LOSS PREVENTION

Tides

SHIPOWNERS

SECURITY FOR SMALL & SPECIALIST VESSELS

The information and recommendations in this booklet are given in good faith and are meant to highlight best practices, good seamanship and common sense to reduce incidents that result in related claims. However, Members must take into consideration the guidance and regulatory requirements given by Flag states and other governing authorities when formulating policy in line with the contents of this publication.

NOT TO BE USED FOR NAVIGATION

Foreword

The Shipowners' Club provides P&I insurance for small and specialised vessels and, as such, the majority of our vessels trade in coastal waters. The fine technique of calculating tides is a very important aspect of voyage planning and is a crucial factor in determining whether passage through a particular waterway is safe or not.

Our analysis of the claims' causation has highlighted the fact that many grounding claims could have easily been avoided by simply following this basic technique.

The purpose of this booklet is to allow the seafarer to have a better understanding on how to perform the tidal calculations. We have included many solved examples as well as practice questions hoping that it will give a better understanding on the subject.

This booklet is one of three publications in a series and it is envisaged that together they will help eliminate some of the difficulties that befall those not so well versed in marine navigation.

We remain forever indebted to Captain H. Subramaniam for compiling this booklet series for us. Captain Subramaniam was a distinguished member of the nautical fraternity in a career spanning over 6 decades, including over 30 years of teaching experience. Apart from this series, he also authored eight textbooks on the operation of merchant ships which continue to be used by seafarers across the globe. It was his ability to put a subject across in a nutshell that made all his books easy to understand and helpful to those these are intended for.

Contents

Chapter 1

Tides: Theory and Definitions

What are Tides?

Tides are the rise and fall of sea levels caused by the gravitational forces of the moon and the sun.

Some Tidal Terms

High Water and Low Water

When the water level is at its highest, it is called High Water (HW) and when it is lowest, Low Water (LW).

Tidal range

The difference in level between HW and LW is called the range of tide or tidal range, expressed in metres.

Flooding and ebbing

When the water level is rising, it is called flood tide or flooding, and when decreasing, ebb tide or ebbing.

Tidal interval

The interval between HW and LW is usually between six and seven hours. Hence most coastal areas experience two HWs and two LWs per day.

Spring tides

During a full moon and new moon, the sun, moon, and the earth are in line. Hence the gravitational forces of the sun and moon complement each other and the tidal range is very high. This phenomenon is called spring tide (figure 1). Spring tides occur every two weeks.

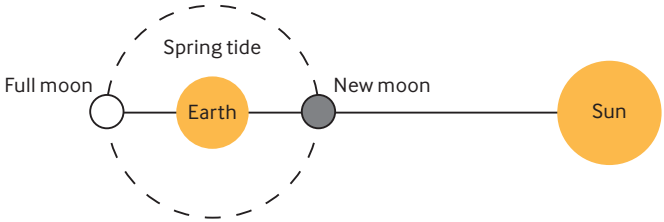


Figure 1

Neap tides

Midway between full moon and new moon, the moon and sun are 90° apart when seen from the earth. Their gravitational forces oppose each other and the tidal range is small. This phenomenon is called neap tide (figure 2). This occurs every two weeks.

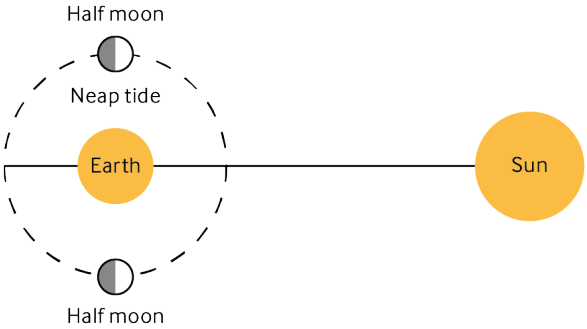


Figure 2

Tidal stream

A tidal stream is the direction and rate of movement of the sea surface due to the tide, wind and shape of adjoining coast.

Chart datum (CD)

CD is the water level at which all the depths shown on the charts would be correct. This is the lowest level of water expected in that area and is usually the level at LAT (Lowest Astronomical Tide) or MLWS (Mean Low Water Springs).

Tide tables would take this level as zero and any height of tide calculated would be above this chart datum. If at a particular location the charted depth is 5m, and the height of tide was calculated to be 1.2m, the actual depth of water at that location, at that time, would be 6.2m.

In rare cases, the tide can fall below chart datum. It is then given a minus sign. If at a particular location the charted depth is 4m, and the height of tide was calculated to be -0.3m, the actual depth of water at that location, at that time, would be 3.7m.

Semi-diurnal nature
Diurnal means daily. Since, in nearly all ports in the world, one cycle of tide (one HW and one LW) occurs every 12 hours or so, tides are termed semi-diurnal.

Mean spring range
This is the height difference between Mean Low Water Springs (MLWS) and Mean High Water Springs (MHWS).

Mean neap range
This is the height difference between Mean Low Water Neaps (MLWN) and Mean High Water Neaps (MHWN).

Tidal information
The times and heights of HW and LW for each day of the year are given in Port tide tables, Regional tide tables, and Admiralty tide tables (ATT).

Port tide tables
Many ports publish their own tide tables annually.

Regional tide tables
Regional hydrographic offices may publish tide tables for the ports listed therein, annually.

Chapter 2

Tides: Calculation of Height of Tide at a Given Time

Admiralty tide tables are published annually in eight volumes:
Volume 1 – The UK and Ireland (including European Channel Ports)
Volume 2 – North Atlantic Ocean and Arctic Regions
Volume 3 – Indian Ocean (including tidal stream tables)
Volume 4 – South Pacific Ocean (including tidal stream tables)
Volume 5 – South China Sea and Indonesia (including tidal stream tables)
Volume 6 – North Pacific Ocean (including tidal stream tables)
Volume 7 – South West Atlantic Ocean and South America
Volume 8 – South East Atlantic Ocean, West Africa and Mediterranean (including tidal stream tables)

To make the ATT volumes less bulky, the ports are classed into standard ports and secondary ports.

Standard ports
Important ports in the area covered by each volume of ATT are designated as standard ports. The daily times and heights of HW and LW and details for calculating the times or heights in between are also provided.

Secondary ports
A large number of less important ports in the area covered by each volume of ATT are designated as secondary ports. Data for each secondary port is based on a standard port nearby such that the times and heights of HW and LW are obtained by applying a time and height difference to those at the standard port.

Such calculation is avoided by consulting the tide tables published by the port, or by the regional hydrographic office, wherein the daily times and heights of HW and LW are listed directly for each port.

To find height or time between tabulated values
The height of tide at a given time, or the time when a given height of tide occurs, can be obtained using tidal curves given in the ATT. The curves are of two types – port specific curves and general curves. Many standard ports in Europe have a page showing tidal curves for that specific port. For other ports, a set of general curves is provided.

Calculation using port-specific curves
Find the height of tide at Flushing in Europe at 1530 LT on 10 March of the year 20YY.

Step 1: Identify the appropriate ATT and open to the page of the given port
In this case, it is ATT for the year 20YY Volume 1: The UK and Ireland (including European Channel Ports).

Look at the Index to standard ports on the inside of the front cover (Appendix 1), locate Flushing, and open to that page (figure 3).

Step 2: Compute the bracketing range and tidal interval
Locate the bracketing tides on that day (figure 4). Required time: 1530 LT. Bracketing range = 4.4–0.3 = 4.1m. Tidal interval = 1735–1146 = 5h 49m.

Step 3: Draw sloping line near curves of the port
On the left side of the curves of that port locate the bracketed HW (4.3m) and LW (0.3m) heights and join them with a straight line as shown by a green line in figure 4.

Step 4: Draw vertical line at required time
Required time: 1530 LT. Bracketed HW time: 1735 LT. Time difference = 2h 5m before HW. Draw a vertical line at 2h 5m before HW to meet the curves, as shown by the red line in figure 4.

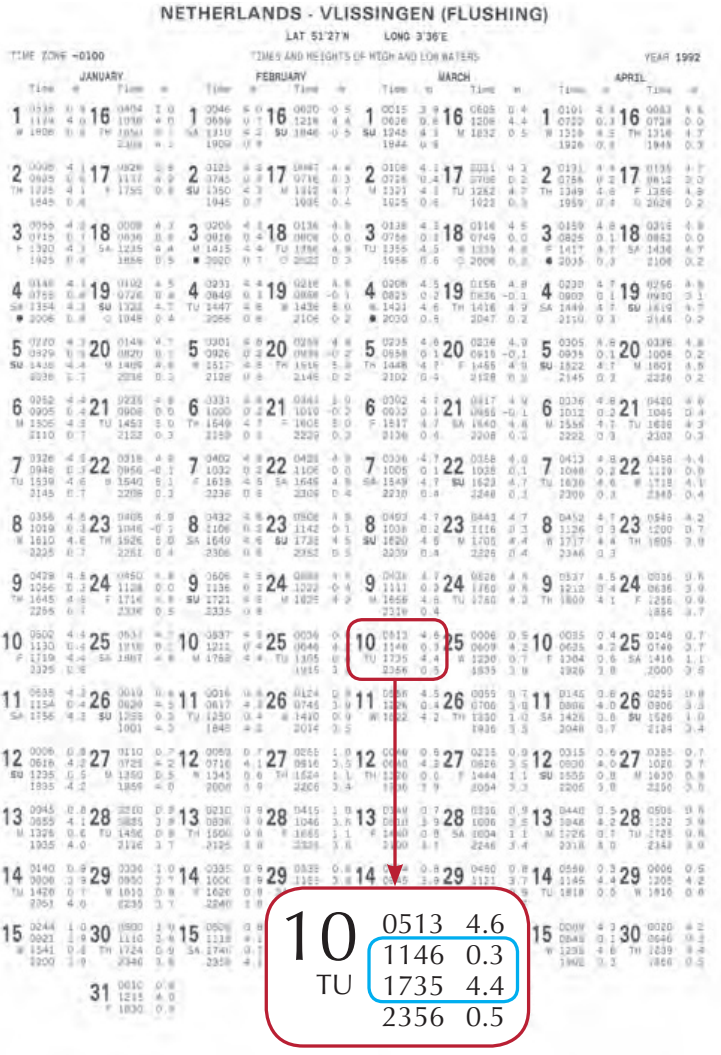

NETHERLANDS - VLISSINGEN (FLUSHING)
LAT 51°27'N LONG 3°36'E
TIME ZONE -0100
TIMES AND HEIGHTS OF HIGH AND LOW WATERS
YEAR 1992
JANUARY
FEBRUARY
MARCH
APRIL
10
TU
0513 4.6
1146 0.3
1735 4.4
2356 0.5

