined in the shipyard. 
   K is defined as the ratio of the maximum hydrogen concentration in the system 
   to the average hydrogen concentration as registered on a hydrogen detector 
   meter.

   It is used to determine the maximum hydrogen detector reading which will 
   not allow the least ventilated area to exceed safe limits. It is used to determine 
   the minimum airflow requirements for charging batteries.

   The value of K surfaced is 1.30 with recirculating fans on and 1.82 with 
   recirculating fans off, used in the formula $Q = 0.009NK$ at $K$ or $Kf$ respectively.

   No K factor for snorkeling has been determined. When snorkel charging the following 
   formula is used for airflow: $Q = 0.009NK(T + I)$. $I$ is equal to the increase in snorkel rate 
   current equivalent to the increase in hydrogen evolution caused by shutting the lead valve.
<table>
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<th>Battery</th>
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After Completion of Charge

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<td>180</td>
<td></td>
<td></td>
<td></td>
<td>280</td>
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<tr>
<td>Att. Batt. Well</td>
<td>665</td>
<td></td>
<td></td>
<td></td>
<td>1030</td>
</tr>
</tbody>
</table>
d. Hydrogen:

(1) What is the limiting percentage for your submarine?
   2.0% on surface or with head valves shut, 1.5% with head valves open.

(2) What are the dangers of hydrogen?
   Hydrogen concentrations greater than 3% will burn, and those greater than 8% will explode. The shipboard hydrogen detectors are generally accurate, but hydrogen concentrations may form in the corners of battery wells or in the service tubes. For these reasons, hydrogen should always be regarded as dangerous in any concentration.

(3) What should be done during a charge if the hydrogen concentration approaches the limiting percentage? Reaches the limiting percentage?

   If the hydrogen concentration cannot be kept below the limiting percentage using normal air flow, the ventilation should be increased. This can be accomplished by slowly speeding up the ventilation blowers or starting an additional engine. If this does not work, reduce the charging rate. If the hydrogen concentration reaches the limiting percentage, secure the charge and continue ventilating.
e. Types of charges:

(1) Describe, give the purpose of, interval between, uses of, disadvantages of, and requirements for completion of the following types of charges as applicable:

(a) Normal.

A normal charge is a routine charge to restore a partially or fully discharged battery to a substantially fully charged condition to maintain the battery on a routine cycle. It is conducted every four days or when the gravity drops 100 points, whichever occurs first. The main disadvantage is that operations must be altered as necessary to allow for this type of charge. In order to be completed, pilot cell uncorrected voltages and total uncorrected battery voltage must not have shown a rise over a period of four 15-minute readings (one hour) on the finishing rate (225 amperes).

(b) Freshening.

A freshening charge is intended to maintain the battery in a substantially fully charged condition during stand. It is conducted every 21 days or not later than 40 days from the manufacturer's initial charge or when the gravity drops 30 points, whichever occurs first. It is conducted when the battery is being shipped in a wet state, during overhaul when taking auxiliary load from the pier, or whenever the battery is on stand. The main disadvantage is the requirement of charging during overhaul.

(c) Float.

A float is a charge that takes auxiliary and propulsion loads off the battery while charging the battery with the generator. The main disadvantage is that the battery receives no charge.

- continued on page 9-16 A -

- continued on page 9-17 -
Question #2 e (1) (b), continued:

In order to be completed: (1) the battery must have 7 hours of charge of at least 1570 ampere hours of charge (2) no voltages show a rise over a period of five 15-minute readings (one hour) after the 7-hour period (3) after ventilating 15 minutes, take pilot cell gravities and resume charge at 2.25 amperes for one hour (4) ventilate 15 minutes, take gravities, and if all gravities are within 5 points the charge is complete. Otherwise, repeat steps (3) and (4).
Another disadvantage is that when carrying a propulsion float on fully charged batteries there is a danger of hydrogen evolution caused by a sudden current surge if the propulsion float is suddenly removed or fire happens if the screw came out of the water.

(d) Equalizing.

An equalizing charge is designed to drive sulfate from the plates and restore the cells to their maximum capacity. It is a normal charge extended on the finishing rate. An equalizing charge should be given at intervals of 28 days. An equalizing charge is continued until the following conditions are satisfied while charging at the finishing rate:

(a) The observed uncorrected total battery voltage and the observed uncorrected pilot cell voltage show no rise over a period of two hours (nine consecutive readings 15 minutes apart). The uncorrected readings may show a decrease due to a temperature rise.

(e) Patrol.

