Contact, Approach, Attack

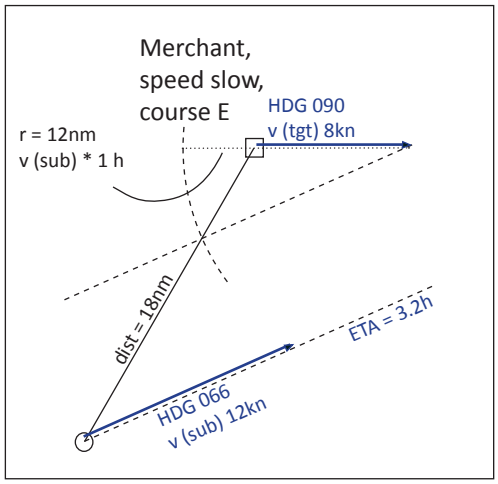
based on:
- „SUBMARINE TORPEDO FIRE CONTROL MANUAL“ (http://www.hnsa.org/doc/attack/) [HNSA]
- „The Hunt“ by Dantenoc (http://www.subsim.com/radioroom/showthread.php?t=88961) [DANT]
- „The ‘broken‘ TDC Attack Methods“ by Makman94. Part of the MaGui (final) package [MAKM]

Contact

Map contacts

No visual contact, position indicator, rough course (N, NNE, NE, ...). Drawn on map even when „map updates“ is off.

Intercept course [DANT]:

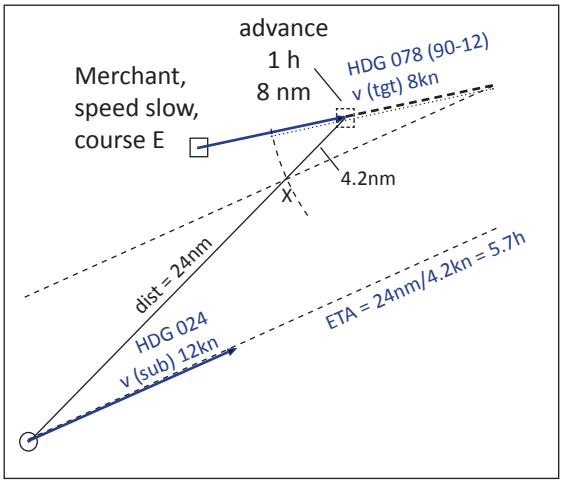


In this example, I‘ve used a map contact 18nm NE of our position (compass bearing 030), speed „slow“ (< 8 knots) - assume 8kn, and given the weather conditions we are confident to be able to make 12kn.

1: plot target course and speed (actually, distance covered in 1h or 30min or ...)
2: draw a line from sub position to target position (current distance to target)
3: draw a circle with center = end point of (1), radius = sub „speed“
4: draw a line from the intersection of (2) and (3) to the end point of (1)
-> intercept course

The resulting course of 066 (ENE) will - theoretically - lead to a collision in approximately 3 1/4 hours. We would have to make close to 20kn in order to arrive one hour early ...

Worst case and „advance“ variant:



1) Course given is within 11,25° of true course („NNE“ is anywhere 011-034)
-> use worst case (12° away from given course)

2) Include „advance“: arrive at a point 1 hour further along target course

Same procedure as above, but use „virtual“ target position
(1 h ahead) instead of map contact position:
1: Again, plot target course and speed (from the virtual target).
2: draw line from sub position to target position (current distance to target)
3: draw circle, mark the intersection of (2) and (3): point „X“
4: draw line from X to the end point of (1)
-> intercept course

Note that the distance from point X to the virtual target gives the „closing speed“ of our intercept course. Divide target distance by closing speed to find the estimated time to arrival.

Visual contacts

When surfaced, the Watch Officer reports target bearing and distance.
When submerged, the apparent height of the target can be used for a crude estimate (tick values are for MaGui final mod).
Double distance - half apparent height:
at 4000 m, 20m appear as 0.29° (2.3 ticks Attack Periscope x12, 1.15 ticks Observation Periscope x6)
at 4000 m, 25m appear as 0.36° (2.9 ticks Att., 1.4 ticks Obs.)

Next step: find angle on bow and speed.
From the Submarine Torpedo Fire Control Manual [HNSA, 803]:

> *(a) When the target is in sight the quickest and simplest way to determine the direction of target motion is by visual observation of angle on the bow.*
> *(b) Estimation of angle on the bow by observation through a periscope is one of the arts peculiar to submarining. An officer‘s ability to accurately estimate angles on the bow increases directly with his experience in submarines.*