Figure 3

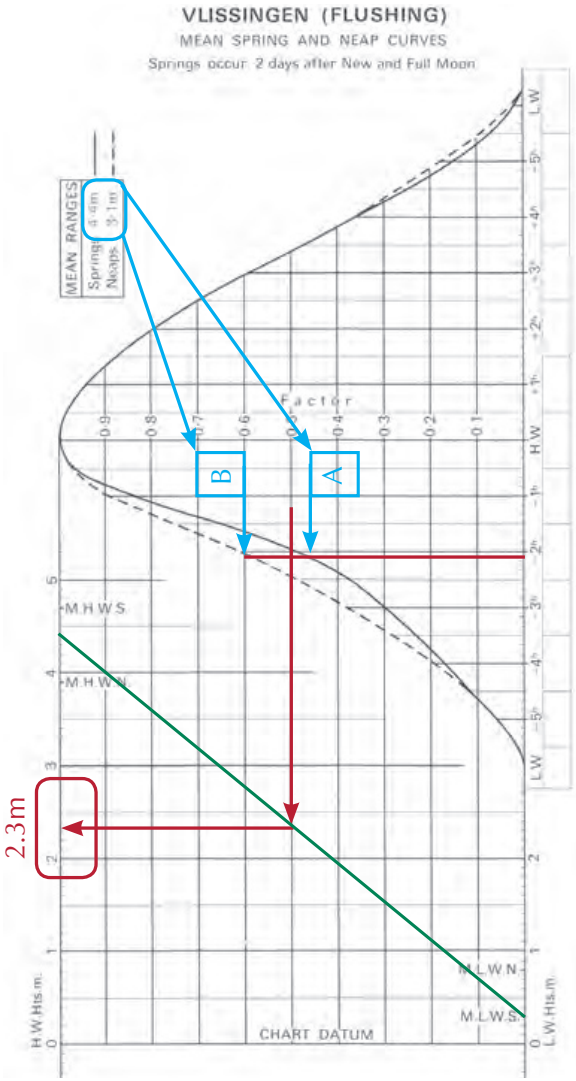

VLISSINGEN (FLUSHING)
MEAN SPRING AND NEAP CURVES
Springs occur 2 days after New and Full Moon
MEAN RANGES
Spring 4·4m
Neaps 3·1m
Factor
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
B
A
H.W
L.W
M.H.W.S
M.H.W.N
M.L.W.N
M.L.W.S
CHART DATUM
H.W.Hts.m.
L.W.Hts.m.
2.3m

Figure 4

Step 5: Draw horizontal line

Note the points, marked as A and B in blue colour in figure 4, where the 2h 5m vertical red line meets the Mean Spring Range curve and the Mean Neap Range curve.

The firm curve is for mean spring range of	4.4m
The dotted curve is for mean neap range of	3.1m
Bracketed range from step 2	4.1m

Interpolate visually on the graph for 4.1m range between point A (for 4.4m range) and point B (for 3.1m range) and draw a horizontal line, as shown in red colour in figure 4, to meet the sloping green line.

From the point of intersection, draw a vertical line, as shown in red colour in figure 4, and obtain the height of tide above chart datum.

Step 6: State your answer

The height of tide at Flushing in Europe at 1530 LT on 10 March 20YY = **2.3m above chart datum**.

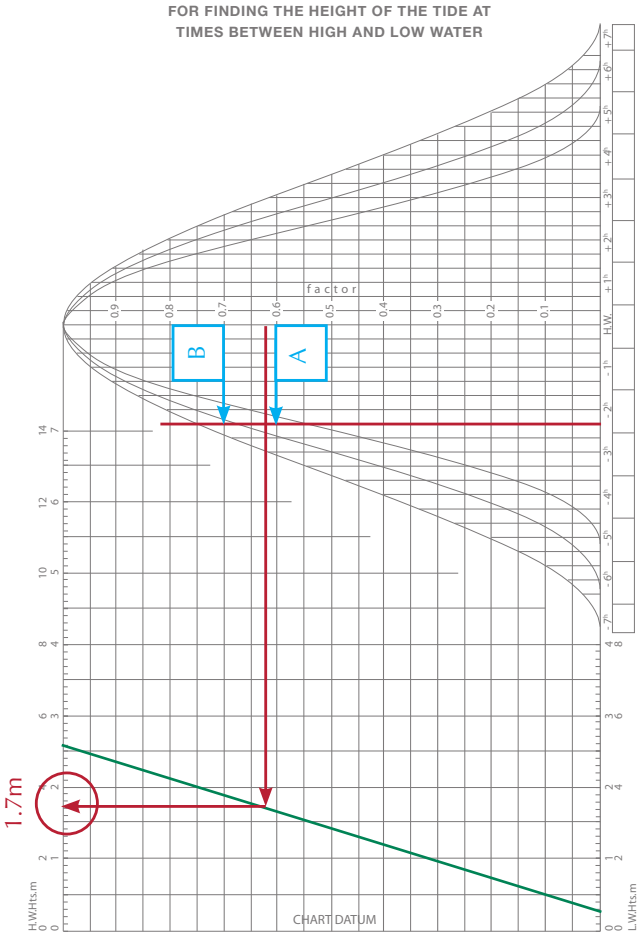

FOR FINDING THE HEIGHT OF THE TIDE AT
TIMES BETWEEN HIGH AND LOW WATER
factor
B
A
H.W.
1.7m
H.W.Hts.m
L.W.Hts.m
CHART DATUM

Figure 5

Calculation using general curves

Find height of tide at Singapore at 2300 LT on 6 April 20YY.

Step 1: Identify the appropriate ATT and open page of the given port

In this case, it is ATT for the year 20YY Volume 5: South China Sea and Indonesia (including tidal stream tables). Look at the index to standard ports on the inside of the front cover (Appendix 5), locate Singapore, and open to that page.

Note 1: The extracted values are given in step 2.

Note 2: There are no specific curves given for Singapore. You have to use a common set of curves given in the beginning of the tide tables which are suitable for tidal intervals between 5 hours and 7 hours. These are reproduced in Appendix 10.

Step 2: Compute the bracketing range and interval

Required time: 6 April 2300 LT. Bracketing tides are:

Date	Time (LT)	Height (m)
6 April	1916	0.3
7 April	0130	2.6

Bracketing range 2.3m and tidal interval 6h 14m.

Step 3: Draw sloping line near the curves

On the left side of the general curves locate the bracketed HW and LW heights and join them with a straight line shown by a green line in the graph, as shown in figure 5.

Step 4: Draw vertical line at required time

Required time: 6 April 2300 LT. Bracketed HW time: 7 April 0130 LT.

Time difference = 2h 30m before HW. Draw a vertical line at 2h 30m before HW to meet the curves, as shown by the red line in figure 5.

Step 5: Draw horizontal line

There are three curves: -5, -6 and -7 hours. Bracketing tidal interval is 6h 14m before HW.

Note the points A and B in figure 5 where the 2h30m vertical red line meets the 6h curve and the 7h curve.

Interpolate visually on the graph for 6h 14m between the points A and B and draw a horizontal line, as shown in figure 5, to meet the sloping green line.

From the point of intersection, draw a vertical line, as shown in red colour in figure 5, and obtain the height of tide.

Step 6: State your answer
Height of tide at Singapore at 2300 LT on 6 April 20YY = **1.7m above chart datum**.

Test yourself
Computing height of tide
Answers are given after each question. Worked solutions in detail are given on subsequent pages.

Question 1
Find height of tide at Dover (UK) at 1130 UT on 28 February of the year 20YY, using the extracts given below and the curve in Appendix 8:

Date	Time (UT)	Height (m)
28 February 20YY	0731	5.0
28 February 20YY	1437	2.3

Answer: 3.6m above chart datum.

Question 2
Find height of tide at Le Havre (France) at 0900 LT on 22 January 20YY, using the extracts given below and the curve in Appendix 9:

Date	Time (LT)	Height (m)
22 January 20YY	0726	0.9
22 January 20YY	1226	8.2

Answer: 5.0m above chart datum.

Question 3
Find height of tide at Tianjin Xingang (China) at 1400 LT on 17 April 20YY, using the extracts given below and the curves in Appendix 10:

Date	Time (LT)	Height (m)
17 April 20YY	1013	0.5
17 April 20YY	1606	4.0

Answer: 3.0m above chart datum.

Question 4
Find the height of tide at Cape Town (South Africa) at 1100 LT on 16 April 20YY using the extracts given below and the curves in Appendix 10:

Date	Time (LT)	Height (m)
16 April 20YY	0850	0.2
16 April 20YY	1458	1.8

Answer: 0.6m above chart datum.

Question 5
Find height of tide at Bhavnagar (India) at 0300 LT on 20 March 20YY using the extracts given below and the curves in Appendix 10:

Date	Time (LT)	Height (m)
20 March 20YY	0042	1.2
20 March 20YY	0548	10.4

Answer: 5.0m above chart datum.

Solutions on computing height of tide

Question 1
Find height of tide at Dover (UK) at 1130 UT on 28 February of the year 20YY, using the extracts given below and the curves in Appendix 8:

Date	Time (UT)	Height (m)
28 February 20YY	0731	5.0
28 February 20YY	1437	2.3

Step 1: Identify the appropriate ATT and open to the page of the given port
In this case, it is ATT for the year 20YY Volume 1: The UK and Ireland (including European Channel Ports).

Look at the Index to Standard Ports on the inside of the front cover (see Appendix 1), locate Dover (UK), and open to that page.

Step 2: Compute the bracketing range and tidal interval
Required time: 1130 UT. Bracketing tides:

Date	Time (UT)	Height (m)
28 February 20YY	0731	5.0
28 February 20YY	1437	2.3

Bracketing range = 5.0–2.3 = 2.7m. Bracketing tidal interval = 1437–0731 = 07h 06m.

Step 3: Draw sloping line near the curves of the port
On the left side of the curves of that port locate the bracketed HW (5.0m) and LW (2.3m) heights and join them with a straight line as shown by a green line in figure 6.

Step 4: Draw vertical line at required time
Required time: 1130 UT. Bracketed HW time: 0731 UT. Time difference = 3h 59m after HW. Draw a vertical line at 3h 59m after HW to meet the curves, as shown by the red line in figure 6.

Step 5: Draw horizontal line
Important Note: The point where the 3h 59m vertical red line meets the tidal curve. In this case the Mean Spring Range curve and the mean Neap Range curve are the same. From this point, draw a horizontal line, as shown in red colour in figure 6, to meet the sloping green line.

From the point of intersection, draw a vertical line, as shown in red colour in figure 6, and obtain the height of tide above chart datum.

Step 6: State your answer
The height of tide at Dover (UK) at 1130 UT on 28 Feb 20YY = **3.4m above chart datum**.