A patrol charge is intended to fulfill the main purpose of an equalizing charge, during times when it is impossible to conduct equalizing charges. They are given at seven day intervals following the last equalizing charge and consist of a normal charge extended for one hour. For each day over seven add 9 minutes of overcharge to the hour. An equalizing charge should be given as soon as possible because the patrol charge is not as effective as the equalizing charge.

(f) Partial.

Partial charges are charges which are insufficient to satisfy the requirements of a normal charge. Partial charges may be given on patrol if operational advantage would result. Otherwise every effort must be made to give normal and equalizing charges at no greater intervals than specified.
Question #2 e (1) (d) continued:

(b) Place battery on open circuit, auxiliary load on float, and maintain ventilation at the same rate, as used while charging. 15 minutes after securing the charge, enter well, take and record the specific gravity, temperature and electrolyte level of the pilot cells.

c) Resume charging at the finishing rate, and continue until the uncorrected total battery voltage and pilot cell voltages show a rise over a period of one hour (5 15-minute readings).

d) Place battery on open circuit, auxiliary load on float and maintain ventilation at the same rate, as used while charging. 15 minutes after securing the charge, enter well, take and record the specific gravity, temperature and electrolyte level of the pilot cells.

e) Resume charging at the finishing rate and continue until the uncorrected total battery voltage and pilot cell voltages show a rise over a period of one hour (5 15-minute readings).

(f) Place battery on open circuit, auxiliary load on float and maintain ventilation at the same rate, as used while charging. 15 minutes after securing the charge, enter well, take and record the specific gravity, temperature and electrolyte level of the pilot cells.

(g) Correct the specific gravity readings obtained in (b), (d), and (f) above for temperature and electrolyte level. If the three corrected readings on each pilot cell agree within 5 points (.005 sp.gr.) the charge is complete. If not, repeat (c) above and secure the charge.
Question 2 e (l) (f) cont'd

Partial charges should, if possible, be continued until the 70 V6 voltage is reached while charging at the finishing rate.

f. Battery water:

(1) Discuss shipboard testing of battery water, and the validity of the various types of tests.

Shipboard testing of battery water consists of electrically testing the conductivity with a meter, and testing for chlorides with silver nitrate.

Before putting water from any source into the battery water tanks, it must first pass either the conductivity test or the silver nitrate test. To pass the conductivity test, the sample's conductivity as measured between the two platinum electrodes in the conductivity cell in which the sample is placed must be 30 or less on the meter scale.

To pass the silver nitrate test, a sample of about 20 milliliters is placed in a test tube and a few drops of silver nitrate solution are added; if the water turns milky the solution contains chlorides and is rejected.

When filling cells from the battery water tanks, about 5 gallons are run through the hose, and then samples are taken for both the conductivity and silver nitrate tests. Buships' Manual places more emphasis on the silver nitrate test, but it is practiced on the ships that samples must pass both tests before being placed in the cells.
(2) Precautions used in watering batteries.

1. Fittings and piping used in watering must be lined with lead, hard rubber, or polyvinyl chloride.
2. Battery water to be used in the cells shall only be stored in the battery water tanks.
3. Watering is done prior to an equalizer charge or a normal charge to facilitate thorough mixing with the electrolyte.
4. A cell should never be filled too full as this reduces cell ventilation and may cause electrolyte spillage.
5. Cells needing more than normal amounts of water should be checked for leaky jars.
6. Cells requiring less than normal amounts of water should be checked for foreign material or leaks from battery cooling water.

(3) What are the restrictions on watering batteries prior to, during, and after snorkeling?

1. Water cells during an interruption in a charge after the charge has proceeded on the finishing rate for at least one hour after watering, resume the charge to completion.
2. If unable to comply with (1) above, water cells after any period of two hours in which no purging has occurred, i.e., two hours on the surface or submerged.
3. If necessary to water while snorkeling and (1) above is not practicable, take hourly pilot cell level readings for four hours prior to watering and if the hourly readings do not decline by an amount greater than usual evaporation it can be assumed that the cell gas content is normal and it is safe to water as usual. Water pilot cell last. Take pilot cell level readings every half-hour while watering and secure watering if an abnormal drop is observed.
4. When watering cells equipped with ceramic domes note whether the water tends to rise in the service tube when the watering gate valve is opened. If this condition is found, the ceramic dome is probably clogged and should be cleaned in accordance with Decker's Manual.
g. Casualties:

(1) What should be done if the battery blowers in one battery well are found stopped?

Secure the charge. Increase speed of ship's exhaust blower to maximum. When the hydrogen concentration is zero in the well, the blowers should be checked, repaired, and restarted. The blower should never be restarted without first securing the charge and ventilating until the hydrogen concentration is zero.

