

10.0 Tides and Currents

knowledge of tides and how to predict them is essential in coastal waters to set a course and schedule a passage
prevent grounding
determine safe passage under bridges and power lines
Understand tidal currents
use the Canadian Tide and Current Tables enables

Tidal Definitions (see Figure 10.1)

Rising and Falling Tide	the vertical movement of water level due to the tide generating forces of the sun and moon.
Range	the difference in height between consecutive low and high tides.
Mean Tide Range	the difference between the heights of high water (HW) and low water (LW) at mean tides when the range is about average.
Large Tide Range	the difference between the heights of high and low water at large tides: usually, but not always, at spring tides. (See Figure 10.2).
Period	the time between successive high tides or successive low tides.
Stand	the short time interval at both high and low water (high water stand & low water stand) when the tide level seems to stand still-it is neither rising nor falling.
Neap Tides	low ranging tides associated with the moon at 1st and 3rd quarter (See Figure 10.2).
Spring Tides	large ranging tides associated with new and full moons (See Figure 10.2).

10.3 Forces that Cause the Tides

gravitational effects and relative motions of the sun, moon and earth
greatest effect is moon's gravitational pull
sun's effect is approximately half the force of the moon, but also affects tides on earth

Spring Tides (Large Tides)

earth, moon and sun are in line (in conjunction or in opposition) as in Figure 10.2
the effects are stronger and produce extra-high tides called spring tides (large tides)
nothing with the time of year
occur after a full moon and a new moon

Neap Tides

the moon/earth line is at 90° to the sun/earth line - quadrature (Figure 10.2)
Counteract each other
tides are lower

moon circles the earth 24h 50 m(avg)
lunar day approx 50 min longer than solar day
tides occur (avg) 50 m later each day
moon rises about 50 min later each night (vary with the time of year, latitude)

10.4 Classification of Tides

10.4.1 Semi-diurnal Tides

Ordinarily two high water levels during a tidal day (avg 24h 50m)

10.4.2 Diurnal Inequality

The two high tides are not necessarily equal
higher is Higher High Water (HHW)
low tides are usually of unequal height
lower is Lower Low Water (LLW)
other tides in the cycles are simply Lower High Water (LHW) and Higher Low water (HLW)
difference between HHW and LHW, or between LLW and HLW is known as diurnal inequality.

moon on elliptical orbit with varying distance between the earth
tidal ranges larger when moon is closest to earth at **perigee**
smaller when moon is farthest from earth at **apogee**
tidal ranges are slightly larger when the earth is closest to the sun at **perihelion**
tidal ranges are smaller when it is farthest at **aphelion**, six months later.

10.4.3 Diurnal Tide (topographical reasons) a single high water and a single low water each day
these stands are called High Water (HW) and Low Water (LW)

10.4.4 Mixed Tides

some places have both semi-diurnal and diurnal tides during lunar monthly cycle (29½ days)
mainly diurnal or mainly semi-diurnal (depending on which occurs more frequently)
peculiar to each specific location

10.5 Sources of Information

tide at various locations responds differently to tide-producing forces
nature of tide at any place determined by observation
predictions in tide tables and tidal data on nautical charts based on observations

tidal predictions made by analysing cyclic and local influences
detailed tables produced for limited number of places- **reference ports**
predictions for these places read directly from tables
other localities called **secondary ports** calculated by applying tabulated corrections to the data
for the appropriate reference port (Advanced Piloting)

Canadian Tide and Current Tables annually by Canadian Hydrographic Service
cover different coastal areas of Canada
Table 10.1, Point Atkinson July, August, September (from Vol 5 2006)
up to-date local Tide and Current Tables essential on board every vessel when cruising coastal
waters

Tide Tables use Standard Time must add 1hr to convert to Daylight Saving Time

10.5.2 Other Sources of Information

Local newspapers abbreviated Tide Table
Commercially published tables correct for daylight savings
Local radio stations, internet www.waterlevels.gc.ca/english/Canada.shtml
Weather reports may indicate an on-shore wind likely to increase the height of tides

10.6 Datum Measurements and Tides

Soundings show depths of water measured from chart datum
measured from lowest of several possible levels
heights are measured from highest of several possible levels
Title Block has the actual reference levels for a particular chart.

Tides rise and fall. Their vertical movement is typically measured from the Low Water chart datum.

Height of the Tide at any time = distance of the water surface from charted depth
depth of water at any time = height of tide + charted depths

Range of Tide = high water level - following low water
or between a low water level and the following high water
range also = HHW - LLW for the day
and = Higher High Water, Large Tide (HHWLT) which is the average of the highest high waters
over 19 years - Lower Low Water Low Tide (LLWLT) or Lowest Normal Tide for the location

Stand the interval of zero vertical water motion at the turn of the tide. At this time and height,
perceptible vertical water movement ceases and reverses. Thus we have HW Stand and
LW Stand

10.7 Practical Applications

barometric pressure changes and/or wind direction can profoundly affect depths of water in heavy weather, predicted tidal heights can vary by as much as 3 m (10 ft) or more boaters need to know the depth of water under the keel and if a rising or falling tide will change the depth appreciably during the stay to put out sufficient scope when at anchor

falling tide may leave insufficient water to avoid grounding. In addition, when tying up to a fixed dock or post, at dock sufficient line must be used to allow for a falling tide constant monitoring of the changing water level is required.