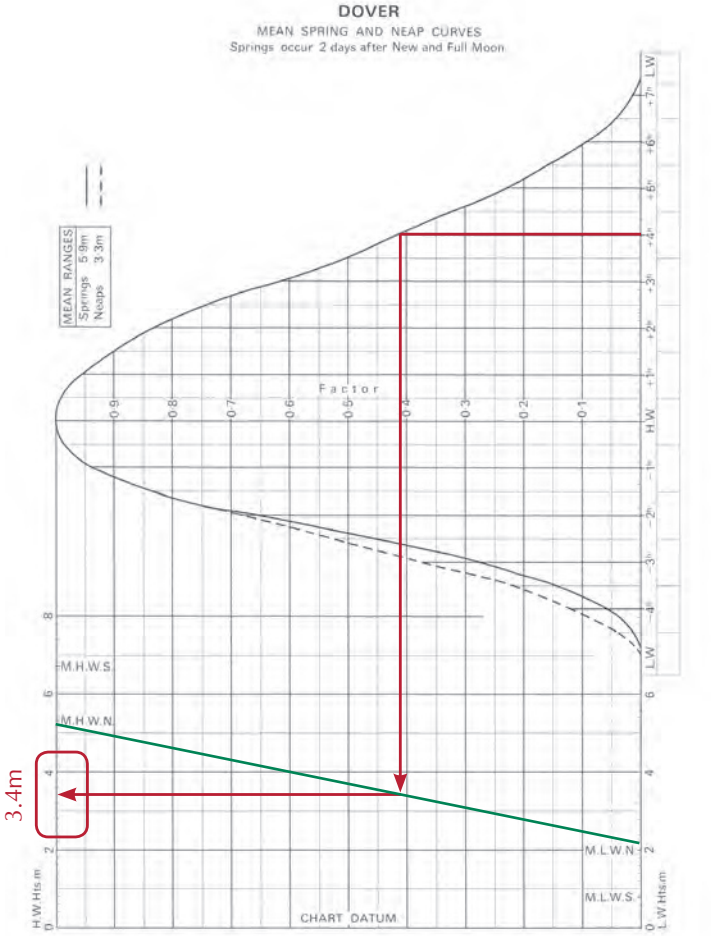

DOVER
MEAN SPRING AND NEAP CURVES
Springs occur 2 days after New and Full Moon
MEAN RANGES
Springs 5.9m
Neaps 3.3m
Factor
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
H.W.
L.W.
M.H.W.S.
M.H.W.N.
M.L.W.N.
M.L.W.S.
CHART DATUM
H.W.Hts.m
L.W.Hts.m
3.4m

Figure 6

Question 2

Find the height of the tide at Le Havre (France) at 0900 LT on 22 January 20YY, using the extracts given below and the curves in Appendix 9:

Date	Time (LT)	Height (m)
22 January 20YY	0726	0.9
22 January 20YY	1226	8.2

Step 1: Identify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 2: North Atlantic Ocean and Arctic Regions, Mediterranean Sea and Atlantic Ocean. Look at the Index to Standard ports on the inside of the front cover (Appendix 2), locate Le Havre, and open to that page.

Step 2: Compute the bracketing range and tidal interval

Required time: 0900. Bracketing tides:

Date	Time (LT)	Height (m)
22 January 20YY	0726	0.9
22 January 20YY	1226	8.2

Bracketing range = 8.2–0.9 = 7.3m. Tidal interval = 1226–0726 = 5h 00m.

Step 3: Draw sloping line on curves of the port

On the left side of the curves of that port locate the bracketed HW (8.2m) and LW (0.9m) heights and join them with a straight line as shown by a green line in figure 7.

Step 4: Draw vertical line at required time

Required time: 0900 LT. Bracketed HW time: 1226 LT.

Time difference = 3h 26m before HW. Draw a vertical line at 3h 26m before HW to meet the curves, as shown by the red line in figure 7.

Step 5: Draw horizontal line

The firm curve is for mean spring range of	6.7m
The dotted curve is for mean neap range of	3.6m
Bracketed range from step 2	7.3m

Note: Bracketed range is 7.3m which is more than the mean spring range of 6.7m

Extrapolation is not allowed. Hence use only the mean spring curve in this case.

From the point where the 3h 26m vertical red line meets the mean spring range curve of 6.7m, draw a horizontal line, as shown in red colour to meet the sloping green range as shown in figure 7.

From the point of intersection, draw a vertical line, as shown in red colour in the graph, and obtain the height of tide.

Step 6: State your answer
The height of tide at Le Havre (France) at 0900 LT on 22 January in the year 20YY = **5.0m above chart datum**.

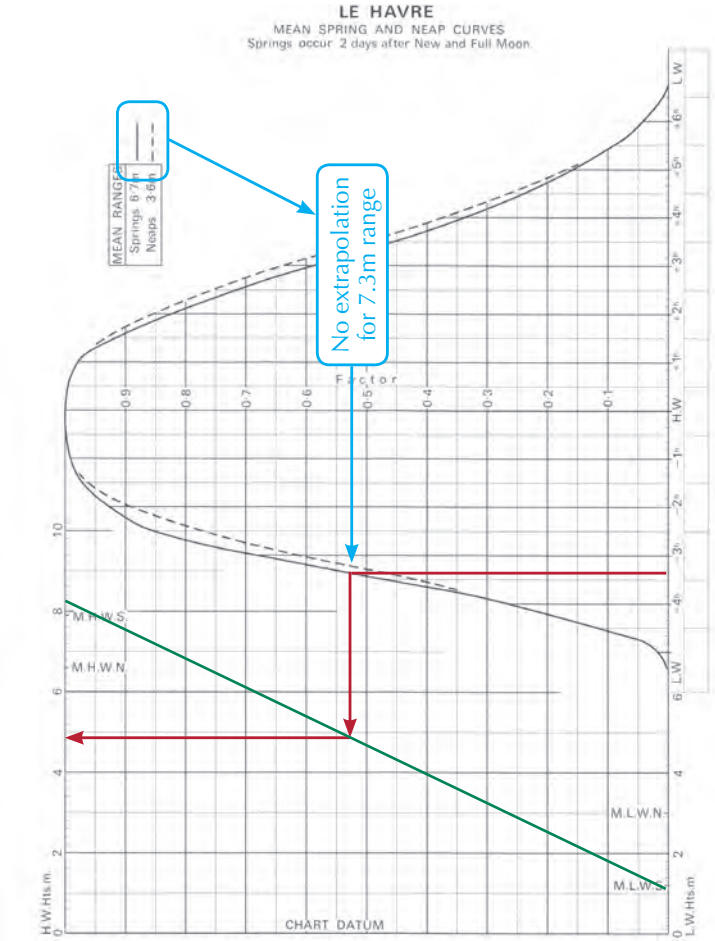

LE HAVRE
MEAN SPRING AND NEAP CURVES
Springs occur 2 days after New and Full Moon
MEAN RANGES
Springs 6·7m
Neaps 3·6m
No extrapolation for 7.3m range
Factor
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
H.W
L.W
M.H.W.S.
M.H.W.N.
M.L.W.N.
M.L.W.S.
CHART DATUM
H.W.Hts.m.
L.W.Hts.m.

Figure 7

Question 3

Find height of tide at Tianjin Xingang (China) at 1400 LT on 17 April 20YY, using the extracts given below and the curves in Appendix 10:

Date	Time (LT)	Height (m)
17 April 20YY	1013	0.5
17 April 20YY	1606	4.0

Step 1: Identify the appropriate ATT and open to the page of given port.

In this case, it is ATT for the year 20YY Volume 6: North Pacific Ocean (including tidal stream tables). Look at the index to standard ports on the inside of the front cover (Appendix 6), locate Tianjin Xingang, and open to that page.

> **Note**: There are no specific curves given for Tianjin Xingang. You have to use a common set of curves given in the beginning of the tide tables which are suitable for tidal intervals between 5 hours and 7 hours.

Step 2: Compute the bracketing range and interval

Required time: 17 April, 1400 LT. Bracketing tides:

Date	Time (LT)	Height (m)
17 April 20YY	1013	0.5
17 April 20YY	1606	4.0

Bracketing range 3.5m and tidal interval 5h 53m.

Step 3: Draw sloping line on curves
On the left side of the general curves locate the bracketed HW and LW heights and join them with a straight line as shown by a green line in figure 8.

Step 4: Draw vertical line at required time
Required time: 17 April 20YY, 1400 LT. Bracketed HW time: 1606 LT.

Time difference = 2h 06m before HW. Draw a vertical line at 2h 06 before HW to meet the curves, as shown by the red line in figure 8.

Step 5: Draw horizontal line
There are three curves: -5, -6 and -7 hours. Bracketing tidal interval is 5h 53m.

Note the points where the 2h 06m vertical red line meets the 5h curve and the 6h curve.

Interpolate visually on the graph for 5h 53m between the 5h and 6h curves and draw a horizontal line, as shown in figure 8, to meet the sloping green line.

From the point of intersection, draw a vertical line, as shown in red colour in figure 8, and obtain the height of tide.

Step 6: State your answer
Height of tide at Tianjin Xingang (China) at 1400 LT on 17 April 20YY = **3.0m above chart datum**.

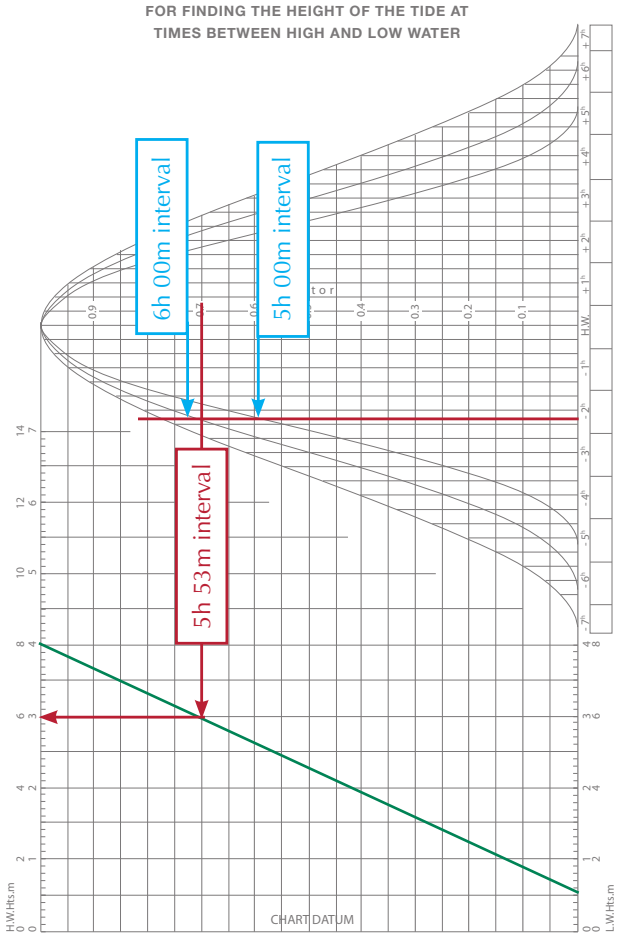

FOR FINDING THE HEIGHT OF THE TIDE AT
TIMES BETWEEN HIGH AND LOW WATER
6h 00m interval
5h 00m interval
5h 53m interval
H.W.Hts.m
L.W.Hts.m
CHART DATUM

Figure 8

Question 4

Find the height of tide at Cape Town (South Africa) at 1100 LT on 16 April 20YY using the following extracts and the curves in Appendix 10:

Date	Time (LT)	Height (m)
16 April 20YY	0850	0.2
16 April 20YY	1458	1.8

Important note: There are no specific curves given for Cape Town. You have to use a common set of curves given in the beginning of the tide tables which are suitable for tidal intervals between 5 hours and 7 hours.

Step 1: Identify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 8: South East Atlantic Ocean, West Africa and Mediterranean (including tidal stream tables).

Look at the index to standard ports on the inside of the front cover (Appendix 7), locate Cape Town (South Africa), and open to that page.

Step 2: Compute the bracketing range and interval

Required time: 16 April 1100 LT. Bracketing tides:

Date	Time (LT)	Height (m)
16 April 20YY	0850	0.2
16 April 20YY	1458	1.8

Bracketing range 1.6m and tidal interval 6h 08m.

Step 3: Draw sloping line on curves
On the left side of the general curves locate the bracketed HW and LW heights and join them with a straight line as shown by a green line in figure 9.

Step 4: Draw vertical line at required time
Required time: 1100 LT. Bracketed HW time: 1458 LT.

Time difference = 3h 58m before HW. Draw a vertical line at 3h 58m before HW to meet the curves, as shown by the red line in figure 9.

Step 5: Draw horizontal line
There are three curves: -5, -6 and -7 hours. Bracketing tidal interval is 6h 8m before HW. Note the points where the 3h 58m vertical red line meets the 6h curve and the 7h curve.

Interpolate visually on the graph for 6h 8m between the 6h and 7h curves and draw a horizontal line, as shown in red colour in figure 9, to meet the sloping green line.