If the air flow is adequate with the battery blowers in one battery well stopped, the battery charge may be continued and the stopped blowers repaired after the completion of the charge when the hydrogen concentration had returned to zero.

(2) What should be done if all battery blowers are found stopped?

Secure the charge. Increase speed of the ship's exhaust blower to maximum. Start an additional engine if necessary to keep the hydrogen concentration below 2%. The blowers should be checked, and restarted when the hydrogen concentration reaches zero.

(3) What should be done if the circulating fans in one battery well are found stopped?

The charge may be continued, but the remaining blowers should be speeded up to provide for the ventilation requirements for circulating fans off.
(4) Describe the procedure for restarting a stopped battery blower.

Never attempt to restart a stopped battery blower without first securing the charge and ventilating long enough to reduce the hydrogen concentration to zero.

(5) Describe emergency ventilation of batteries when battery blowers are inoperative.

Procedures for in-port emergency ventilation are:
1. Secure the charge and shut out the promoting lanyard.
2. Open the FTR cap, and lower hatches and all watertight doors aft to the FER and watertight door which shall be dogged shut.
3. Open all exhaust bulkhead flappers forward of and including FER.
4. Secure ships ventilation supply blower.
5. Shut the main induction and the coming tower hatch.
6. Shut all supply bulkhead flappers.
7. Leave ship's exhaust line rigged to discharge directly to the engines.
8. Check air flow meters to ensure proper ventilation.
9. Station a man at each bulkhead to insure that line up is not changed.
10. Ventilate battery wells until hydrogen concentration is zero; using one engine at a speed consistent with observed air flow.

Procedures for underway ventilation are:

Follow the above procedures with the following exceptions:

1. Do not open FTR hatches.
2. Do not shut main induction.
3. Do not shut ventilation supply line flappers.
4. Shut engine air inductions.
5. Do not secure ship's ventilation supply blower.
6. Use only one engine at a speed consistent with the supply of air flow furnished the battery compartments.
(6) Safety devices:

(a) Describe the battery circuit breakers.

Circuit breakers are devices for interrupting in air circuits between separable contacts under infrequent normal and abnormal conditions. The battery circuit breakers at the Douglas ACR KN circuit breakers rated at 1600 amperes continuous current and 50,000 amperes interrupting current at 500 volts DC. There are four of these circuit breakers, manufactured by the ITE Circuit Breaker Company, one for each battery.

The circuit breakers may be manually opened and closed at the breakers in the well, manually opened only at the mechanical linkages at negative compartment bulkhead, or electrically opened and closed from the starboard vehicle in the maneuvering room.

(7) Safety precautions:

(a) Discuss all applicable battery safety precautions.

1. No one shall enter a battery well when a charge is in progress.
2. Before entering a battery well, a man is required to wear a long sleeve shirt with sleeves rolled down, and all exposed knees, tools, etc. shall be removed.
3. All tools used in the battery wells will be properly insulated with insulation capable of withstanding 3000 volts.
4. No work shall be done on connectors, battery well wiring, or booster switches unless the battery is in a normal circuit.

- continued on page 9-22A -
(8) Discuss battery low voltage limits. What must be done when a low voltage limit is reached?

The low voltage limit of a battery is the limit of discharge set by the manufacturer beyond which damage may be done to the plates.

The curves and data plans set three values of low voltage limits which are reached when:
1. The average cell voltage reaches the average final cell voltage for the discharge rate in use.
2. Total battery voltage falls to the final battery terminal voltage for the discharge rate in use.
3. The voltage of the lowest cell falls to the minimum final cell voltage for the discharge rate in use.

The low voltage limits vary with discharge rates. When a low voltage limit is reached, the discharge must be secured or the rate of discharge must be reduced.
3. Compare the reliability of ampere hour meters versus cell voltage and gravity as a means of determining the state of charge of a battery.

Ampere hour meters are very reliable indicators of the state of charge of the battery if they are properly set. They provide the best information during high rates of discharge before the battery reaches low limits.

Cell voltage is the most reliable indicator when the battery is being charged or when the battery is nearing the low-voltage limit on discharge.

Specific gravity is most reliable during normal slow discharge rates or for determining the completion of the state of charge. However, to be accurate, the electrolyte must be thoroughly mixed.

In practice, all three methods are used for best information with gravities being considered the most reliable.

4. Make a simple workable line sketch of the following:

a. Battery ventilation system up to compartment exhaust line.
   Sketch appears on page 9-24A
b. Battery water system.
   Sketch appears on page 9-24B
c. Battery cooling system.
   Sketch appears on page 9-24C
d. Electrolyte agitation system.
   Sketch shows no electrolyte agitation system.
5. Discuss the "sealed boat test".

