

## **U-Boat Sonar Operator's Manual**

As a sonar operator, your job is critical for accomplishing our mission and the survival of the crew. On a patrol in enemy waters the lives of your shipmates may be in your hands. Most of these things you *cannot* learn from books. Only long hours of practice on the gear itself will make you proficient. The information here will prepare you to make the most of your practice time.

### **The Hydrophone**

The shaft on which the hydrophone is mounted goes down through the pressure hull into the forward torpedo room. Inside the shaft a cable carries the electric current to the amplifier. Geared to the shaft is a handwheel. The target's relative bearing may be read with the pointer off the dial marked in degrees.

### **Rapid search**

From the bearing at which the hydrophone was left by the previous watch, sweep through 000 degrees and continue on to 180 degrees. Then, reversing direction, sweep back around the full circle to 180 degrees. If no suspicious sounds are heard, shift to ...

### **Progressive search**

Sweep forward 90 degrees on handwheel and then turn back 45 degrees. Continue up the same side, 90 degrees forward and 45 degrees back, until you have crossed the bow. Then train rapidly down the opposite side to 180 degrees. Reverse direction and train 90 degrees forward, 45 degrees back, 90 degrees forward, 45 degrees back, until you have crossed the bow again. Then train rapidly down the other side ... and so on. Continue this procedure for the duration of your watch, unless ordered to do otherwise.

### **Sounds**

- Enemy ships' propellers have rhythmic, swishing beats. PT boats whine and freighters chug.
- Enemy echo-ranging (pinging) produces dull thuds or sometimes shrill peeps.
- On your own submarine, electric motors have a smooth hum; bow planes grate; the TDC whirrs; blowing tanks make a roaring sound.

### **Adjust the amplifier controls**

While you are reporting, set your amplifier controls to sharpen the target sound. Set volume low enough to make the target distinct from the background noise. Raise volume to enhance distant sounds.

## Hydrophone Sound Trainer

Load the Sound Trainer in the single missions menu to practice identifying and targeting vessels with hydrophones.

All 16 merchants are there, 14 are parked, two are moving. Both moving ships are traveling at the same speed, but have different rpm's. One ship moves across the bow, and the other one crosses the stern, both at 90 degrees.

### Objectives are:

1. Determine target speeds (count number of rpm's using a stopwatch for 1 minute)
2. Identify targets ( using the speed and rpm chart below for the two moving targets)
3. Destroy targets (using the bearing speed charts below for 30 knot torpedo for bow torpedoes and stern torpedos).

I want to mention here about the peculiarities for the propellers sounds at certain speeds. The dev team used 26 propeller rpm sounds, 21 to 47. Some ships peak out at 47 or bottom out at 21, my guess is that you wont see these ships doing those speeds in a convoy, so the dev team felt no need to distinguish those speeds that remain the same. You'll see what I mean below.

### Speed of the target

As soon as possible, decide the probable kind of target. If it is a ship, notice the speed of the screws (slow, medium, or fast) and the weight of the sound (light or heavy). Determining the targets speed will help in identification through elimination. See tables.

Train the hydrophone directly on the bearing where the prop beats are loudest.

Notice whether the beats are accented or unaccented. Accented beats go CHUG, chug, chug (three-bladed propeller)-or CHUG, chug, chug, chug (four-bladed propeller). Unaccented beats go chug, chug, chug, chug, chug.

Get in rhythm with the beats by pumping your arm up and down like a band conductor. If there is an accented beat, let your hand come down with every accented CHUG -or if the beats are all the same, on every chug.

Count the number of times you pump your hand down in 15 seconds.

Multiply this count by 4 to get the number of rpm (revolutions per minute). For example, if your 15-second count is 12, the rpm will be 48. If the beats are too rapid count for a full minute for accuracy.

For the merchants, the screws have a cycle of four beats, of which you only count the first beat, or beginning beat. To me the cycle sounds like the beating of the war drums of the cheyanne, or apache. Another analogy is music in four four time, four quarter notes, four beats to a measure, 1- 2-3-4 1-2-3-4, count the beats of the 1 only.

**Identify the target**

The two ships moving are the C-2 and the liberty ship. Remember, most times you will have to visually id the target first in order to get speed. (a true propeller pitch number would likely eliminate this, for the most part). Below is the speed rpm chart for both ships.