From the point of intersection, draw a vertical line, as shown in red colour in figure 9, and obtain the height of tide.

Step 6: State your answer
The height of tide at Cape Town (South Africa) at 1100 LT on 16 Apr 20YY = **0.6m above chart datum**.

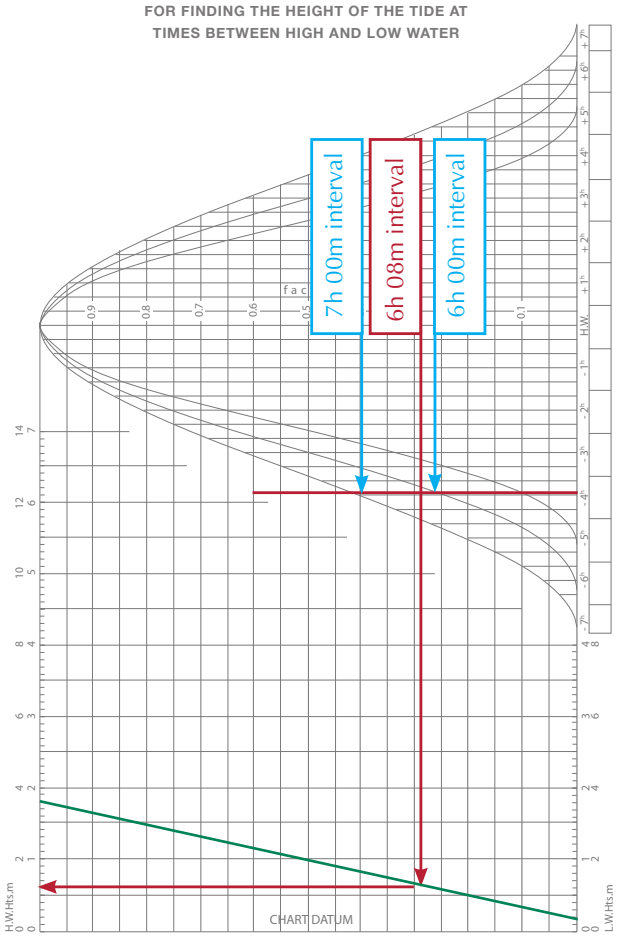

FOR FINDING THE HEIGHT OF THE TIDE AT
TIMES BETWEEN HIGH AND LOW WATER
7h 00m interval
6h 08m interval
6h 00m interval
f a c
0.9
0.8
0.7
0.6
0.5
0.1
H.W.
H.W.Hts.m
L.W.Hts.m
CHART DATUM

Figure 9

Question 5

Find height of tide at Bhavnagar (India) at 0300 LT on 20 March 20YY using the extracts given below and the curves in Appendix 3:

Date	Time (LT)	Height (m)
20 March 20YY	0042	1.2
20 March 20YY	0548	10.4

Important note: There are no specific curves given for Bhavnagar. You have to use a common set of curves given in the beginning of the Tide Tables which are suitable for tidal intervals between 5 hours and 7 hours.

Step 1: Identify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 3: Indian Ocean (including Tidal stream tables). Look at the Index to Standard Ports on the inside of the front cover (Appendix 3), locate Bhavnagar, and open to that page.

Step 2: Compute the bracketing range and interval

Required time: 20 March, 0300 LT. Bracketing tides:

Date	Time (LT)	Height (m)
20 March 20YY	0042	1.2
20 March 20YY	0548	10.4

Bracketing range 9.2m and tidal interval 5h 06m.

Step 3: Draw sloping line on curves

On the left side of the general curves locate the bracketed HW and LW heights and join them with a straight line as shown by a green line in figure 10.

Step 4: Draw vertical line at required time

Required time: 0300 LT. Bracketed HW time: 0548 LT. Time difference = 2h 48m before HW. Draw a vertical line at 2h 48m before HW to meet the curves, as shown by the red line in figure 10.

Step 5: Draw horizontal line

There are three curves: -5, -6 and -7 hours. Bracketing tidal interval is 2h 48m before HW. Note the points where the 2h 48m vertical red line meets the 5h curve and the 6h curve.

Interpolate visually on the graph for 5h 6m between the 5h and 6h curves and draw a horizontal line, as shown in figure 10, to meet the sloping green line.

From the point of intersection, draw a vertical line, as shown in red colour in figure 10, and obtain the height of tide.

Step 6: State your answer

Height of tide at Bhavnagar (India) at 0300 LT on 20 March 20YY = **5.0m above chart datum**.

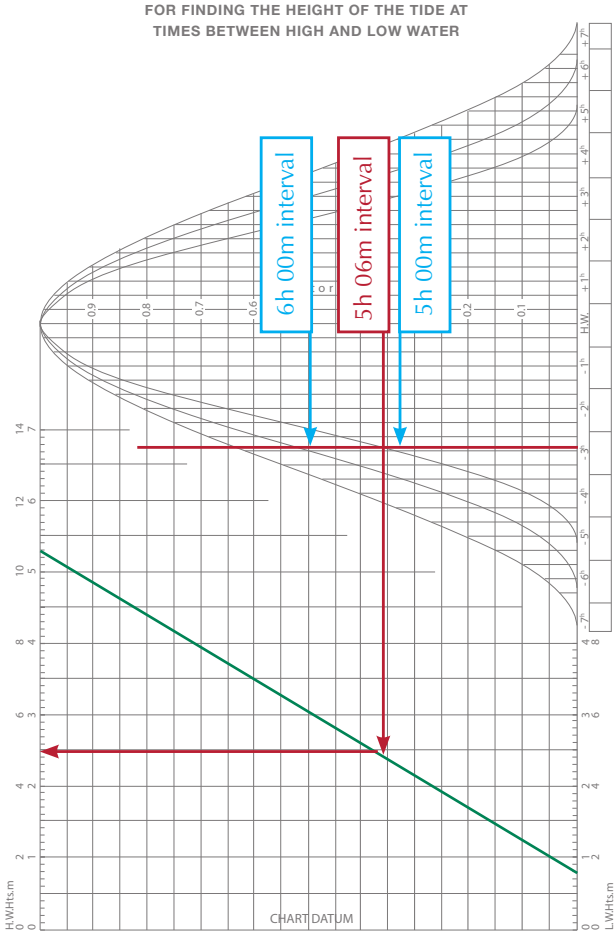


Figure 10

Depth of water = Charted depth + height of tide above CD

Depth of water = Draft of ship + under keel clearance

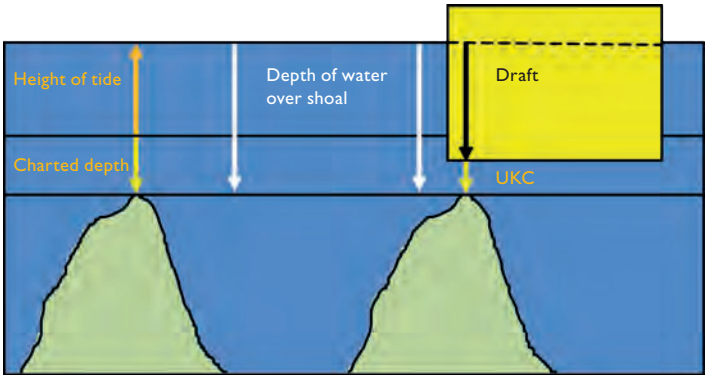


Figure 11

Calculation using port-specific curves

Find the earliest time on the afternoon of 9 January 20YY, at Flushing in Europe, when your ship with 5.5m draft aft can cross a bar marked 3.0m on the chart with UKC (Under Keel Clearance) of 1.0m.

If your ship is delayed by a couple of hours, how late can you cross the bar?

Note: 'Earliest time' indicates rising tide - there is insufficient height of tide 15 minutes earlier but it has now risen to level needed. Similarly, 'latest time' would indicate falling tide.

Chapter 3

Tides: Calculation of Time for a Given Height of Tide

Preliminary calculation

DRAFT	5.5m
UKC	1.0m
Required depth	6.5m
Charted depth	3.0m
Required height of tide	3.5m

Step 1: Identify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 1: The UK and Ireland (including European Channel Ports). Look at the index to standard ports on the inside of the front cover (Appendix 1), locate Flushing, and open to that page (figure 12).

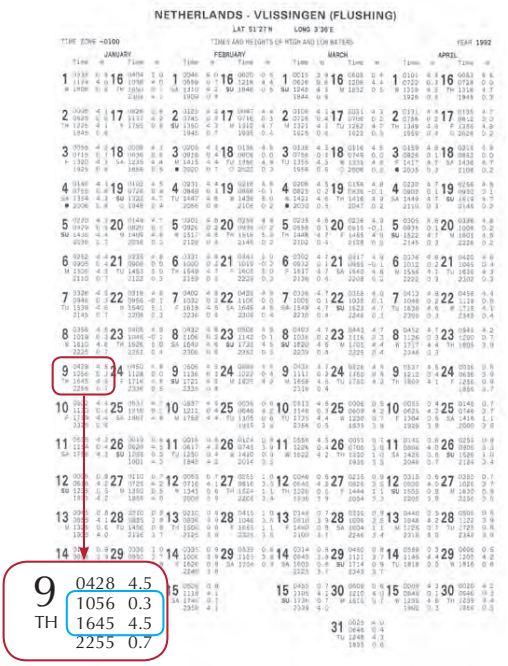


Figure 12

Step 2: Compute the bracketing range and tidal interval

Locate the bracketing tides on that day (figure 12). Required: Afternoon, rising tide, height of 3.5m.

Date	Time (LT)	Height (m)
9 January 20YY	1056	0.3
9 January 20YY	1645	4.5

Bracketing tides: Range 4.2m; tidal interval 5h 49m.

Step 3: Draw sloping line on curves of the port

On the left side of the curves of that port locate the bracketed heights – HW 4.5m and LW 0.3m and join them with a straight line as shown by a green line in figure 13.

Step 4: Draw vertical and horizontal lines

Required height of tide: 3.5m. Draw a vertical line at 3.5m to meet the sloping green line. From the point of intersection, draw a horizontal line, as shown in red colour in figure 13, across the curves for rising tide.

Step 5: Draw vertical line at appropriate curve and compute time

The firm curve is for mean spring range of	4.4m
The dotted curve is for mean neap range of	3.1m
Bracketed range from step 2	4.2m

Note the points where the horizontal red line meets the mean spring range curve of 4.4m and the mean neap range curve of 3.1m as shown in blue colour in figure 13.

Interpolate visually in figure 13 for 4.2m range between the curves for 4.4m and 3.1m and draw a vertical line, as shown in red colour in figure 13. Read off the interval before HW and compute the required time which is 1h 20m before HW in this case. Required time = 1645 – 1h 20m = 1525 LT.

Step 6: State your answer

The earliest time on the afternoon of 9 January 20YY, at Flushing in Europe, when your ship drawing 5.5m at the after end can cross a bar marked 3.0m with UKC (Under Keel Clearance) of 1.5m is 1525 LT.

If your ship is delayed by a couple of hours:

Extend the horizontal line in step 4 to meet the falling tide. From the point of intersection, draw a vertical line, as shown by blue dotted lines in figure 13, and read off the time interval. In this case it is 02h 10m after HW. Latest time = 1645 + 2h 10m = 1855 LT.

Answer: If your ship is delayed by a couple of hours, you can still cross the bar up to **1855 LT**.