The "sealed boat test" provides data on which to base the need for hydrogen eliminators and to show the rate of charge and discharge of chemical self-discharge during the life of the battery. Sealed boat tests shall be conducted on Navy submarines, prior to entering the first overhaul after battery installation and every six months after overhaul. No test is necessary if the battery is to be renewed during the first overhaul. Procedures for the test are:

1. Give the battery a normal or longer charge ending with a temperature between 120° and 130°F. Battery water cooling should be secured.

2. Ventilate the submarine for 20 minutes after the charge and seal the boat.

3. Discharge batteries at the 48-hour rate or slower for 10 hours or until the hydrogen concentration reaches 3% which ever occurs first.

4. Take the following readings at the start of the test and hourly thereafter:
   a. Hydrogen detector readings for each installed hydrogen detector.
   b. Battery ventilation rate.
   c. Boat cell temperatures and specific gravities.
   d. Battery discharge rate in amperes.
   e. Ampere-hour readings.

The results of the sealed boat test should be forwarded to the Bureau of Ships and included in the quarterly battery report.

6. Discuss battery test discharges.

In order to determine the actual condition of the battery, every six months the battery is completely discharged at the 48-hour rate. This test is the best single indication of the actual condition of the battery. The 48-hour test discharge is performed as follows:

a. Fill all cells with battery water to the proper level.

b. Give the battery an equalizing charge.

c. Carry the battery on a zero float in the fully charged condition until discharge commences.

d. The total load should be equal to the desired battery rate multiplied by the number of batteries in parallel.

e. The limiting voltage should correspond to that for the discharge rate.

---continued on page 9-25A---
Question #6 continued:

8. The amper-hour meters are set and read at the beginning of the discharge and at the end of the discharge. The discharge is complete when the low voltage limit is reached.

9. After the discharge is over, divide the total amper-hour of discharge by the actual time of discharge. This gives the discharge rate in amperes.

10. Refer to the plan and find the rated time duration of discharge for the average discharge rate used. This rated time of discharge is then corrected for temperature based on the average pilot cell electrolyte temperature at the start of the charge.

11. Compute the percent service amper-hour capacity obtained. This is equal to 100 times the actual time of discharge divided by the corrected rated time of discharge. If the battery is operating at a load above requirements, it will have a percent capacity above 100. If it old and losing its capacity, it will fall short of 100.
B. Main Power Equipment - Notebook Requirements and Sketches:

1. Make a simple workable sketch of the following:
   a. Block diagram of electrical propulsion equipment.  
      Sketch appears on page 9-268
   b. Circulating water system for main motors.  
      Sketch appears on page 9-26C
   c. Cooling system for one main generator.  
      Sketch appears on page 9-26D

2. Briefly describe the following:

   a. Main propulsion control cubicle.

      The Stores cubicle is a sliding base propulsion control unit which controls
      the operation of the port and starboard motors. The operator and the four batteries
      are used to start, stop, reverse and regulate the speed of the motors, regulate
      the output of the generator paralleled or series, the batteries, control charging rate
      when charging batteries, and control the main motors independently of each other.

      The cubicle is divided into two sections, the switchboard control panel and the
      port control panel. The two panels are in most respects identical and opposite. The
      instrument panel contains various gauges, voltages, engine generator controls,
      generator field rheostat, speed wheels, ground detectors and battery circuit
      breaker levers. Below the instrument panels are the operating levers: lock walk has
      six operating levers, reversing lever, starter lever, generator lever, reverser lever, and
      select lever. The cubicle also located the generator and battery switching groups which
      reverse the motor starting position, battery and generator controls. Main fuel tank
      pressure, switch and motor switch. The size and capacity of the controllers vary by the
      field current of 3000 amperes. A reminder, attached to the field controller, as safety
      devices, are overload tripping mechanisms, and reverse current relays. Interconnections
      in series with the generator fields.

   b. Main generators.