List of the rpm's of a C-2 cargo, max speed is 15 knots;

<b>Knots</b>	<b>Beats</b>	<b>Knots</b>	<b>Beats</b>
15	45	07	28
14	42	06	26
13	40	05	24
12	38	04	22
11	36	03	21
10	34	02	21
09	32	01	21
08	30	00	00

Notice speeds 3, 2, and 1 are all at 21rpm, the dev team only used from 21 low to 47 high for the merchants, this is the peculiarity that was explained before.

List of the rpm's of a liberty ship, max speed is 13 knots;

<b>Knots</b>	<b>Beats</b>	<b>Knots</b>	<b>Beats</b>
13	42	06	29
12	42	05	27
11	42	04	24
10	40	03	21
09	37	02	21
08	34	01	21
07	32	00	00

## **Torpedo the target**

Use the TDC to manually set the AoB to 90 degrees PORT or STARBOARD depending upon which direction you are approaching from. Manually set the TDC bearing dial to 0 degrees. Set the speed dial to zero as well, remember you want the torpedo to come straight out, no gyro angle. Position the sub perpendicular to the targets heading and wait. Fire when the bearing from the hydrophone is indicated in chart below for your targets speed.

When firing torpedoes using the speed bearings chart, your TDC dials will all stay at the default settings, accept for torpedo depth, torpedo speed, and pistol, all your choice.

For this type of shooting we want to keep:

Target across the bow

target bearing = 0 degrees (target will be at 0 degrees at torpedo impact)  
target speed = 0 knots  
target course = 0 degrees  
torpedo gyro angle = 0 degrees

Target across the stern

target bearing = 180 degrees (target will be at 180 degrees at torpedo impact)  
target speed = 0 knots  
target course = 0 degrees  
torpedo gyro angle = 0 degrees

Periscope should only be used to visually id sound contact. After visual id bring scope back to the direction of fire, either 0 degrees or 180 degrees, then bring down the scope.

Have torpedo doors opened.

Track the sound contacts movement with the hydrophones, continually ask sonarman for bearing within 10 degrees of firing bearing. At the correct bearing fire torpedo using enter key.

Lay the bearing needle of the hydrophones on the torpedo direction of fire. Listen to the whine of the torpedo on a collision course with the sound contact. Torpedo impact time will vary according to the speed of the torpedo. If all goes right, you should be able to have torpedo impact from 300 meters out to max range of the torpedo being used.

### Bow Speed Bearings Chart

Bearing	Target Speed	Target Heading	Intercept	Torpedo	1km/min	5km/min
2	1	270	0	30	1:04	5:23
4	2	270	0	30	1:04	5:23
6	3	270	0	30	1:04	5:22
8	4	270	0	30	1:04	5:20
9	5	270	0	30	1:04	5:19
11	6	270	0	30	1:03	5:18
13	7	270	0	30	1:03	5:15
15	8	270	0	30	1:02	5:12
17	9	270	0	30	1:01	5:09
18	10	270	0	30	1:01	5:08
20	11	270	0	30	1:00	5:04
22	12	270	0	30	1:00	5:00
23	13	270	0	30	0:59	4:58
25	14	270	0	30	0:58	4:53
26.5	15	270	0	30	0:57	4:48
28	16	270	0	30	0:57	4:46
29.5	17	270	0	30	0:56	4:40
31	18	270	0	30	0:55	4:37
32	19	270	0	30	0:54	4:34
34	20	270	0	30	0:53	4:28
35	21	270	0	30	0:53	4:25
36	22	270	0	30	0:52	4:22
38	23	270	0	30	0:51	4:16
38.5	24	270	0	30	0:50	4:11
40	25	270	0	30	0:49	4:08
41	26	270	0	30	0:48	4:04
42	27	270	0	30	0:48	4:00
43	28	270	0	30	0:47	3:56
44	29	270	0	30	0:46	3:53

So if the C-2 was traveling at 7 knots, you would wait in the soundroom, until the bearing was 13 degrees starboard, then fire. Range does not matter as you can see from the time to target at 1km to 5km, the max range of the 30 knot torpedo.

The only concern about range is that the target has to be within the fuel range of the torpedo you are using. For t-1 torpedoes:

- 30 knot speed, thats 12km
- 40 knot speed, thats 7.5km
- 44 knot speed, thats 5km

Position the sub stern perpendicular to the targets heading and wait. Fire from stern tubes when the bearing from the hydrophone is indicated in chart below for your targets speed.