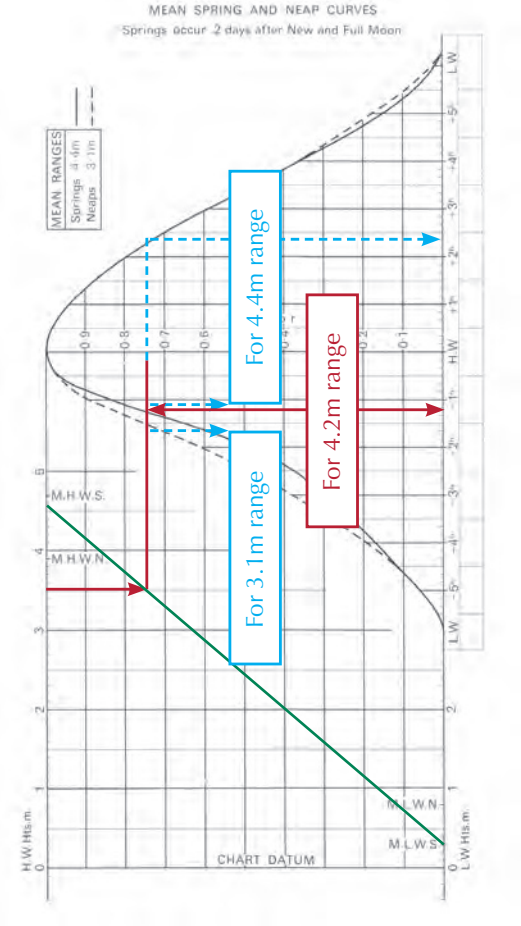


Figure 13

Calculation of time using general curves

Find the latest time on the afternoon of 19 January 20YY, at Boston (USA east coast), when your ship drawing 3.5m at the after end can cross a bar marked 2.0m on the chart with UKC (Under Keel Clearance) of 1.0m, using the following extracts and the curves given in appendix 7.

Date	Time	Height (m)
19 January 20YY	1009	3.6m
19 January 20YY	1636	-0.5m

Note: 'Latest time' indicates falling tide - there is sufficient height of tide at the calculated time, but after 15 minutes it is too shallow. So tide is falling. Similarly, 'earliest time' would indicate rising tide.

Preliminary calculation

DRAFT	3.5m
UKC	1.0m
Required depth	4.5m
Charted depth	2.0m
Required height of tide	2.5m

Step 1: Identify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 2: North Atlantic Ocean and Arctic Regions. Look at the index to standard ports on the inside of the front cover (Appendix 2), locate Boston, and open to that page. For convenience, the extract for that day is given in the question and is used in step 2.

Note: There are no specific curves given for Boston. You have to use a common set of curves given in the beginning of the Tide Tables which are suitable for tidal intervals between 5 hours and 7 hours. These are reproduced in Appendix 10.

Step 2: From the bracketing tides on that day, obtain tidal interval and range
Required: Afternoon, falling tide, height of 2.5m.

Bracketing tides:

Date	Time	Height (m)
19 January 20YY	1009	3.6m
19 January 20YY	1636	-0.5m

Tidal interval is 6h 27m and range is 4.1m

Note: The minus sign indicates that the tide is below chart datum.

Step 3: Draw sloping line on general curves
On the left side of the curves, locate the bracketed HW and LW heights and join them with a straight line as shown by a green line in figure 14.

Step 4: Draw vertical and horizontal lines
Required height of tide: 2.5m. Draw a vertical line at 2.5m to meet the sloping green line. From the point of intersection, draw a horizontal line, as shown in red colour in figure 14, across the curves for falling tide.

Step 5: Draw vertical line at appropriate curve and compute answer
Bracketed tidal interval = 6h 27m. Note the points where the horizontal red line meets the 6h and the 7h curves as shown in blue colour in figure 14.

Interpolate visually in figure 14 for 6h 27m between the curves for 6h and 7h and draw a vertical line, as shown in red colour in figure 14. Read off the interval after HW and compute the required time which is 2h 10m after HW in this case. Required time = 1009 + 2h 20m = 1229 LT.

Step 6: State your answer
The latest time on the afternoon of 19 January 20YY, at Boston (USA east coast), when your ship drawing 3.5m at the after end can cross a bar marked 2.0m on the chart with UKC of 1.0m is **1229 LT**.

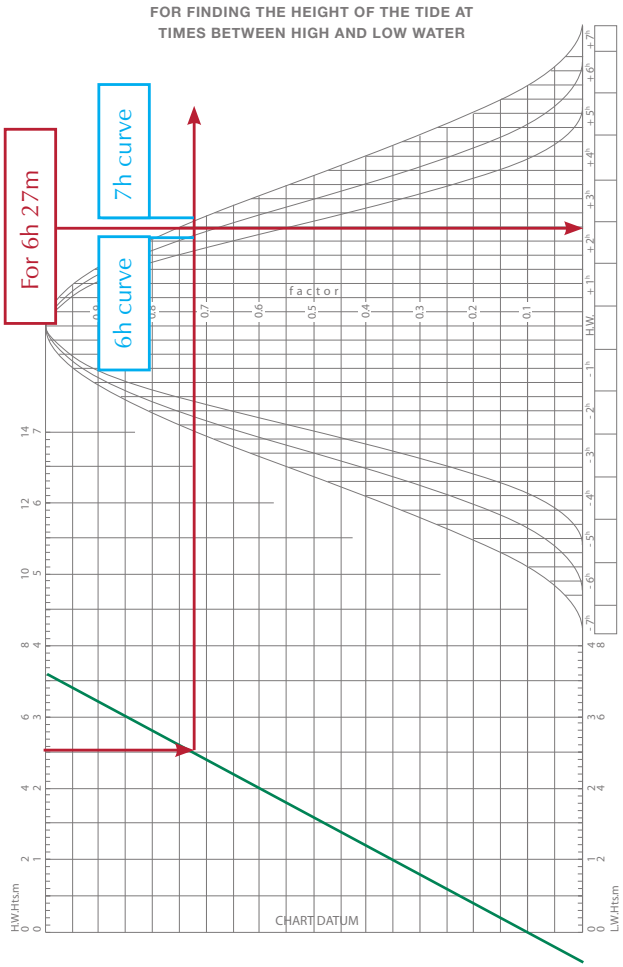

FOR FINDING THE HEIGHT OF THE TIDE AT
TIMES BETWEEN HIGH AND LOW WATER
For 6h 27m
7h curve
6h curve
factor
H.W.
CHART DATUM
H.W.Hts.m
L.W.Hts.m

Figure 14

Test yourself

Computing required time

Answers are given after each question. Worked solutions in detail are given in subsequent pages.

Question 1

On the very early hours of 3 April 20YY, at Sheerness (England), find the latest time when your ship drawing 5.0m can sail over a bar marked 2.5m on the chart with UKC of 0.5m, using the curve in Appendix 11 and the tidal extracts below:

Date	Time (LT)	Height (m)
3 April 20YY	0027	5.6m
3 April 20YY	0645	0.6m

If the ship is ready to sail earlier by a few hours, what is the earliest time that it can sail?

Answer: Latest 0312 LT on 3 April. Earliest 2107 LT on 2 April.

Question 2

On the afternoon of 4 March 20YY, at Lisbon (Portugal), find the latest time when your ship drawing 4.5m can sail over a bar marked 3.0m on the chart with UKC of 1.5m, using the curve in Appendix 12 and the tidal extracts below:

Date	Time (LT)	Height (m)
4 March 20YY	1524	3.6m
4 March 20YY	2051	0.7m

Answer: 1704 LT.

Question 3

Your ship expects to complete loading at 1800 LT on 6 January 20YY, at Kuwait (Mina Al Ahmadi) with draft aft of 6.5m. Find the earliest time you can sail out with UKC of 1.0m over a bar marked 5.0m on the chart, using the curves in Appendix 10 and the tidal extracts below:

Date	Time (LT)	Height (m)
6 January 20YY	1820	1.7m
7 January 20YY	0005	2.9m

Answer: 2235 LT on 6 January.

Question 4

Your ship expects to complete loading at 0500 LT on 17 February 20YY, at Twin Island, Torres Strait, (Australia) with draft of 5.5m. Find the earliest time you can sail out with UKC of 1.5m over a bar marked 4.0m on the chart, using the curves in Appendix 10 given the tidal extracts below:

Date	Time (LT)	Height (m)
17 February 20YY	0535	0.2m
17 February 20YY	1138	3.7m

Answer: 0958 LT.

Question 5

Your ship expects to arrive at Elephant Point, Rangoon River (Myanmar) at 0200 LT on 16 April 20YY, with draft of 5.0m aft. Find the latest time you can pass over a bar with UKC of 1.0m over a bar marked 2.0m on the chart, using the curves in Appendix 10 given the tidal extracts below:

Date	Time (LT)	Height (m)
16 April 20YY	0246	6.0m
16 April 20YY	0912	0.9m

Answer: 1202 LT.

Detailed solutions on computation of time

Question 1

On the very early hours of 3 April 20YY, at Sheerness (England), find the latest time when your ship, drawing 5.0m, can sail over a bar marked 2.5m on the chart with UKC of 0.5m, using the curve in Appendix 11 and the tidal extracts below:

Date	Time (LT)	Height (m)
3 April 20YY	0027	5.6m
3 April 20YY	0645	0.6m

If the ship is ready to sail a few hours earlier, what is the earliest time that it can sail?

Note: 'Latest time' indicates falling tide and earliest, rising tide.

Preliminary calculation

DRAFT	5.0m
UKC	0.5m
Required depth	5.5m
Charted depth	2.5m
Required height of tide	3.0m

Step 1: Identify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 1: The UK and Ireland (including European Channel Ports).

Look at the index to standard ports on the inside of the front cover (Appendix 1), locate Sheerness, and open to that page. For convenience, data from that page is given in the question and used in step 2.

Step 2: Extract the bracketing tides and compute the range and tidal interval

Required: very early morning, falling tide, height of 3.0m. Bracketing tides:

Date	Time (LT)	Height (m)
3 April 20YY	0027	5.6m
3 April 20YY	0645	0.6m

Bracketed tidal interval 6h 18m, range 5.0m.

Step 3: Draw a sloping line on the curves of the port
On the left side of the curves of that port locate the bracketed HW and LW heights and join them with a straight line as shown by the green line in figure 15.

Step 4: Draw vertical and horizontal lines
Required height of tide: 3.0m. Draw a vertical line at 3.0m to meet the sloping green line. From the point of intersection, draw a horizontal line, as shown in red colour in figure 15, across the curves for **falling** tide.

Step 5: Draw a vertical line at the appropriate curve and compute the time

The firm curve is for mean spring range of	5.1m
The dotted curve is for mean neap range of	3.3m
Bracketed range from step 2	5.0m

Note the points where the horizontal red line meets the mean spring range curve and the mean neap range curve. In this case there is only one curve on the falling tide.

At the point of intersection, draw a vertical line, as shown by the red colour in figure 15. Read off the interval after HW and compute the required time which is 2h 45m after HW in this case. Required time = 0027 + 2h 45m = 0312 LT.

Step 6: State your answer
On the very early hours of 3 April 20YY, at Sheerness (England), the latest time when your ship drawing 5.0m can sail over a bar marked 2.5m on the chart with UKC of 0.5m is 0312 LT.

If ready to sail a few hours earlier:
From the point where the horizontal line in step 5 crosses the rising tide, draw a vertical line as shown by the blue dotted line in figure 5, and read off the interval before HW. In this case it is 03h 20m before HW.