      The main generators on the Stores are Elliot submarine propulsion
      generators, having a maximum output of 122 horsepower at 120 RPM. The
      generator develops 445 volts at 750.5, engine input at full capacity. The
      prime mover of the generator is the diesel engine. The one of the tubular
      wire, direct-current, compensated, shunt-wound type, separate-field excitation
      is provided from the main storage batteries. The generator is totally enclosed
      and is self-ventilated by air which is circulated by a fan attached to the base
      of the shaft. The air is directed over a water-cooler on top of the generator. The generator is
      supplied to the engine by a belt type flexible coupling. The bearing is on the after
      end of the generator and is forced fed by the oil supply from the engine lubricating
      system. continued on page 9-26A
Question 2.6 continued:

The construction of the armature, field coils, and commutator is as follows:

a. Armature
1. Number of conductors - 490
2. Diameter - 37 inches
3. Number of slots - 245
4. Construction - one piece hollow steel forging
5. Core - laminated, low-loss, non-aging, electrical sheet steel, varnished and baked before stacking.

b. Field Coils
1. Number - 10
2. Turns per coil - 312
3. Connected - series
4. Compensating windings - 10 coils, 3 turns per coil

c. Commutator
1. Number of segments - 245
2. Diameter - 24 inches
3. Construction - electro-trode copper segments, hard drawn to the desired tapered section.
4. Brushes - 10 brushes, a positive brassing and a negative brassing bolted to a circular steel yoke.
Main Motor Circulating Water System
Question #2. b. cont'd

c. Main motors.

The main motors on the storage are Elliott two wire direct current compensated type with shunt and series field winding. They are totally enclosed and free ventilated. Each motor has two sleeve type force lubricated bearings. The two motors, located on the port and starboard side of the motor room have two armatures each which are mounted on a single hollow forged shaft, flanged at the after end for connection to the propeller shaft. Each motor is equipped with a motor driven two-wheel ventilating fan and two two-section double tube air coolers. The motors each develop 2700 horse power at 2800RPM.

The motors are cooled by air ventilation blowers mounted on the top of the motor frames. A circulated air through a closed system which consists of the field frame, air ducts, and air coolers.

3. Fill in the applicable portions of the table:

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4. Discuss the reason for taking megger readings.

Measurements of insulation form an important part of any adequate program for the maintenance of electrical equipment.

-continued on page 9-27A-
Question #2, c., continued:
The capacity of the blower is 12,000 CFM. The air is cleaned by a mechanical dust filter of glass fibers on the outlet side of the coiler.
In order to prevent any friction, action by cooking of particles, and thereby entry of contaminated air, a slight pressure is kept on the system, typically a separate blower. This air is called "making" air, and is cleaned with the precipitation air cleaner.

Two sleeve type journal bearings support the armature. The forward pedestal and cap also exceeds the Kingsbury thrust bearing.
Separate enclosed oil systems are provided to lubricate the motor bearings. Principal units of the system are the oil reservoir, a motor operated pump, an oil strainer, and an oil cooler.

Construction data on the armature field and commutator areas as follows:

a. Armature
   1. Number of slots - 144
   2. Diameter - 40 inches
   3. Number of conductors - 576

b. Field windings
   1. Number of poles - 8
   2. Turns per coil - 359
   3. Connections - series

c. Commutator
   1. Number of segments - 268
   2. Diameter - 28 inches
   3. Construction - same as generators
Question #4, continued:

The reason for measuring values of resistance are:

a. To serve as a guide in determining when cleaning, drying, overhaul or replacement is necessary to prevent further development of conditions which might lead to eventual failure and loss of equipment from service.

b. To eliminate needless shutdown and overhaul to improve the insulation resistance of cables or machines on which the insulation is not entirely adequate.

Megger readings are taken daily on all idle main generators. They are also taken after an extended run on each individual piece of equipment, and all readings must be higher than one Megohm. Readings are taken on all individual pieces of equipment as listed on the Engineer Officer's Preventative Maintenance Check Off Sheets weekly. These readings must also be one Megohm or greater.
C. Auxiliary Equipment - Notebook Requirements and Sketches:

1. Make a simple line sketch of the following:
   a. Auxiliary power system (DC) up to the compartment distribution system.
      [Sketch appears on page 9-28 A]
   b. Normal lighting system up to compartment distribution system.
      [Sketch appears on page 9-28 B]
   c. Emergency lighting system.
      [Sketch appears on page 9-28 C]

2. Discuss the auxiliary power and lighting systems with regard to maintaining a balanced load between batteries and port and starboard feeders.

   The auxiliary load is balanced by daily switching of battery loads, that is, the after battery carries the load on odd days and the forward battery carries the load on even days. The changing of auxiliary loads from one power source to the other takes place at 0800 each day.
   
   The port and starboard lighting feeders carry the lighting load on alternate days. There are two battery lighting lines with a center tap coming from each battery. The center tap acts as a common lead to both halves of the battery. Therefore, the other two lines are used on alternate days so that each half of the battery will be used equally.
   
   This procedure is as prescribed by BU SHIPS MANUAL and effective department instructions.