**Stern Speed Bearings Chart**

Bearing	Target Speed	Target Heading	Intercept	Torpedo	1km/min	5km/min
182	1	270	0	30	1:04	5:23
184	2	270	0	30	1:04	5:23
186	3	270	0	30	1:04	5:22
188	4	270	0	30	1:04	5:20
189	5	270	0	30	1:04	5:19
191	6	270	0	30	1:03	5:18
193	7	270	0	30	1:03	5:15
195	8	270	0	30	1:02	5:12
197	9	270	0	30	1:01	5:09
198	10	270	0	30	1:01	5:08
200	11	270	0	30	1:00	5:04
202	12	270	0	30	1:00	5:00
203	13	270	0	30	0:59	4:58
205	14	270	0	30	0:58	4:53
206.5	15	270	0	30	0:57	4:48
208	16	270	0	30	0:57	4:46
209.5	17	270	0	30	0:56	4:40
211	18	270	0	30	0:55	4:37
212	19	270	0	30	0:54	4:34
214	20	270	0	30	0:53	4:28
215	21	270	0	30	0:53	4:25
216	22	270	0	30	0:52	4:22
218	23	270	0	30	0:51	4:16
218.5	24	270	0	30	0:50	4:11
220	25	270	0	30	0:49	4:08
221	26	270	0	30	0:48	4:04
222	27	270	0	30	0:48	4:00
223	28	270	0	30	0:47	3:56
224	29	270	0	30	0:46	3:53

## Merchant Tables

Here is the complete list for all the merchants in the game,

### **coastal merchant** max speed 9 kts

9kts 35rpm  
8kts 33rpm  
7kts 30rpm  
6kts 28rpm  
5kts 26rpm  
4kts 23rpm  
3kts 21rpm  
2kts 21rpm  
1kts 21rpm  
0kts 00rpm

### **fishing boat** max speed 8 kts

8kts 47rpm  
7kts 47rpm  
6kts 42rpm  
5kts 38rpm  
4kts 33rpm  
3kts 29rpm  
2kts 24rpm  
1kts 21rpm  
0kts 00rpm

### **c-3 cargo** max speed 17 kts

17kts 47rpm  
16kts 47rpm  
15kts 47rpm  
14kts 47rpm  
13kts 47rpm  
12kts 47rpm  
11kts 47rpm  
10kts 47rpm  
09kts 47rpm  
08kts 45rpm  
07kts 41rpm  
06kts 38rpm  
05kts 34rpm  
04kts 30rpm  
03kts 26rpm  
02kts 22rpm  
01kts 21rpm  
00kts 00rpm

## Merchant Tables

**victory cargo** max speed 17 kts

17kts 47rpm  
16kts 47rpm  
15kts 47rpm  
14kts 47rpm  
13kts 47rpm  
12kts 47rpm  
11kts 47rpm  
10kts 47rpm  
09kts 47rpm  
08kts 47rpm  
07kts 44rpm  
06kts 40rpm  
05kts 35rpm  
04kts 31rpm  
03kts 27rpm  
02kts 23rpm  
01kts 21rpm  
00kts 00rpm

**t-3 tanker** max speed 18 kts

18kts 47rpm  
17kts 46rpm  
16kts 44kts  
15kts 43rpm  
14kts 40rpm  
13kts 39rpm  
12kts 37rpm  
11kts 34rpm  
10kts 33rpm  
09kts 31rpm  
08kts 29rpm  
07kts 27rpm  
06kts 25rpm  
05kts 23rpm  
04kts 22rpm  
03kts 21rpm  
02kts 21rpm  
01kts 21rpm  
00kts 00rpm

**small coastal vessel** max speed 9 kts

9kts 47rpm  
8kts 47rpm  
7kts 46rpm  
6kts 42rpm  
5kts 38rpm  
4kts 33rpm  
3kts 29rpm  
2kts 24rpm  
1kts 21rpm  
0kts 00rpm