The ship can sail as early as: 0027 - 0320 = 2107 on 2 April.

Answer: Earliest time 2107 LT on 2 April.

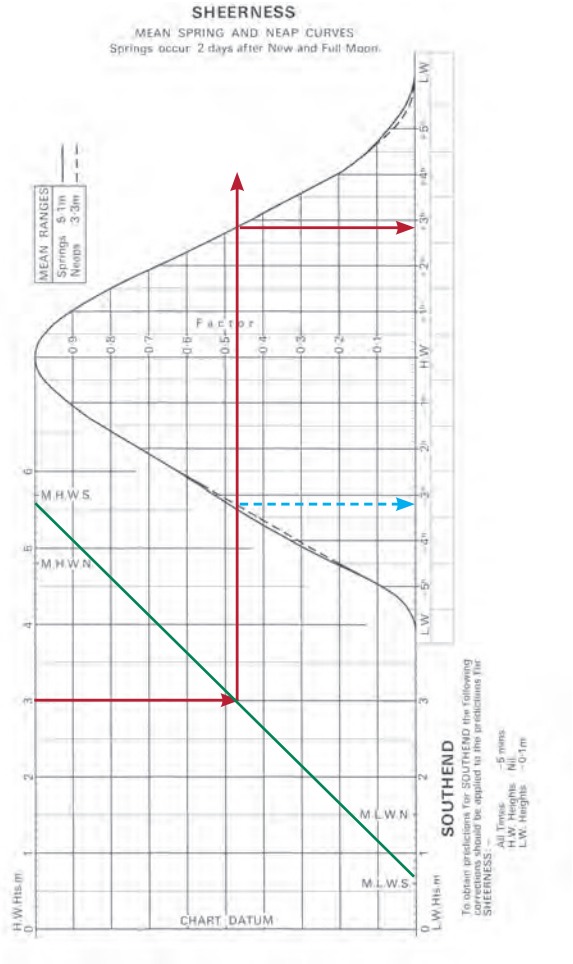

SHEERNESS
MEAN SPRING AND NEAP CURVES
Springs occur 2 days after New and Full Moon
MEAN RANGES
Springs 5·1m
Neaps 3·3m
Factor
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
M.H.W.S.
M.H.W.N.
M.L.W.N.
M.L.W.S.
CHART DATUM
H.W. Hts.m
L.W. Hts.m
H.W.
L.W.
SOUTHEND
To obtain predictions for SOUTHEND the following corrections should be applied to the predictions for SHEERNESS:-
All Times -5 mins
H.W. Heights Nil
L.W. Heights -0·1m

Figure 15

Question 2

On the afternoon of 4 March 20YY, at Lisbon (Portugal), find the latest time when your ship drawing 4.5m can sail over a bar marked 3.0m on the chart with UKC of 1.5m using the curve in Appendix 12 and the tidal extracts below:

Date	Time (LT)	Height (m)
4 March 20YY	1524	3.6m
4 March 20YY	2051	0.7m

Note: 'Latest time' indicates falling tide.

Preliminary calculation

DRAFT	4.5m
UKC	1.5m
Required depth	6.0m
Charted depth	3.0m
Required height of tide	**3.0m**

Step 1: I dentify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 8: South East Atlantic Ocean, West Africa and Mediterranean (including tidal stream tables). Look at the index to standard ports on the inside of the front cover (Appendix 7), locate Lisbon, and open to that page. The data extracted from that page is given in the question and is used in step 2.

Step 2: Extract the bracketing tides and compute the range and tidal interval

Required: Afternoon, falling tide, height of 3.0m. Bracketing tides:

Date	Time (LT)	Height (m)
4 March 20YY	1524	3.6m
4 March 20YY	2051	0.7m

Extracted tidal interval 5h 27m; range 2.9m.

Step 3: Draw a sloping line on the curves of the port

On the left side of the curves of that port locate the bracketed HW and LW heights and join them with a straight line as shown by the green line in figure 16.

Step 4: Draw vertical and horizontal lines

Required height of tide: 3.0m. Draw a vertical line at 3.0m to meet the sloping green line. From the point of intersection, draw a horizontal line, as shown by the red colour in figure 16, across the curves for falling tide.

Step 5: Draw a vertical line at the appropriate curve and compute time

The firm curve is for mean spring range of	3.3m
The dotted curve is for mean neap range of	1.6m
Bracketed range from step 2	2.9m

Step 6: State your answer

On the afternoon of 4 March 20YY, at Lisbon (Portugal), the latest time a ship drawing 4.5m can sail over a bar marked 3.0m on the chart with UKC of 1.5m is **1704 LT**.

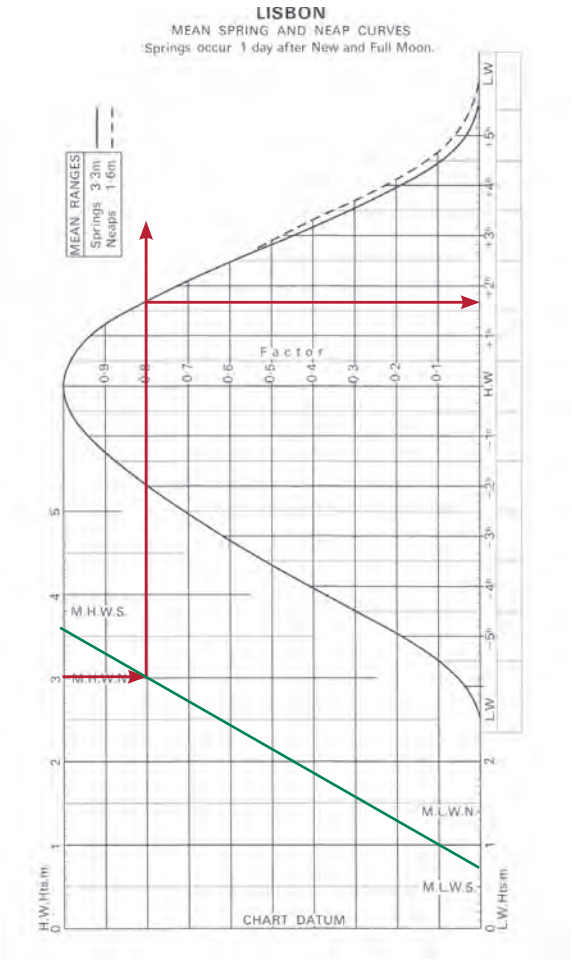

LISBON
MEAN SPRING AND NEAP CURVES
Springs occur 1 day after New and Full Moon.
MEAN RANGES
Springs 3·3m
Neaps 1·6m
Factor
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
H.W.
L.W.
M.H.W.S.
M.H.W.N.
M.L.W.N.
M.L.W.S.
CHART DATUM
H.W. Hts. m.
L.W. Hts. m.

Figure 16

Question 3

Your ship expects to complete loading at 1800 LT on 6 January 20YY, at Kuwait (Mina Al Ahmadi) with draft aft of 6.5m. Find the earliest time you can sail out with UKC of 1.0m over a bar marked 5.0m on the chart, using the curves in Appendix 10 given the tidal extracts below:

Date	Time (LT)	Height (m)
6 January 20YY	1820	1.7m
7 January 20YY	0005	2.9m

Required: Rising tide after 1800LT; height of 2.5m. Bracketing tides:

Note: 'Earliest time' indicates rising tide.

Preliminary calculation

DRAFT	6.5m
UKC	1.0m
Required depth	7.5m
Charted depth	5.0m
Required height of tide	**2.5m**

Step 1: Identify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 3: Indian Ocean (including Tidal stream tables).

Look at the Index to Standard Ports on the inside of the front cover (Appendix 3), locate Mina Al Ahmadi, and open to that page. For convenience, the extract for that day is given in the question and is used in step 2.

Note: There are no specific curves given for Mina Al Ahmadi. You have to use a common set of curves given in the beginning of the tides tables which are suitable for tidal intervals between 5 hours and 7 hours. These are reproduced in Appendix 10.

Step 2: From the bracketing tides on that day, obtain tidal interval and range.
Required: Rising tide after 1800LT; height of 2.5m. Bracketing tides:

Date	Time (LT)	Height (m)
6 January 20YY	1820	1.7m
7 January 20YY	0005	2.9m

Tidal interval 5h 45m; range 1.2m.

Step 3: Draw a sloping line on the general curves
On the left side of the curves, locate the bracketed HW and LW heights and join them with a straight line as shown by the green line in figure 17.

Step 4: Draw vertical and horizontal lines
Required height of tide: 2.5m. Draw a vertical line at 2.5m to meet the sloping green line. From the point of intersection, draw a horizontal line, as shown by the red colour in figure 17, across the curves for rising tide.

Step 5: Draw vertical line at appropriate curve and compute time
Note the points where the horizontal red line meets the 5h curve and the 6h curve. Interpolate visually on the horizontal red line for the required tidal interval 5h 45m (from step 2), and draw a vertical line, as shown by the red colour figure 17. Read off the interval, which is 1h 30m before HW in this case, and compute the required time.

Required time = 0005–2h 00m = 2205 LT on 6 January.

Step 6: State your answer
On 6 January 20YY, at Kuwait (Mina Al Ahmadi) with draft aft of 6.5m, the earliest time after 1800LT the ship can sail out with UKC of 1.0m, over a bar marked 5.0m, on the chart is **2205LT**.

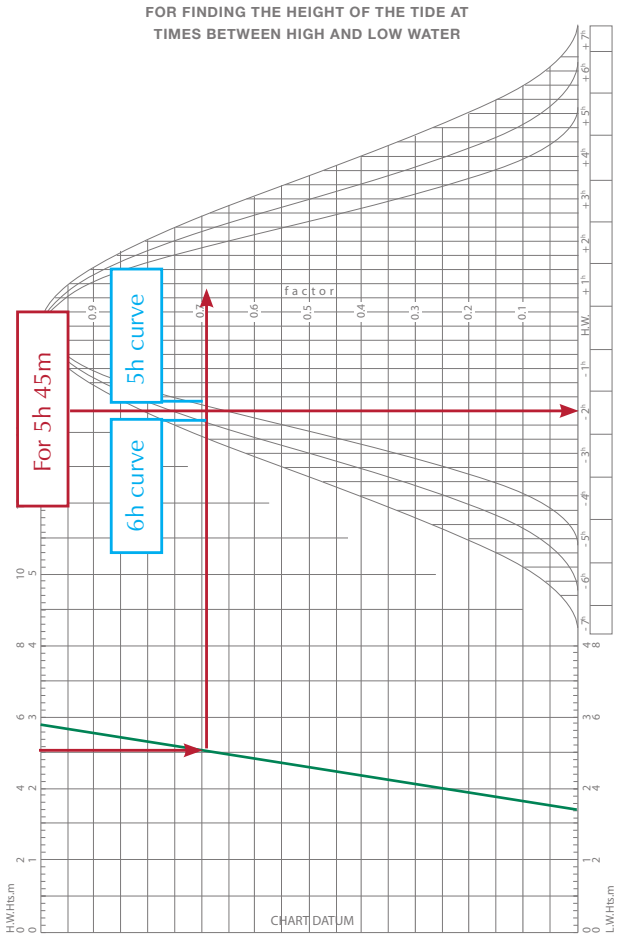

FOR FINDING THE HEIGHT OF THE TIDE AT
TIMES BETWEEN HIGH AND LOW WATER
For 5h 45m
5h curve
6h curve
factor
H.W.
H.W.Hts.m
L.W.Hts.m
CHART DATUM

Figure 17

Question 4

Your ship expects to complete loading at 0500 LT on 17 February 1992, at Twin Island, Torres Strait, (Australia) with draft of 5.5m. Find the earliest time you can sail out with UKC of 1.5m over a bar marked 4.0m on the chart, using the curves in Appendix 7 given the tidal extracts below:

Date	Time (LT)	Height (m)
17 February 20YY	0535	0.2m
17 February 20YY	1138	3.7m

Note: 'Earliest time' indicates rising tide.