3. Make a simple line sketch of the following:
   a. AC power system up to the compartment distribution boxes.
      [Sketch appears on page 9-28 D]
   b. 1 and 7 MC systems showing all speakers, microphones and klaxons (indicate power sources and show isolation switches).
      [Sketch appears on page 9-28 E]
Auxiliary Power System

Shore Power Connection (After Engine Room)

After Auxiliary Power Distribution Board

900 Amp. Fuses

Circuit Breaker After 0.12 in

Circuit Breaker Forward 0.06m

900 Amp. Fuses

#4 Battery

#3 Battery

#2 Battery

#1 Battery
Normal Lighting System
c. All other MC systems (such as 21, 27 and 31 MC) on your ship except sonar talkbacks.

Sketch appears on page 9-29B

d. JA and XJA telephone circuits showing all outlets, ringer boxes and cross-connects.

Sketch appears on page 9-29A

e. All other telephone circuits (such as 61JS and X40J) on your ship.

Sketch appears on page 9-29B

f. 400 cycle power system up to the equipment utilizing the power.

Sketch appears on page 9-29C

4. List the equipment supplied with AC power from the IC board; DC power; both AC and DC power. Which equipment have emergency power sources? Where does the power supply for the IC board come from?

The following equipment is supplied with AC power from the IC board:

- General Announcing System (1MC)
- Submarine Control Announcing System (7MC)
- Wireless Order Telegraph (H and P1) and (2MB)
- Bow and Stern Plane Indicators (NB and NS)
- Hull and Tank Opening Indicators (TR and TP)
- Turbine Oil and Circulating Water Alarms (EC)
- Bunker Angle Indicator (N)
- Bow Plane Rigging (BPR)
- Underwater Tube (Y)
- Smoke Safety Circuit (SN)
- Hydrogen Detectors (HYD)
- Air Flow Meters (HG)

The following equipment is supplied with DC power from the IC Board:

- Diving Alarm Relay (GD)

The following equipment is supplied with both AC and DC power from the IC Board:

- Gyro Compass (2 LC)
- Auxiliary Gyro Compass (X2 LC)
- Torpedo Data Computer (GAE and M6A1)
- Torpedo Ready Light Circuits (GR)
- Torpedo Firing Circuits (GPA)
- Torpedo Designation System (GT)

The following equipment have emergency power sources:

- Hull and Tank Opening Indicators (TR and TP)
- Torpedo Data Computer
- Master Gyro Compass

The power supply for the IC board comes from a feeder for the AC paralleling switchboard (AC) and the port starboard lighting feeder (OC).
27 MC, X40J AND 61 JS Systems
400 Cycle Power System
5. Briefly describe the underwater log installation; list all equipments using log outputs. Explain the function of the dummy log.

The Sirago has an electro-magnetic type underwater log made by the Control Instrument Co., Inc., of Brooklyn, New York. The electro-magnetic log measures speed of the ship and distance traveled. The rudder meter is a rod extending through the hull in the sonar room. Its tip has two electrodes between which water moves as the ship's moves. The water, acting as a conductor, generates an electric current to the oscillator amplifier unit which consists of the oscillator which generates a voltage to excite the rudder meter, and the amplifier which amplifies the speed voltage produced by the rudder meter. The indicator transmitter indicates on a dial the speed of the ship through the water, and transmits the speed as a synchro output to various repeaters aboard the ship. The indicator also registers in the sonar room the distance traveled which is transmitted as a synchro output.

6. Briefly describe the operation and use of the DRAI.

The Sirago has an Naval Class II Mark 5 Mod 0 Dead Reckoning Analyzer Indicator which is located in the control room. It gives the generating continuous position of the ship in longitude and latitude. It is used to give an assumed ship's position based on a DR so the navigator can use this position from which to obtain fixes through celestial navigation.

Its inputs are ship's speed from the underwater log, and course from the rudder, or auxiliary gyros. Through warm-glowing telemeter ouputs are resolved onto vectors and converted to latitude and longitude which is read on dials. The dials are adjustable so that the instrument may be set according to the latest fix and generate a DR from that fix.
Question #5 continued:
The signal generated by the rudder, amplified by the amplifier, and transmitted by the transmitter indicator is sent through a synchro system to the following repeaters:
- Wardroom Plotting Indicator
- Diving Station Instrument Panel
- Wardroom DRT (from DRA1)
- Conning Tower DRT (from DRA1)
- DRA1 (through gyro board)
- Conning Tower Indicator
- TDC
- Master Gyro (through gyro board)

The dummy log is an emergency synchro system which is used in case of the electro-magnetic log being out of commission. The dummy has output signals going to all equipments and indicators receiving an input from the electro-magnetic log. The dummy log is not based on the movement of water, the speed is determined by the shaft RPM which is converted to speed in knots and cranked into the system manually. The switch for shifting to the dummy log is located on the gyro follow-up board. The dummy log transmitter is in the maneuvering room, the distance indicator is in the control room.
7. Briefly discuss the master and auxiliary gyro compass installation. Include the following:

a. Type compass.

b. Power supplies required.

c. Time to settle out.

d. Accuracy.

e. Higher latitude usable.

f. High latitude modification.

g. Follow ups.

h. Alarms.

i. Repeaters.

j. Equipments using compass inputs.

