



Tidal Prediction Worksheet (V 6.1)

Disclaimer and Terms of Use *Although the Tidal Prediction Worksheet (TPW) is set up with care, it may contain errors yielding wrong results. Therefore the author does not take any responsibility at all for the correctness of the computed results. Instead it is the user's sole responsibility when relying on the outcome of the TPW for navigation or any other purposes.*

Note: The TPW is only operational if these terms are accepted at the bottom of the worksheet.

General Calculating tidal data manually using some paper form is error-prone. Wrong results are often caused by arithmetic errors creeping in whilst performing tedious calculations, by read or clerical errors and by insertion of wrong data or of correct data in the wrong field of the paper form. The *Tidal Prediction Worksheet* (TPW) is an EXCEL 2010 based spreadsheet (EXCEL 2013 works as well) to calculate tidal data for ports using the *Admiralty Tide Table* (ATT) method. After insertion of data from the ATT, the tides at a secondary port are computed by the TPW. For calculating the time required for meeting a given height at a port and the height at a port at a given time, the tide curves of several standard ports are included in the TPW. For standard ports not supported by the TPW, time and height are estimated by a method similar to the *Rule of the Twelfths*. Alternatively, a user may obtain the required data from the tide curve of the ATT to insert it into the TPW. Further manual activities, like drawing diagrams etc., are not required.

The TPW not only relieves one from tedious calculations (thus avoiding arithmetic errors) and does not confuse the inserted data, but also performs several plausibility checks for detecting absurd user inputs. For instance, the height of a LW at a secondary port exceeding the height of the HW or the user statement of non-consecutive tides for calculating the time at a port to meet a given height is recognized by the TPW. In addition, the need for user activities are minimized whenever possible, e.g. by finding the appropriate HW and LW tides when calculating the height at a port at a given time.

For working with the TPW, familiarity with the ATT method for tide calculation is assumed. Tutorials and other material about this method may be found elsewhere.

Input and Results Data is inserted into the white and yellow fields of the TPW, where the yellow fields need (and must) not be filled when working with supported standard ports. Results are displayed in the blue fields. The purple fields display system messages. Some fields of the TPW carry comments displaying requirements for input fields and explanations for result fields. Comments are indicated by a small red triangle in the upper right corner of a field. Move the mouse pointer to a field for viewing its comment.

Type and Format of Data The TPW uses the following data types and formats:

- *Calendar date* is written as *DD.MM.YYYY* or as *YYYY-MM-DD*, where *DD*, *MM* and *YYYY* are unsigned integers denoting the number of the day, the month and the year respectively.
- *Duration Offset* is given as an unsigned integer in format [hhmm] satisfying $0 \leq hh \leq 2$ and $mm = 0$ or $mm = 30$.
- *Time Zone Offset* and *Local Time Offset* are given as signed integers in format [+/-hh00] for relating time-zone time with *Universal Time Coordinated* (UTC) and local time (LT) with time-zone time. The time-zone offset must satisfy $-12 \leq hh \leq +12$ and $-4 \leq hh \leq +4$ is demanded for the local time offset. Local times are displayed in italics to avoid confusion with time-zone time.
- 16 characters at most are allowed for the name of the *Standard Port* and of the *Secondary Port*.
- *Times* are written in format [+/-hhmm], where *hh* satisfying $-23 \leq hh \leq 23$ is a signed integer denoting hours and *mm* satisfying $0 \leq mm \leq 59$ is an unsigned integer denoting minutes. Negative times are displayed unsigned in red colour. *Time Differences* are written in format [+/-hhmm] with *hh* satisfying $-5 \leq hh \leq 5$.
- *Heights and Height Differences* are written as signed numbers where the unit is in meters. Negative heights are displayed signed in red colour. Heights may have two decimal positions at most and height differences one decimal position.
- *Age of Tide* as well as *Factor* is written as an unsigned number with two decimal positions at most, ranging from 0,00 to 1,00.
- *Barometric Pressure* is written as an unsigned integer between 963 and 1043 (where the unit is *hPa*).
- When writing numbers, the sign for the decimal separator as defined in the EXCEL options must be used. Usually the separator sign “,” of the operating system is selected. A leading “+”-sign as well as leading zeros may be omitted.