Preliminary calculation

DRAFT	5.5m
UKC	1.5m
Required depth	7.0m
Charted depth	4.0m
Required height of tide	**3.0m**

Step 1: Identify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 4: South Pacific Ocean (including tidal stream tables). Look at the index to standard ports on the inside of the front cover (Appendix 4), locate Twin Island, Torres Strait, (Australia), and open to that page. For convenience, the extract for that day is given in the question and is used in step 2.

Note: There are no specific curves given for Twin Island. You have to use a common set of curves given in the beginning of the tide tables which are suitable for tidal intervals between 5 hours and 7 hours. These are reproduced in Appendix 10.

Step 2: From the bracketing tides on that day, obtain tidal interval and range
Required: Rising tide after 0500LT; height of 3.0m. Bracketing tides:

Date	Time (LT)	Height (m)
17 February 20YY	0535	0.2m
17 February 20YY	1138	3.7m

Tidal interval 6h 03m; range 3.5m.

Step 3: Draw a sloping line on the general curves
On the left side of the curves, locate the bracketed HW and LW heights and join them with a straight line as shown by a green line in figure 18.

Step 4: Draw vertical and horizontal lines
Required height of tide: 3.0m. Draw a vertical line at 3.0m to meet the sloping green line. From the point of intersection, draw a horizontal line, as shown by the red colour in figure 18, across the curves for rising tide.

Step 5: Draw a vertical line at the appropriate curve and compute time
Note the points where the horizontal red line meets the 6h curve and the 7h curve. Interpolate visually on the horizontal red line for the required tidal interval 6h 03m (from step 2), and draw a vertical line, as shown in red colour in figure 18. Read off the interval, which is 1h 40m before HW in this case, and compute the required time.

Required time = 1138 - 1h 40m = 0958 LT.

Step 6: State your answer
On 17 February 20YY, at Twin Island, Torres Strait, (Australia) with draft aft of 5.5m, the earliest time ship can sail out with UKC of 1.5m, over a bar marked 4.0m, on the chart is **0958 LT**.

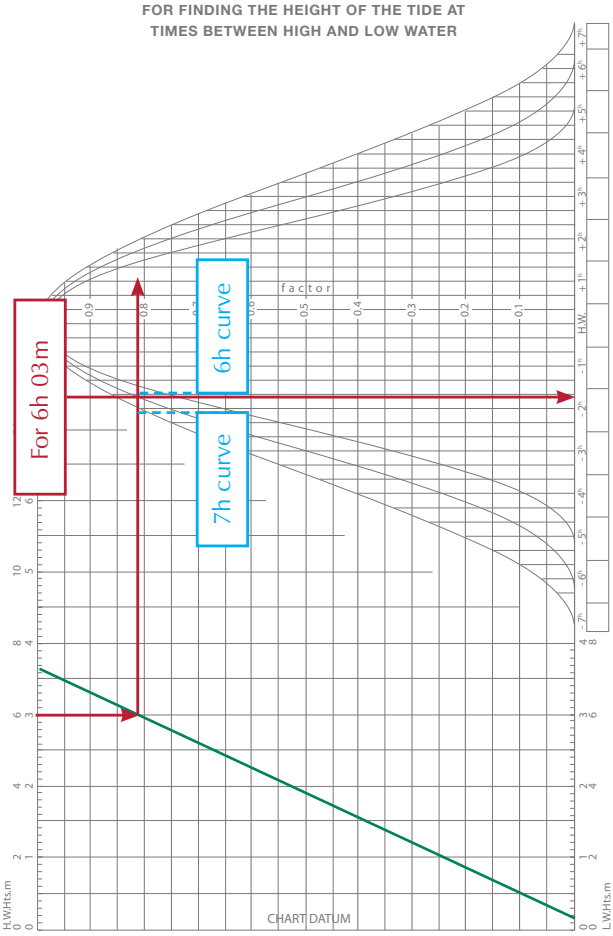

FOR FINDING THE HEIGHT OF THE TIDE AT
TIMES BETWEEN HIGH AND LOW WATER
For 6h 03m
6h curve
7h curve
factor
H.W.
H.W.Hts.m
L.W.Hts.m
CHART DATUM

Figure 18

Question 5

Your ship expects to arrive at Elephant Point, Rangoon River (Myanmar) at 0200 LT on 16 April 20YY, with draft of 5.0m aft. Find the latest time you can pass over a bar with UKC of 1.0m over a bar marked 2.0m on the chart, using the curves in Appendix 10 given the tidal extracts below:

Date	Time (LT)	Height (m)
16 April 20YY	0246	6.0m
16 April 20YY	0912	0.9m

Note: 'Latest time' indicates falling tides.

Preliminary calculation

DRAFT	5.0m
UKC	1.0m
Required depth	6.0m
Charted depth	2.0m
Required height of tide	**4.0m**

Step 1: Identify the appropriate ATT and open to the page of the given port

In this case, it is ATT for the year 20YY Volume 3: Indian Ocean (including tidal stream tables). Look at the Index to Standard Ports on the inside of the front cover (Appendix 3), locate Elephant Point, Rangoon River (Myanmar), and open to that page. For convenience, the extract for that day is given in the question and is used in step 2.

Note: There are no specific curves given for Elephant Point. You have to use a common set of curves given in the beginning of the tide tables which are suitable for tidal intervals between 5 hours and 7 hours. These are reproduced in Appendix 10.

Step 2: From the bracketing tides on that day, obtain tidal interval and range.
Required: Falling tide after 0200 LT; height of 4.0m. Bracketing tides:

Date	Time (LT)	Height (m)
16 April 20YY	0246	6.0m
16 April 20YY	0912	0.9m

Tidal interval 6h 26m; range 5.1m.

Step 3: Draw a sloping line on the general curves
On the left side of the curves, locate the bracketed HW and LW heights and join them with a straight line as shown by a green line in figure 19.

Step 4: Draw vertical and horizontal lines
Required height of tide: 4.0m. Draw a vertical line at 4.0m to meet the sloping green line. From the point of intersection, draw a horizontal line, as shown by the red colour in figure 19, across the curves for falling tide.

Step 5: Draw a vertical line at the appropriate curve and compute time
Note the points where the horizontal red line meets the 6h curve and the 7h curve. Interpolate visually on the horizontal red line for the required tidal interval 6h 26m (from step 2), and draw a vertical line, as shown in red colour in figure 19. Read off the interval, which is 2h 50m after HW in this case, and compute the required time.

Required time = 0912 + 2h 50m = 1202 LT.

Step 6: State your answer
On 16 April 20YY, at Elephant Point, Rangoon River (Myanmar), the latest time the ship can sail out with draft aft of 5.0m, and UKC of 1.0m, over a bar marked 2.0m on the chart is **1202 LT**.

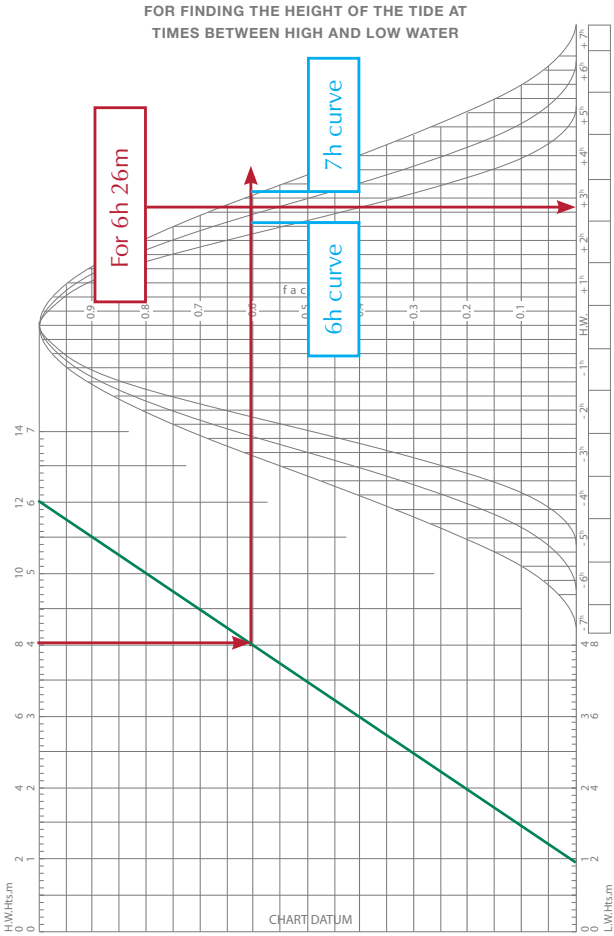

FOR FINDING THE HEIGHT OF THE TIDE AT
TIMES BETWEEN HIGH AND LOW WATER
For 6h 26m
7h curve
6h curve
f a c
H.W.
H.W.Hts.m
L.W.Hts.m
CHART DATUM

Figure 19

Appendix 1

Inside cover of ATT Volume 1: The UK and Ireland (including European Channel Ports)

INDEX TO STANDARD PORTS

* Hourly height predictions also included

iii

Appendix 2

Inside cover of ATT Volume 2: North Atlantic Ocean and Arctic Regions

INDEX TO STANDARD PORTS

iii

Appendix 3

Inside cover of ATT Volume 3: Indian Ocean (including tidal stream tables)

INDEX TO STANDARD PORTS

Appendix 4

Inside cover of ATT Volume 4: South Pacific Ocean (including tidal stream tables)

INDEX TO STANDARD PORTS

Appendix 5

Inside cover of ATT Volume 5: South China Sea and Indonesia (including tidal stream tables)

INDEX TO STANDARD PORTS

Appendix 6

Inside cover of ATT Volume 6: North Pacific Ocean (including tidal stream tables)

INDEX TO STANDARD PORTS

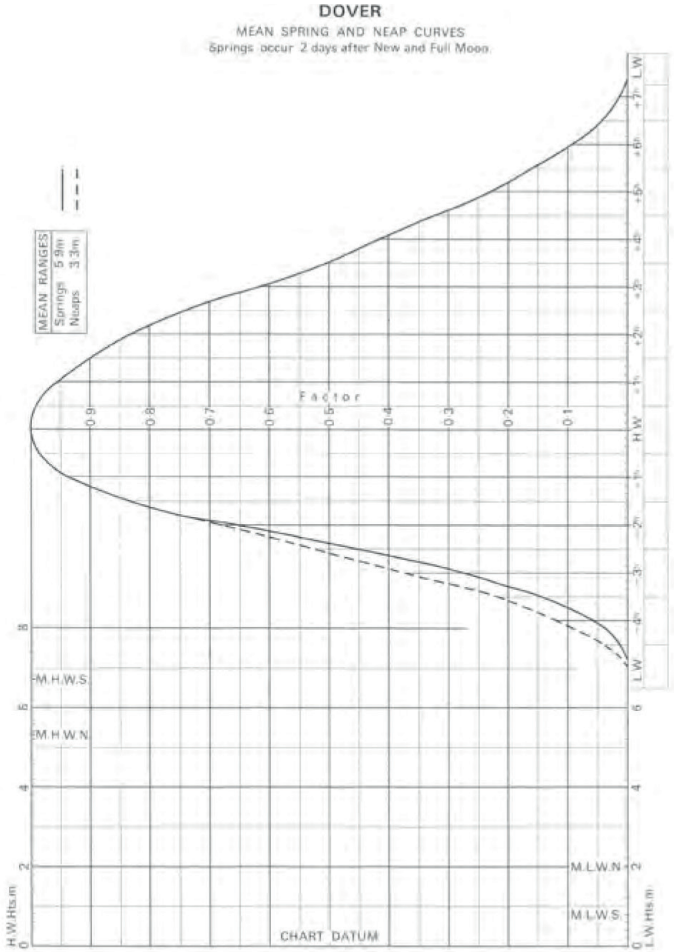
Appendix 7

Inside cover of ATT Volume 8: South East Atlantic Ocean, West Africa and Mediterranean (including tidal stream tables)