The master compass on the groups is an Arma Gyro Compass MK 7, Mod 4. Power supplies required by the compass are drawn from a rectifier and the lighting feeder in values as follows:

1. Gyro current 1.7 to 2.6 ampere.

2. D.C. voltage 115 volts.

3. A.C. single phase 115 volts.

4. Amplifier tube plate current 1.5 to 2.5 milliamper.

The time required for the compass to settle out is about 3 hours although it is spinning at full speed within 10 minutes of being turned on. The accuracy using the normal supplies with variations of voltage and frequency plus minus 10% of prescribed value is 1/2 degree. The highest latitude at which the compass is usable as prescribed by the Arma Corporation is 80°. Beyond this latitude the compass is expected to tumble.

-continued on page 4-32-
Question #7 cont'd

When using the compass at latitudes higher than 70° which is the limit of the latitudes, bond adjustments must be made to the speed dial. A chart on page 85 of the Armco Gyro Compass Instruction Book gives settings to be made on the speed dial up to 48.2 knots for every latitude from 71° to 80°.

The follow-up mechanism on the master gyro is the same applied to the system of signal output from the gyro itself to the gyro follow-up board. This system consists of the north-south rotor, which is the rotor on a synchro transmitter. The output signal passes through the azimuth rotor to the follow-up board. Here the signal is amplified and transmitted to all cut-in repeaters throughout the ship.

The master gyro alarm consists of an alternating flashing blinder light, mounted over the follow-up board and a constant ringing bell alarm. This alarm works with and will actuate when an interruption of current occurs in the D.C. or A.C. power supplies. The alarms will also actuate when a change occurs in the values of voltage, current and frequency of the power-supply inputs. Test switches on the follow-up board facilitate determination of the trouble circuit when the switch is thrown to a position that does not produce an alarm. The repeaters in the ship receive their input from the synchro transmitter located on the follow-up board. The repeaters are located as follows:

1. Bridge T/R
2. Helm station in the conning tower
3. Helm station in the control room
4. Captain's stateroom
5. Wardroom repeaters (two)

--continued on page 9-33--
Question #7 cont'd

The equipments using inputs to give a true bearing indication are as follows:
1. OKA1, which gives course and speed to the ORT's located in the wardroom and the conning tower.
2. Mark 8 periscope repeater
3. AN/PSQ-2 sonar
4. AN/BRQ-2B sonar
5. AN/BLR-1
6. Torpedo Data Computer
7. SS Radar

---continued on page 9-33A---

8. Describe the magnetic compass installation.

The ships have two magnetic-type compasses, one in the conning tower and the other in the control room. They both are Bendix Aviation Corp. Type "Pioneer" compasses designed for installation in tanks and armored cases. They are of conventional design with a horizontal cylindrical compass card mounted on a limited throw gimbals housed in a small tank containing clear liquid.

The compass has two quadrantal correction spheres (Weiger's balls) mounted on either side of the compass to correct for ship's magnetic influence. The screw projections are mounted on the vertical axis of the compass which accommodate small bolts used as weights. This device is a correction device at the face of the unit with a magnet in it is used to correct the compass for variation and deviation. A periodic routine of swinging ships is required to keep the compasses adjusted, although even when the compasses are as accurate as can be set they will only be accurate to about 5 degrees.
Question #7 continued:

The auxiliary gyro aboard the dirigible is a Sperry MK 18 MOD. 1. The power supply is from an a.c. motor generator. The a.c. power to the gyro is derived from the motor generator. Therefore, although the compass uses a.c. and d.c. in the same manner as the master gyro, its ultimate power source is all d.c. directly from the main storage battery through the gyro board to the compass. The time it takes the auxiliary gyro to settle out is about 4 hours maximum, although it is practical to start both master and auxiliary gyro's at least 12 hours in advance of getting underway. The accuracy of the auxiliary gyro is the same as that of the master with the exception that the Sperry has no automatic speed correction. Speed correction is accomplished by setting a balancing weight to the correct speed scale. The gyro will not be accurate to 1/2 degree above 65° latitude inasmuch as there is no way of making a latitude correction by changing the speed knob.