It may be possible only at close to high tide for a boat to pass over a shoal safely or a bridge may be so low that the boat can pass safely under it only at low tide.

Planned maintenance of the boat's bottom, rudder and propellers can be achieved easily for the duration of the low water, without reliance on shore facilities, if the fall of the tide is used to ground the boat in a safe manner.

10.7.1 To Determine the Height of the Tide

Tide Tables give the times and heights for highs and lows(see Table 10.1) to obtain the height of tide this course uses is the One Rule, where a graph is constructed gives a picture of the tidal curve and a better intuitive feeling for what the tide is doing boater needs to know how high the tide will be at a certain time or when the height of tide will produce a specific depth of water graphical method may be plotted well in advance of a trip, provide planning information

Graphic Method· the 1110 Range Rule

times and heights of high waters and low waters from Tide Tables graph will show the state of the tide at all times by means of a curve.

Figures 10.3 and 10.4 are for Point Atkinson, September 9, 2006

Procedure

1. Construct a graph on a piece of squared paper, setting out **height** of tide along the **left**-hand margin and the **time** (in hours), along the **bottom** margin. See Figure 10.3(a).
2. **Plot** the **high** water and **low** water levels and **connect** them by straight lines.
3. **Divide** each of these lines **into quarters**. Draw a short **vertical** line through each **first** and **third** quarter point. See Figure 10.3(b).
4. **Along** each **vertical** line **layoff one-tenth of the range, upwards** near a high water and **downwards** near a low water point. This will establish points through which to draw the sine curve. Use a graduated scale or ruler. Geometric precision is not necessary.

5. **Draw** a smooth **curve** through the **points established**, the mid-points, and the high water and low water points. Remember that the curve should pass horizontally through the high water and low water points. See Figure 10.4 for the finished example.

1. Calculate the height of the tide for the time required.
2. Subtract that height from the higher high water level of the day.
3. Determine the clearance of the bridge above higher high water
4. **Clearance is the sum of steps 1 and 2.**
5. **Add a safety factor of one metre** (three feet) to the height of the main mast.
6. The boat will pass safely under the overhead obstruction if the mast height is less than the available clearance (see Figure 10.5).

When calculating clearance under power lines, remember that 'sag' increases in hot weather.

Example 1:

There are several references regarding HHW in the Title Block of a chart. Using chart IC/CA 9996, in the Tidal Information block, HHW Large Tide at Pt. Atkinson is given as 5.0 m (16.4 ft.) above datum. The charted clearance of the bridge under which you wish to pass is given as 6.1 m (20 ft.).

Using Point Atkinson as the reference station, you have calculated the height of tide for the time that you wish to pass under the bridge as 2.1m (6.9 ft).

Water level below HHW LT is 5.0 m, minus height of tide for the time of day = $5.0\text{ m} - 2.1\text{ m} = 2.9\text{ m}$. Clearance = $6.1\text{ m} + 2.9\text{ m} - 1\text{ m}$ (for safety) = 8.0 m (26.2 ft.)

Example 2:

Water level below HHW LT is 16.4 ft, minus height of tide for the time of day $16.4\text{ ft.} - 6.9\text{ ft.} = 9.5\text{ ft.}$ Clearance = $20\text{ ft.} + 9.5\text{ ft.} = 29.5\text{ ft.} - 3\text{ ft.}$ (for safety) = 26.5 ft. (8.1 m).

10.8 Tidal Currents

Only British Columbia mariners need to know about calculating tidal currents at secondary current stations.

complex tidal current situations that exist on Canada's Pacific coast

Atlantic Canada may have the largest ranging tides in the world, 17 m (53 ft) at Burntcoat Head, NS

Canada's Pacific coast can boast of some of the fastest tidal currents

maximum **ebb** tidal stream in Nakwakto Rapids at the entrance to Seymour and Belize Inlets, BC, is about 16 knots. maximum **flood** stream is about 14 knots

Not to be left out, central Canada has the **only lake in the world** that has **tidal currents** at **Little Current** narrows **between Georgian Bay and Lake Huron**

all daily information for current stations are predictions

inaccuracies in predicting currents

meteorological influences

arrive at a current station at least 30 minutes before predicted time of slack

visual observation insures a safe time to travel hazardous areas.

Current Prediction Tables provide times of turn, directions, and rates (in knots) of maximum flood and ebb

10.8.2 Current Basics

Current is the horizontal movement of water

tidal currents (tidal streams) are horizontal movements of water produced when the tide rises or falls

hydraulic current occurs in certain passes where the times of Highs and Lows are different and consequently the heights of water at each end are continuously changing. The current flows from the higher level to the lower.