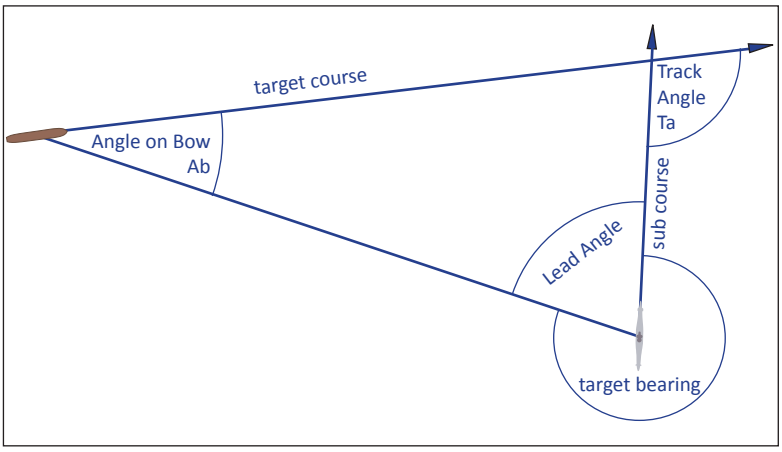
Unless the target is sailing right towards us, [HNSA, 852 and 853, 902] suggests the „Normal Approach Course“ (NAC - target bearing +/- 90) or the „Optimum Approach Course“ (OAC target bearing +/- 80).

Approach

Goal: to be in a favorable position for the torpedo attack AND to collect necessary data for the attack.

[HNSA 1000]: *„In order to compute a hitting torpedo gyro angle there are four values which must be known, namely, target course, target speed, range and bearing of the target. The conventional method of obtaining these values is by successive observations of the target's range and bearing."*

Ideally, we are able to plot the target course, determine target speed, and reach a **waiting position:**
- ahead of the target (distance to target >= critical range)
- at 800-1000 m distance from target track
- with a heading roughly +/-90° to the target course



Critical range: [HNSA 105]
„The range at which the submarine normally passes from the Approach Phase to the Attack Phase. It is equal to a 7 1/2 minute run of the target..." .

7 1/2 minutes is twice the familiar 3:15 minutes interval: the distance travelled (in m) is 200 times the speed in knots.
In a typical situation the target might approach with 10 - 12 knots, the critical distance is then 2000 - 2400 m.

Attack

Preparations - the TDC

Data needed for the TDC:
- target course (plot & note track angle Ta, then calculate GyroAngle **G = 90-Ta** (Ta-90 if target comes from stb)
- target speed
- distance to track: this will be the „range" entered into the TDC

Data NOT needed for the TDC: angle on bow and range of the target. During the approach phase we used those measurements to plot the target's course and determine its speed, but during the attack the Ab is close to 90° and the range will be used to verify the course of the target, but will NOT be entered into the TDC.

4 steps - immediately after the submarine has arrived at the waiting position, time needed: approx. 1 minute

1) move the periscope to **bearing 0** ! BTW, the **periscope** is **down** almost all the way, unlocked.
2) set TDC to MANUAL, enter speed = 0, **AoB = Ta** (this in effects sets the target course)
3) set TDC to AUTO, move the periscope until Gyroangle shows the calculated value G, verify that AoB is 90°
4) enter **torpedo data** (F6), set TDC to MANUAL, enter **speed**, **range**. Set TDC to **AUTO**, verify AoB is still 90°

DONE - the periscope (always on AUTO) can be used freely.

The Final Stretch

When to fire? After setting up the TDC, we could fire at any time, but the chances for success increase greatly near the „perfect" moment: when fired at that moment, the torpedo will hit the target at a 90° angle. To find that right moment, move the periscope until the gyroangle shows the calculated value G (again). That is the target bearing for a „perfect shot".

> Example: let's assume that the target moves at 7kn on a course due E (090) and we have already arrived at a position 1000m south of the plotted target track, heading 010. The track angle is 100°. Gyroangle G is 90-100 = -10° or 350. The target is coming from port and the torpedo must make a slight left turn to meet the target track at 90°.
> I select a „M" (medium) torpedo speed of 40kn and find the „perfect" moment at a target bearing of 341.