Warning (1) Usually data in wrong format is detected by the TPW, but some wrong inputs cannot be recognized as EXCEL internally converts certain ill-formed data into well-formed one. Therefore each value in an input field should be carefully inspected after insertion to verify that the value displayed is equal to the intended value. (2) EXCEL does not check input which is pasted into a cell instead of being typed in or pasted into the input line. Also data

formats may be changed if whole input cells are pasted. Therefore **cells must not be pasted into cells** as results may become wrong and the system might enter an inconsistent state.

Working with the TPW The TPW is organized into seven sections:

- (1) **Date, Age and Duration of Tide, Standard and Secondary Port, Time Zone & Local Time** Here the *Date*, i.e. the day of interest, the *Age of Tide*, the *Duration (offset)*, the *Standard* and the *Secondary Port*, the *Time Zone* and the *Local Time* offsets are noted.

If *Age of Tide* is left empty (recommended default), the spring curve of a *supported* standard port is used if the predicted range at that port is above the *Mean Range for Springs* (as noted in the tide curve diagram), and the neap curve is used if the predicted range is below the *Mean Range for Neaps*. Interpolation (based on the ATT method) is used in the remaining case yielding weights expressing to which degree the values of the spring and neap curve are considered when computing required time and height in Section 5. Interpolation may be replaced by a user specified weight N (where $0 \leq N \leq 1$) for the neap curve to be inserted into *Age of Tide* (giving $1 - N$ as the weight for the spring curve).

The TPW uses values for the *minimal* and the *maximal duration of rising tide* and similar values for *falling tide* to check user inputs for plausibility, i.e. to detect absurd data. The four values are obtained from the diagram for the spring and neap tides of a supported standard port (or commonly set to 6 hours for non-supported standard ports) and a subsequent adjustment by the *Duration (offset)*. Upon insertion of data in sections 2 and 3 (and computing results in Section 4) the TPW checks whether the times of HWs and LWs are in the time frame given by the duration values: An input is rejected if the time distance between two HWs or between two LWs is less than the *minimal duration of rising tide* plus the *minimal duration of falling tide* or is greater than the *maximal duration of rising tide* plus the *maximal duration of falling tide*. Input is also rejected, if the time distance between a HW and an adjacent LW on rising/falling tide is less than the *minimal duration of rising/falling tide* or is greater than the *maximal duration of rising/falling tide*. The preset value for *Duration* can be changed, if one feels that the rejection of an input by the duration checks is inappropriate for a certain tide time: More tides are accepted by an increase of the value for *Duration*. However, data given to the TPW (and the name of the standard port) should be compared with the data of the ATT before changing the *Duration* parameter.

The field for naming the *standard port* provides a pull-down menu which lists supported standard ports in alphabetic order. Either some port of the list is selected or the name of some non-supported standard port is written into the field. For facilitating selection, the area filter *Area of Standard Port (StP)* (one row above) may be used. This field provides a pull-down menu for the selection of a specific area. If the area filter contains a valid area, the pull-down menu for the standard port only shows the stan-

dard ports within this area. Otherwise all supported standard ports are shown. The name of the *secondary port* is inserted below the entry for the standard port.

The times of the ATT are used in the TPW *without time conversion*. The *time-zone offset* must not be omitted and should be set such that the *time-zone of the standard port* is obtained. A time-zone offset of *-100*, for instance, yields time-zone *UTC+1* (i.e. the time-zone of Western Europe except for Portugal, Ireland and the UK). Displayed times do not change when changing the time-zone (offset). The *local time offset* should be set such that the local time of the standard port is obtained. For instance, *+100* is used in Western Europe when daylight saving time (DST) is to be respected. Local times are not displayed, if the local time offset is omitted. Local time is calculated relative to time-zone time and vice versa. Consequently the displayed local times change when changing the local time offset. All times in the TPW are inserted and calculated in time-zone time, except when *LT* explicitly is mentioned for a field (then requiring or displaying local time).

- (2) **Tide at Standard Port (StP)** The times and heights of the HW and LW tides at the day of interest must be obtained from the ATT and inserted here. At most two HW and two LW tides can be entered, where a HW/LW time must be placed into a HW/LW field and the earlier HW/LW time must be inserted above the later one. The corresponding heights are placed in the same row one column right of the time entry. All HW/LW times inserted as *non-negative* integers are displayed in black colour and belong to the same day (which is to be documented in Section 1 as the day of interest). It may be necessary, however, to consider also tides which belong to an adjacent day: When sailing in the early morning, the last tide(s) at the previous day may be required. The time of such a tide is inserted as a *negative* integer and displayed unsigned in red colour thus indicating that this tide belongs to the previous day. Likewise the first tide of the following day may be needed when sailing in the late night. In such a case, the day of interest has to be moved one day forward, the time of the morning tide is inserted as a *non-negative* integer and the time of the evening tide previous to the morning tide then is given as a *negative* one.