Direction - velocity of currents affect speed and course of a boat

maximum velocities may exceed the top speed of the vessel

current more significant to boater than tide height

10.8.3 Causes of Tidal Currents

rising tide flows toward land at an angle

irregularities in coastline, changing depths, interrupt the forward path tidal flow change

direction and rate creating currents

After a short pause and no horizontal movement of water, tidal current reverses, **ebbs back** towards the ocean

reversal of vertical height of water (stand) can occur several hours before or after reversal flow of water (slack)

Current Definitions

Slack Water (not stand) the short interval when tidal current stops and changes direction

slack water can be 2-3 hours before or after high or low water

better usage is **slack before ebb** and **slack before flood**

Turn	the instant when tidal current stops and starts flowing in the other direction (the time of slack water as listed in the Current Tables).
Flood	tidal currents moving toward shore or up a tidal estuary or river associated with a rising tide.
Ebb	tidal currents moving away from shore or out of a river or estuary associated with a falling tide.
Set	the true direction towards which the tidal current flows
Drift	the rate, in knots, at which the current flows

10.9 Sources of Current Information

predictions can be made for certain locations (movements observed for years)
currents not consistent along whole coastline because of irregularities
predictions for direction and rate of current good for only specified location.

flood and ebb are related tidal action therefore predictable timing.

semi-diurnal tide, four daily reverses of tidal current

diurnal tide two reverses

like times of tides, the times of the turns of tidal currents change daily

times of slack water seldom coincide with the times of High Water stand or Low Water stand

important to use official data for predictions

10.9.1 The Chart

current arrows on charts give general indication of tidal current, rate and direction of flood and ebb (Figure 10.6)

don't tell a boater when these events will occur

10.9.2 Tide and Current Tables

tables give current predictions for important passes (reference stations)

magenta chart symbol indicates locations where current data are tabulated in the Tides and Currents for area

Training Chart IC/CA 9996 near West Vancouver and Porlier Pass

For some other passes, time corrections for secondary stations are tabulated in the Tide and Current Tables.

10.9.3 Local Knowledge

local knowledge is required for unlisted passes
Information maybe in Small Craft Guide, Sailing Directions and Cruising Guides

10.10 Using Current Tables

essential to know the current's set and drift in areas of significant tidal current activity
must predict when slack water will occur
students are expected to be able to determine directly from the current table the times and directions of tidal current flow in certain locations, the maximum speed in knots of the current and when slack will occur

Turns		Maximum	
Day	Time	Time	Rate/kn.
8	0027	0414	- 4.9
	0751	1119	+ 7.2
	1529	1808	- 3.0
	2103	2310	+ 2.4

+ indicates flood - the flood current sets 030° True. - indicates ebb - the ebb current sets 210° True.
Table 10.2
Standard Time, Current Tables are valid for only one year (like Tide Tables)

Example: Porlier Pass, Saturday, July 8, 2006 The 'Turns' are the times of slack water
0027 slack before ebb
Shortly after ebb current begins flow, setting 210° True
0414 the ebb current achieves maximum rate 4.9 kn.
continues to 210° True at decreasing rate until 0751, time of slack before flood
nearly three hours later, flood current achieves maximum rate of 7.2 kn, setting at 030° True
after turn at 1529, second ebb of day, maximum 3.0 kn

10.11 Practical Considerations

10.11.1 Before Cruising in Tidal Waters

Get latest volume of the Tide and Current Tables for area
study chart and tables to see how the times of high and low tides and turns of tidal currents plotted course
Tidal Current Atlases are published by the Canadian Hydrographic Service for some areas
must be used with set of annual tables

10.11.2 Rules of Thumb for non Tabulated Areas

- **Ebb** current is usually **stronger** than flood it and lasts longer
- in **bays** and few rivers, tidal current is normally a **reversing** current
- where two bays meet, expect strong currents
- within about **one mile off shore**, both flood and ebb tend to set **parallel** to shore
- the change in rate is **greatest just after slack** water.
- **maximum** rate lasts for **about one-fifth** of the duration of the flow.
- **average rate** through the whole period of the flow is about **two thirds of the maximum** rate

10.11.3 Effects of Weather

waves higher when wind blows against the tidal stream, lower when blowing with the stream
stronger the opposing current and wind, the steeper the resulting wave
heights can increase by 50% to 100% in a 2 to 3 knot current
without wind, an incoming ocean swell against an ebbing tidal stream can be dangerous for a small boat
strong currents meeting a rough seabed in coastal waters can create tide rips with waves of unusual proportions
safest to cross these areas at or near slack water

10.12 Additional Current Terms

- Rip** An area of choppy turbulence where one current meets another, or where a rapid current passes over an irregular bottom, or where there are sudden changes in depth.
- Race** A swift current near a headland separating two bays.
- Bore** Where a river mouth is narrow and shallow, tidal water piles up until it breaks through and surges upstream in a wall of water. The best-known bore in Canadian waters occurs in the Petitcodiac River in New Brunswick.