The follow-up system consists of a weak signal generated by an amplifier through the north-south and azimuth rotors to the gyro board where it is transmitted to the ship's repeaters through the same synchronous system as the master.

The alarms for the auxiliary gyro is a buzzer which will continue to sound until it is shut off manually.

The repeaters for the auxiliary gyro are the same as for the master gyro.
CHAPTER 9

ENGINEERING (ELECTRICAL) - PART II

This is to certify that all work within this section has been completed.

Approved:

[Signatures]

R.M. Weidman, Jr., LCDR, USN

B. Peters, LCDR, USN
CHAPTER 9

ENGINEERING - Part III

(To be completed on board your submarine)

A. Machinery, Practical Factors

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1. Demonstrate ability to operate the following equipments or systems:
   a. Own ship's diesel engine under surfaced and snorkel conditions.
   b. Fresh water distilling units.
   c. High pressure air compressor, including commencing a normal air charge.
   d. Main hydraulic system, including charging accumulator by hand, venting the system and adding oil to the system.
   e. Fuel system, including receiving fuel from a shore connection, venting the fuel system and shifting service tanks.
   f. Fresh water system, including receiving fresh water from a shore connection, and shifting fresh water tank on service.
   g. Drain system, including pumping the forward torpedo room bilges.
   h. Lube oil system, including receiving lube oil on board, and operating purifiers.
   i. Supervise the greasing of the ship, including use of lubrication chart.
   j. Air conditioning system and refrigeration system, including cross connecting the two systems.
   k. Emergency steering system (control and stern rooms).
   l. Permanently installed submersible pump.
CHAPTER 9

ENGINEERING - Part IV

(To be completed on board your submarine)

A. Electrical, Practical Factors

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1. Satisfactorily demonstrate the ability to:
   a. Operate the main propulsion control cubicle.
   b. Operate the individual cell voltage scanner.
   c. Take on board and test battery water.
   d. Line up the main motor circulating water and lube oil system prior to getting underway.
   e. Shift the auxiliary load between batteries.
   f. Shift auxiliary power and lighting from battery to shore power (if shore power not available make all preparations on board).
   g. Start and secure the master and auxiliary compasses.
   h. Administer proper treatment in case of electric shock.
CHAPTER 10

REQUIREMENTS FOR QUALIFICATION FOR COMMAND OF SUBMARINES

A. Article C-7303(7), Bureau of Naval Personnel Manual is quoted herein for information:

"C-7303(7)(a) QUALIFICATION FOR COMMAND OF SUBMARINES. An officer who has previously 'qualified in submarines', in accordance with the provisions of the foregoing paragraphs, may be recommended by his commanding officer as 'qualified for command of submarines. Division and Squadron Commanders should forward these recommendations approved, only, if they are willing to receive the applicant for the command of a submarine in their own organization as soon as he obtains the necessary seniority or rank. The Bureau of Naval Personnel, if finally approving, will record these recommendations and make necessary additions to the list of officers qualified for command of submarines."

B. In order to provide for a uniform and high standard for qualification for command and yet permit officers to qualify during their first sea cruise, the following policies are established.

1. The officer shall have completed a minimum of two years service in submarines following Qualification in Submarines, except that the Force Commander may waive this minimum in the case of outstanding officers who have entered submarine service appreciably later than their contemporaries, or those who are ordered to shore duty appreciably in advance of their contemporaries. The candidate shall have convincingly demonstrated over a considerable period of time that he has the requisites of a good commanding officer.

2. He should have demonstrated his thorough up-to-date knowledge of submarines and submarine development by preparing a thesis on a professional subject approved by the Squadron Commander. The format is optional; however, the contents should be limited to less than 10,000 words. These should be forwarded via the commanding officer and division commander to the squadron commander. If considered of particular interest they should be forwarded by the Squadron Commander to the appropriate Force Commander.

3. The Squadron Commander will appoint a board of officers consisting of himself as senior member and one division commander (not the candidate's own division commander) for the purpose of examining the officer's qualification for command. This board will give the candidate a practical, professional and oral examination. This should include at least one day at sea during which time the candidate will act as commanding officer (under the supervision of the actual commanding officer).
The candidate should make the decisions, maneuver the ship, originate and release all radio traffic, be conning officer during diving and surfacing, demonstrate his capability to make a good torpedo approach, have a thorough knowledge of the capabilities and limitations of the ship, and answer questions pertaining to command of a submarine. In addition, he should be given a hypothetical problem to solve in:

(a) A disciplinary case.
(b) An administrative problem.
(c) An operational problem.