The blue rows below display the tides at standard port in *local time*. Tides shown in black colour belong to the day of interest, tides displayed in red colour occur at the previous day and tides belonging to the day following the day of interest are denoted by blue colour.

- (3) **Differences at Secondary Port (SeP)** The values needed for computing the tidal data for the secondary port must be looked up in the ATT and inserted here:
- *Time at Standard Port and Time Diffs at Secondary Port:* The ATT provides two pairs of HW/LW times (for the standard port) as well as a time difference (for the secondary port) for each of the four time-pairs. The time-pairs and their associated differences are inserted into the columns of the TPW in the same order as given in

the ATT (the pair starting with the earlier HW/LW time in the column left of the pair starting with the later HW/LW time; the earlier time of a pair above the later one). Times (for the standard port) which are not required for calculating a tide at the secondary port may be omitted, however without violating the order in which the remaining times are presented in the ATT.

- *Spring and Neap MHW/MLW at Standard Port and Height Diff's at Secondary Port:* The values for MHWs, MHWn, MLWn and MLWS at a supported standard port are displayed in the blue row. The symbol "X" is displayed instead of values for a supported standard port to which no secondary port is assigned. For non-supported standard ports, the symbol "—" is displayed instead of values which then have to be obtained from the ATT to be inserted into the yellow row below the blue one. In either case, the corresponding height differences for the secondary port (obtained from the ATT as well) are inserted into the white row below the yellow one.

(4) **Tide at Secondary Port (SeP)** For each *Tide at Standard Port* given in Section 2, the corresponding tide at the secondary port is displayed in terms of time and height in time-zone time as well as in local time, provided the entry *Secondary Port (SeP)* in Section 1 is not empty and the required data is provided in Section 3. Tides displayed in black colour belong to the day of interest, tides shown in red colour occur at the previous day and tides belonging to the day following the day of interest are denoted by blue colour. Results failing the plausibility tests are annotated with hints (see *System Messages* below). An appropriate message instead of a value is displayed in a result field when some required data is missing.

(5) **Required Time & Height at Standard/Secondary Port** The left sub-section displays the time which is required to meet a given height at the *Port of Interest*, i.e. the standard or the secondary port. The right sub-section shows the height which is expected at a given time at the *Port of Interest*. In this section also times belonging to the day following the day of interest may be inserted. Those times are given as non-negative integers, and the system then determines whether the day of interest (time displayed in black colour) or the following day (time displayed in blue colour) is the appropriate.

The results are calculated for (a secondary port assigned to) a supported standard port either in *ATT* or in *ATT+* mode: When working in *ATT+* mode (keep *Scaling* entry cleared), the time scale of the tide curve is adjusted to the duration of the actual rising/falling tide. This mode is the recommended default as the quality of results computed in *ATT+* mode improves the more the duration of the actual rising/falling tide differs from the fixed duration of the tide curve. The factors for adjusting the time scales are displayed under *Spring|Neap Curve Scaling*, where a factor < 1 stretches the time scale and a factor > 1 shrinks it. Alternatively one may work in *ATT* mode (by insertion of "no" into the *Scaling* field) for using the fixed time scales of the tide curves. The weights assigned to the spring and neap curve values for respecting the age of tide

can be seen under *Spring|Neap Curve Interpolation*. Interpolation may be replaced by a user specified weight N (where $0 \leq N \leq 1$) for the neap curve to be inserted into the *Age of Tide* field of Section 1 (giving $1 - N$ as the weight for the spring curve).

For non-supported standard ports the result values are *estimated*. The estimation uses the squared *cosine* function as a substitute for the tide curve. This corresponds to the use of the *Rule of the Twelfths*, where however the values of the squared *cosine* function are computed instead of being approximated. If the *Scaling* entry is cleared, the duration of the actual rising/falling tide is used and a fixed 6 hour interval is assumed by insertion of "no" into the *Scaling* field. Like for the original *Rule of the Twelfths*, the quality of the estimation strongly depends on the shape of the tide curve, where the quality decreases the more the shape of the tide curve deviates from the shape of the squared *cosine* function. More reliable results are obtained by inspecting the tide curve in the ATT, where a set square is needed to get the required values from the curve for inserting them into the yellow fields of the TPW. See the comments of these input fields to learn how to proceed.