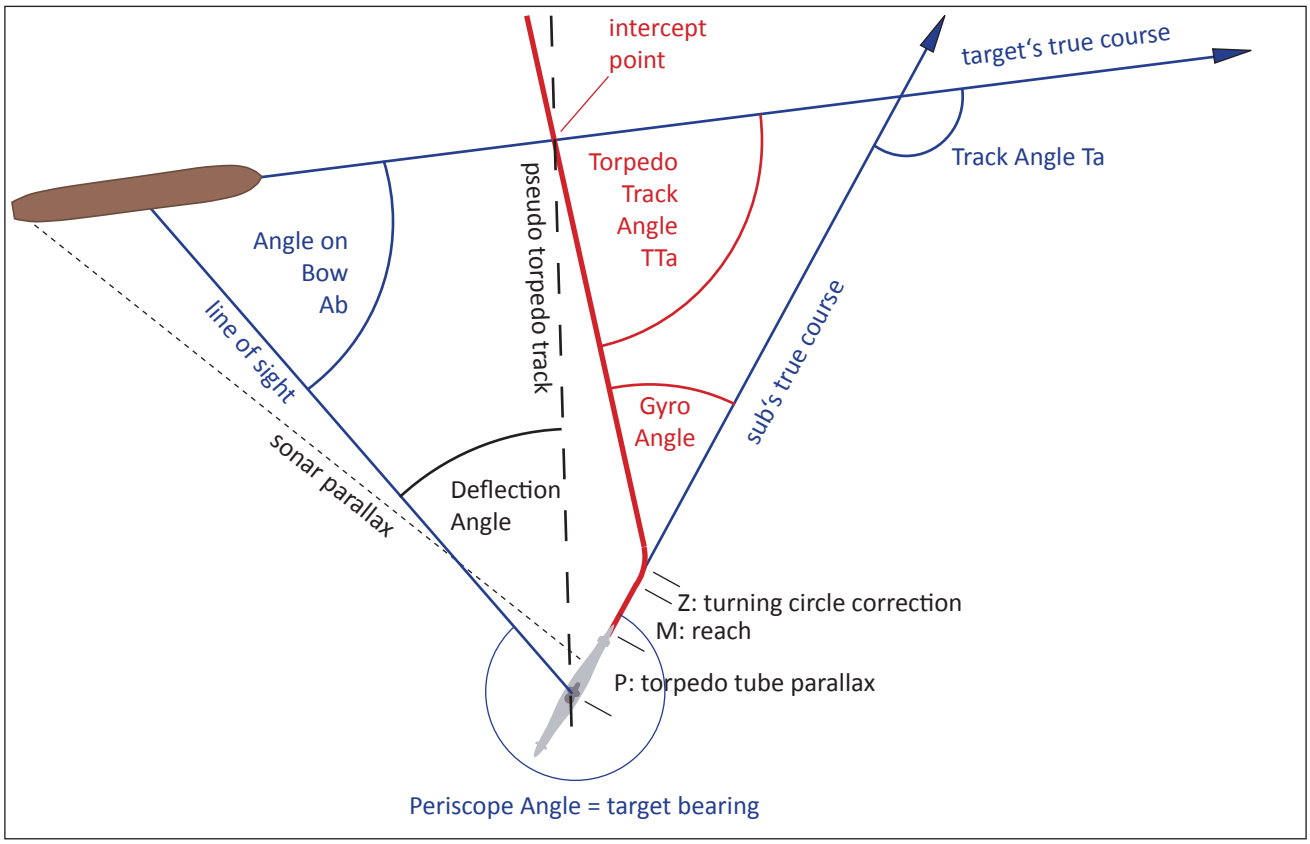
Wait and see. During the last minutes of waiting, use the periscope for a few seconds to verify that the target is still on course and that the speed has not changed. Never mind a few degrees or a few tenths of knots. If the error is substantial, apply
Corrections:
A - Range too small: use your motor. Do not get run over.
B - Speed has changed: TDC manual, change speed, TDC auto. Find new bearing for firing (Gyroangle = G)
C - Course has changed. Quick, do it again: measure Ta, calculate G, go through the 4 steps, find „fire" bearing

Do not forget to IDENTIFY the FLAG and to always LOWER the PERISCOPE after use.
When the target gets close to the magic bearing, open the torpedo tubes (Q).

Helmut „Nataraj" Saueregger, 2013-12-06

A closer view

A more detailed picture of the attack position can be seen here:



Target Bearing at Firing

The Gyroangle computed by the TDC takes into account the corrections P, M and Z shown in the above figure. Therefore the correct target bearing for a shot is slightly more „forward" than simply 360°-G / 0°+G.

Hydrophone Only ?

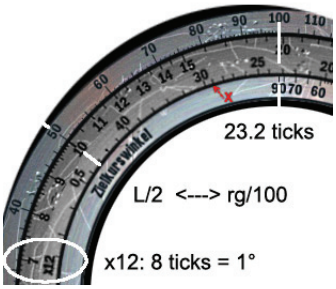
The hydrophone cannot provide accurate range information. But during the final minutes range will not change much, so after having verified flag, course and speed of the target, it is possible to lower the periscope and dive (no turning while diving!) and continue with hydrophone information only - if (!) the target remains on its course.

Apply the **„Sonar Parallax Correction"** (HNSA 120): near the end of the attack, the distance between the center of the target and its propellers is L/2. Without this correction, the shot is an almost certain miss!

The error is slightly greater than arctan(L/2rg), or approximately **3°** for a **100m target at range 1000m**.

Find the Sonar Parallax Correction using MaGui's Range and AoB Finder:

- Align L/2 on the outer ring („Basis") with range/100 on the moveable ring.
- Read the angle in „ticks" on the moveable ring above the 90° mark on the inner ring.
- Divide by 8 (Attack Periscope) or 4 (Observation periscope) to obtain the correction in degrees.



Example: align „50" (length/2) with „10" (range 1000m / 100) and read: 23.2 [ticks]
divide 23.2 [ticks] / 8 [ticks/°] = 2.9°