INDEX TO STANDARD PORTS

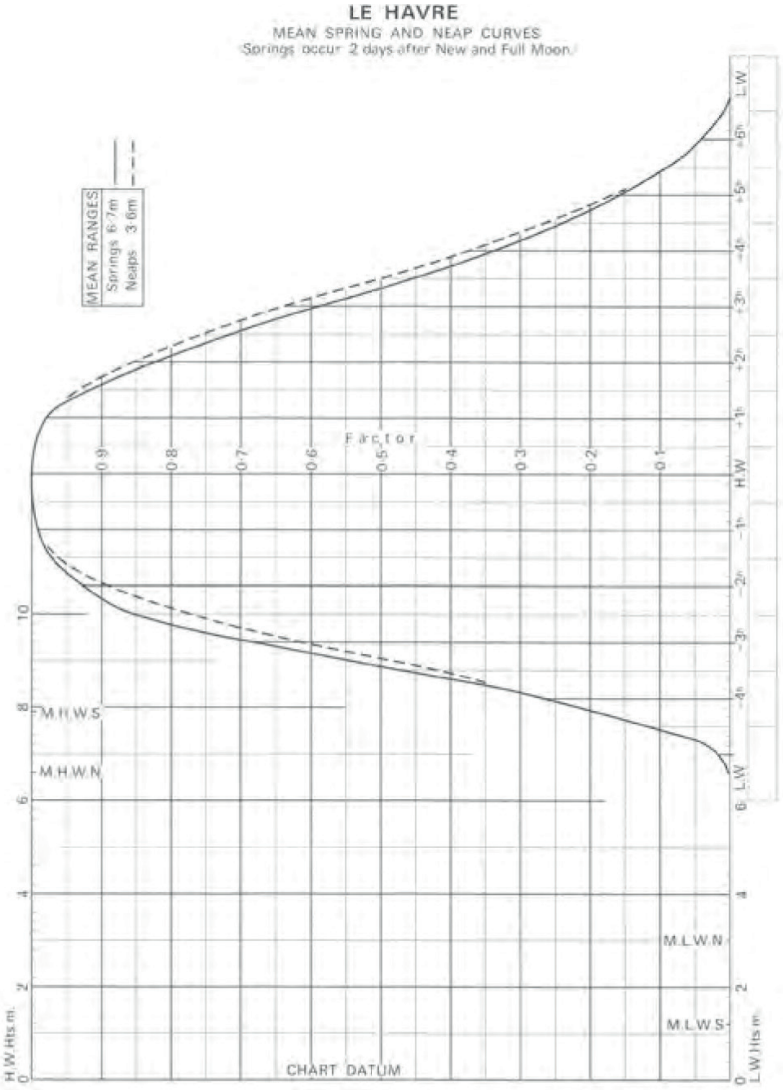
Appendix 8

Tidal Curves: Dover



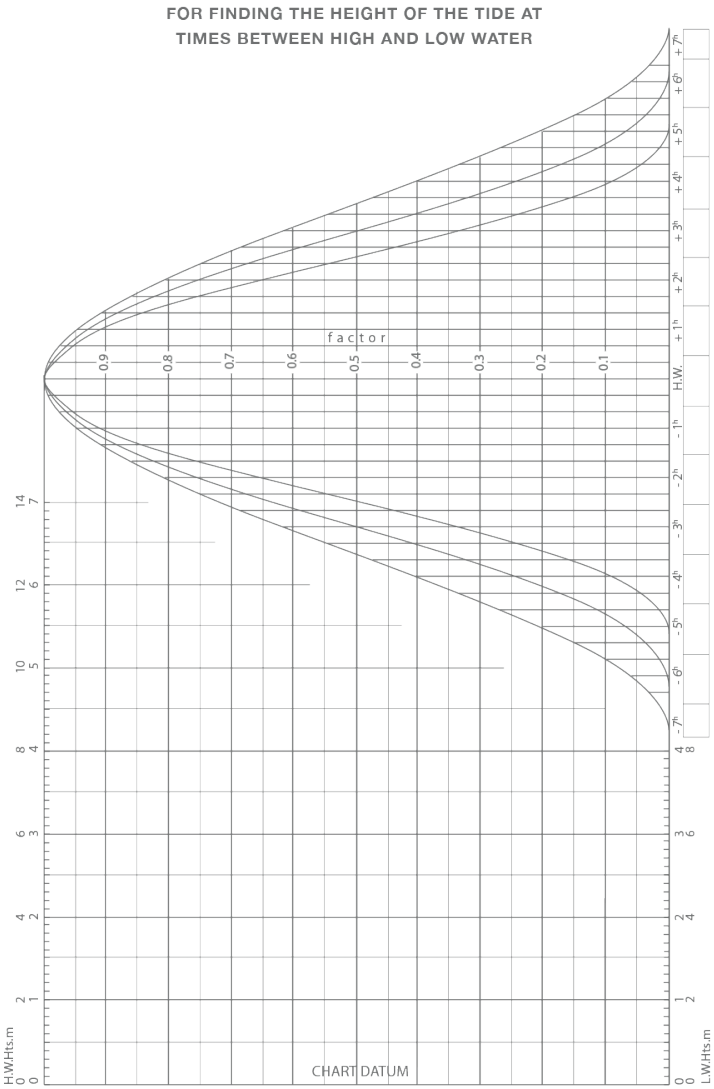
Appendix 9

Tidal Curves: Le Havre



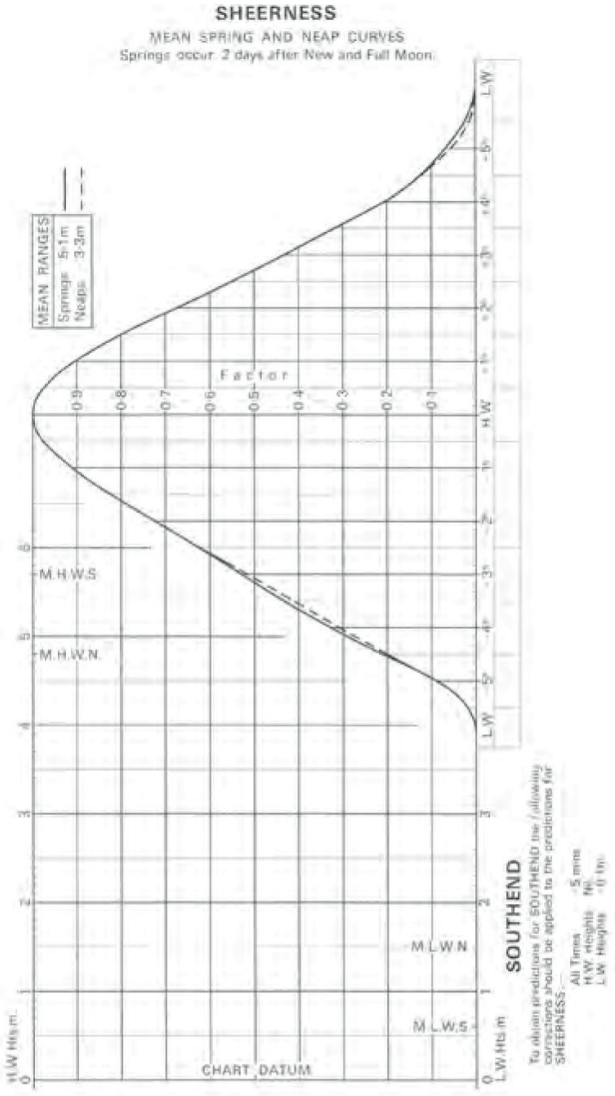
Appendix 10

Tidal Curves: General



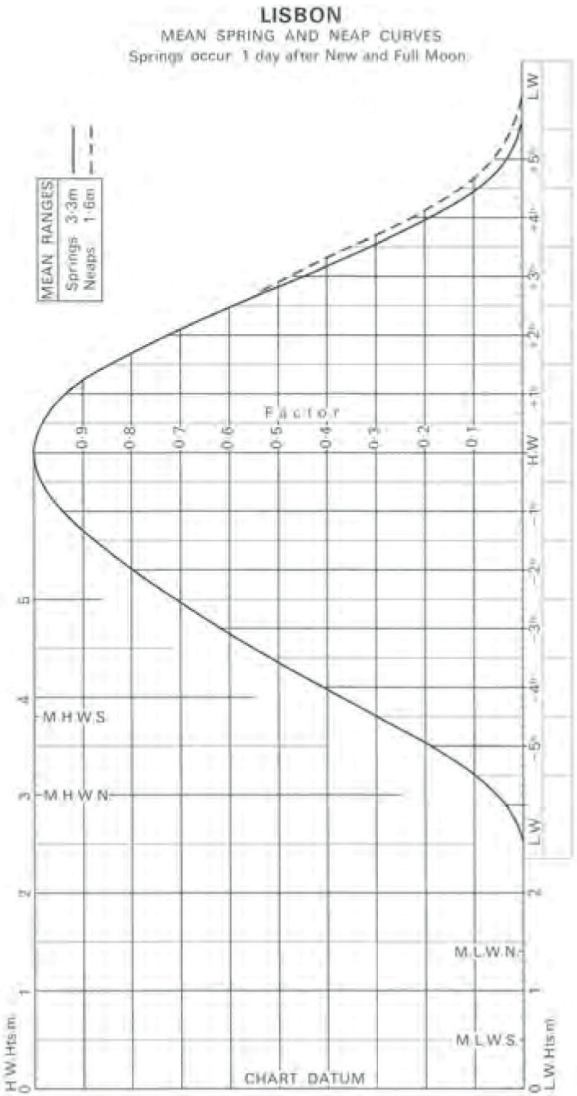
Appendix 11

Tidal Curves: Sheerness



Appendix 12

Tidal Curves: Lisbon



London
White Chapel Building, 2nd Floor
10 Whitechapel High Street
London
E1 8QS
T +44 207 488 0911
F +44 207 480 5806
E info@shipownersclub.com
W www.shipownersclub.com

Singapore
9 Temasek Boulevard
#22-02 Suntec Tower 2
Singapore
038989
T +65 6593 0420
F +65 6593 0449
E info@shipownersclub.com.sg

The Shipowners' Mutual Protection and Indemnity Association (Luxembourg) | 16, Rue Notre-Dame | L–2240 Luxembourg | Incorporated in Luxembourg | RC Luxembourg B14228

The Shipowners' Mutual Protection and Indemnity Association (Luxembourg) | Singapore Branch | Company No. T08FC7268A