**liberty cargo** max speed 13 kts

13kts 42rpm  
12kts 42rpm  
11kts 42rpm  
10kts 40rpm  
09kts 37rpm  
08kts 34rpm  
07kts 32rpm  
06kts 29rpm  
05kts 27rpm  
04kts 24rpm  
03kts 21rpm  
02kts 21rpm  
01kts 21rpm  
00kts 00rpm

**trawler** max speed 12 kts

12kts 47rpm  
11kts 47rpm  
10kts 47rpm  
09kts 46rpm  
08kts 42rpm  
07kts 39rpm  
06kts 35rpm  
05kts 32rpm  
04kts 28rpm  
03kts 25rpm  
02kts 21rpm  
01kts 21rpm  
00kts 00rpm

**tug boat** max speed 15 kts

15kts 47rpm  
14kts 47rpm  
13kts 47rpm  
12kts 47rpm  
11kts 47rpm  
10kts 47rpm  
09kts 47rpm  
08kts 47rpm  
07kts 47rpm  
06kts 47rpm  
05kts 47rpm  
04kts 47rpm  
03kts 42rpm  
02kts 33rpm  
01kts 24rpm  
00kts 00rpm

## Merchant Tables

### **landing ship tank** max speed 10 kts

10kts 47rpm  
09kts 47rpm  
08kts 47rpm  
07kts 47rpm  
06kts 44rpm  
05kts 39rpm  
04kts 34rpm  
03kts 29rpm  
02kts 24rpm  
01kts 21rpm  
00kts 00rpm

### **c-2 cargo** max speed 15 kts

15kts 45rpm  
14kts 42rpm  
13kts 40rpm  
12kts 38rpm  
11kts 36rpm  
10kts 34rpm  
09kts 32rpm  
08kts 30rpm  
07kts 28rpm  
06kts 26rpm  
05kts 24rpm  
04kts 22rpm  
03kts 21rpm  
02kts 21rpm  
01kts 21rpm  
00kts 00rpm

### **t-2 tanker** max speed 14 kts

14kts 47rpm  
13kts 47rpm  
12kts 47rpm  
11kts 47rpm  
10kts 47rpm  
09kts 45rpm  
08kts 42rpm  
07kts 39rpm  
06kts 35rpm  
05kts 32rpm  
04kts 28rpm  
03kts 25rpm  
02kts 21rpm  
01kts 21rpm  
00kts 00rpm

## Merchant Tables

### **small tanker** max speed 15 kts

15kts 47rpm  
14kts 47rpm  
13kts 47rpm  
12kts 47rpm  
11kts 47rpm  
10kts 47rpm  
09kts 47rpm  
08kts 43rpm  
07kts 40rpm  
06kts 36rpm  
05kts 32rpm  
04kts 29rpm  
03kts 25rpm  
02kts 22rpm  
01kts 21rpm  
00kts 00rpm

### **small merchant** max speed 9 kts

9kts 37rpm  
8kts 34rpm  
7kts 32rpm  
6kts 29rpm  
5kts 27rpm  
4kts 24rpm  
3kts 22rpm  
2kts 21rpm  
1kts 21rpm  
0kts 00rpm

### **troop transport** max speed 16 kts

16kts 47rpm  
15kts 47rpm  
14kts 47rpm  
13kts 47rpm  
12kts 47rpm  
11kts 46rpm  
10rpm 43rpm  
09kts 40rpm  
08kts 37rpm  
07kts 34rpm  
06kts 31rpm  
05kts 29rpm  
04kts 25rpm  
03kts 23rpm  
02kts 21rpm  
01kts 21rpm  
00kts 00rpm

## Merchant Tables

**passenger liner** max speed 31 kts

31kts 47rpm  
30kts 47rpm  
29kts 47rpm  
28kts 47rpm  
27kts 47rpm  
26kts 47rpm  
25kts 47rpm  
24kts 47rpm  
23kts 47rpm  
22kts 47rpm  
21kts 47rpm  
20kts 47rpm  
19kts 45rpm  
18kts 44rpm  
17kts 43rpm  
16kts 40rpm  
15kts 39rpm  
14kts 37rpm  
13kts 36rpm  
12kts 34rpm  
11kts 32rpm  
10kts 31rpm  
09kts 29rpm  
08kts 27rpm  
07kts 26rpm  
06kts 23rpm  
05kts 22rpm  
04kts 21rpm  
03kts 21rpm  
02kts 21rpm  
01kts 21rpm  
00kts 00rpm