- (6) ***Under Keel & Masthead Clearance*** Here the results of the former sections are applied to calculate under keel and masthead clearances when the height of tide is given. Alternatively the height of tide required for meeting a given clearance may be displayed. For computing clearances or heights respectively, the barometric pressure may (but need not) be taken into account. Any pressure between 963 hPa and 1043 hPa can be inserted into the respective field. A fixed height increase of 0,5 m is assumed for a pressure between 963 hPa and 973 hPa. Between 973 hPa and 983 hPa a decrease/increase of 1 hPa causes a height increase/decrease of 0,02 m. A height increase/decrease of 0,01 m is assumed for a decrease/increase of 1 hPa for pressures between 983 hPa and 1043 hPa. However, a more significant effect for the height of the water level usually is caused by wind stresses on the surface of the water. An estimate of the in- or decrease of the water level caused by wind may (but need not) be inserted into the *Wind Tide* field. Finally, it is good practice to calculate with a safety margin which also may (but need not) be inserted into the respective input field.
- (7) ***Remarks*** Any text not exceeding 225 characters may be inserted here.

System Messages The TPW provides two kinds of messages:

1. User input is checked for certain requirements and is rejected if some of these are not satisfied. An error window pops up in this case displaying a list of possible causes for the rejection. In addition a message may be displayed in the purple field of the *System Log* (situated between sections 2 and 3 as well as sections 5 and 6) giving additional information about the rejection. Some of these messages are preceded by the number of the section in which the problem occurs.

User input is rejected for the following reasons:

- Data does not satisfy the presentation order given for sections 2 and 3, e.g. when an earlier HW time is placed below the later one.
- Data cannot be processed because it is not in the required format, e.g. when a text is inserted where a number is expected.
- User input seems to be absurd and must be corrected, e.g. if the height of a LW at a standard port exceeds the height of a HW or the time of a tide violates the requirements given by the duration values.
- An input field is filled with a value which might become obsolete by changing another input value and therefore must be cleared before the change. For instance, the field of "Time HW at Pt LT" must be cleared in Section 5 before the time of a HW is changed in Section 2.
- An input field is filled with a value which may require a change when changing the value of another field. For instance, if the time of a HW is to be changed, the value for the height of this HW may become false and must be cleared before. By this requirement a partial change of data for a tide by mistake shall be avoided.

Only *possible* causes for a rejection are listed in the error window. Often fields are designated which must be cleared before accepting an input, where fields already cleared may be listed as well. Different to that, the cause of a rejection displayed in the *System Log* is *definitive*. The *System Log* not only displays a message in reaction of a user input but may also provide a message if an input field is cleared (no error window pops up in this case). Each input is rejected as long as a message is displayed in the *System Log* and therefore the problem causing the message must be resolved before continuing with an input.

2. Plausibility tests are also performed for calculated data. This is needed because absurd results may be computed although the user input seems to be reasonable as it passed the tests. It may happen, for instance, that the height of a LW at the secondary port exceeds the height of a HW although the heights of the LWs at the standard port all are below the heights of the HWs (and therefore some wrong height differences for the secondary port might have been used). If a test fails for some result of Section 4,

the calculated value *cannot be used* in Section 5 but is annotated with a hint in the corresponding result field:

- If the time distance between two HWs/LWs is less than the *minimal duration of rising tide* plus the *minimal duration of falling tide*, the times of these tides are annotated with arrows pointing to each other.
- If the time distance between two HWs/LWs is greater than the *maximal duration of rising tide* plus the *maximal duration of falling tide*, the times of these tides are annotated with arrows pointing away from each other.
- If the time distance between a HW and a LW on rising/falling tide is less than the *minimal duration of rising/falling tide*, the times of these tides are annotated with arrows pointing to each other.
- If the time distance between a HW and an adjacent LW on rising/falling tide is greater than the *maximal duration of rising/falling tide*, the times of these tides are annotated with arrows pointing away from each other.
- If the height of a LW exceeds the height of a HW, an inequation $H \leq L$ is displayed in both result fields, where H is the value calculated for the height of the HW and L is the height computed for the LW.

The result fields may also display messages when something other went wrong, and the cause for such a message then is explained in the comment of the respective field.

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