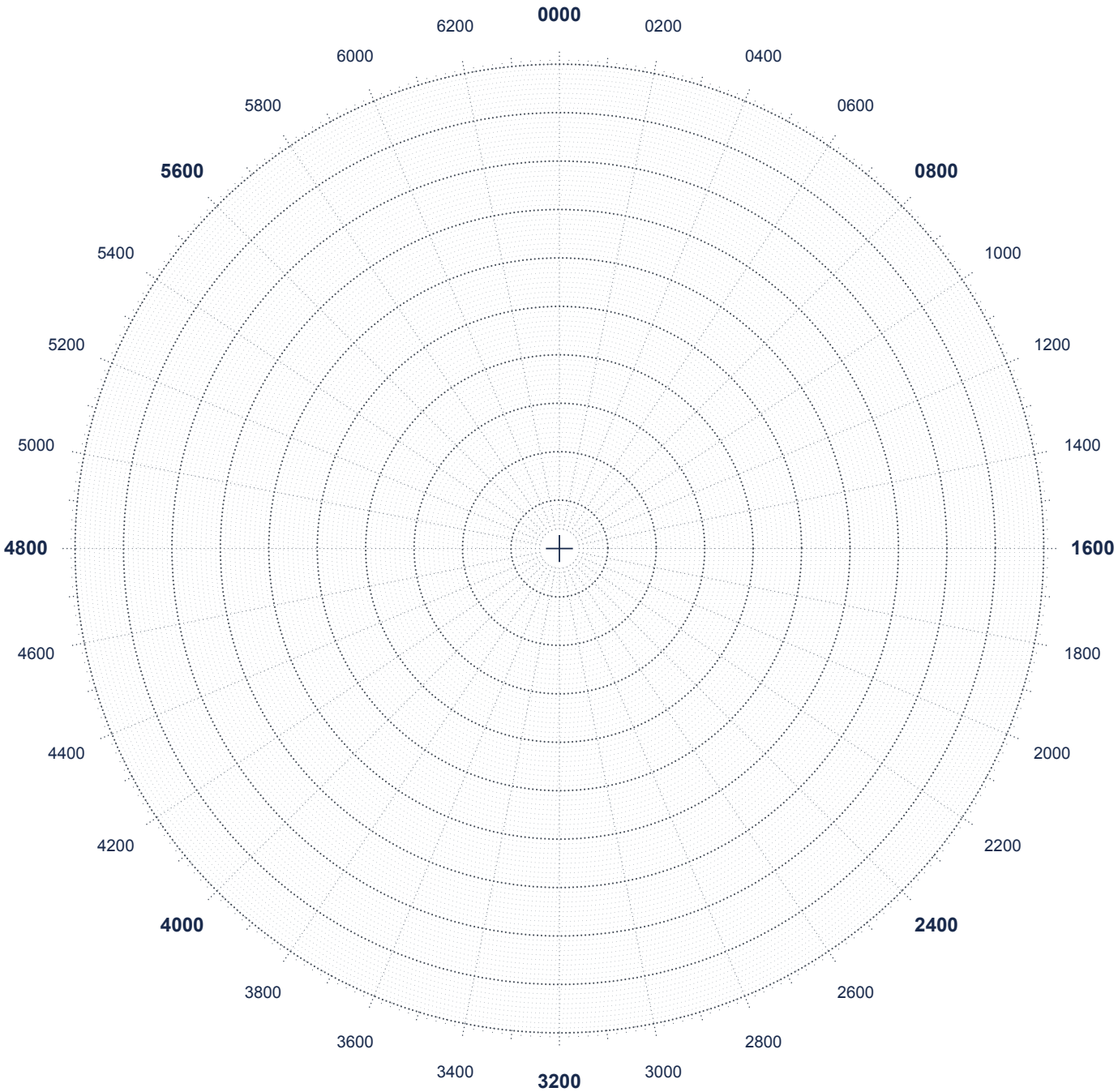


01 / Mil plotting sheet

Direction in NATO mils · 6400 mils = one revolution · distance from the centre in nautical miles

Vessel / location: _____ Date / time: _____

Reference: ☐ true north ☐ magnetic north ☐ bow = 0000

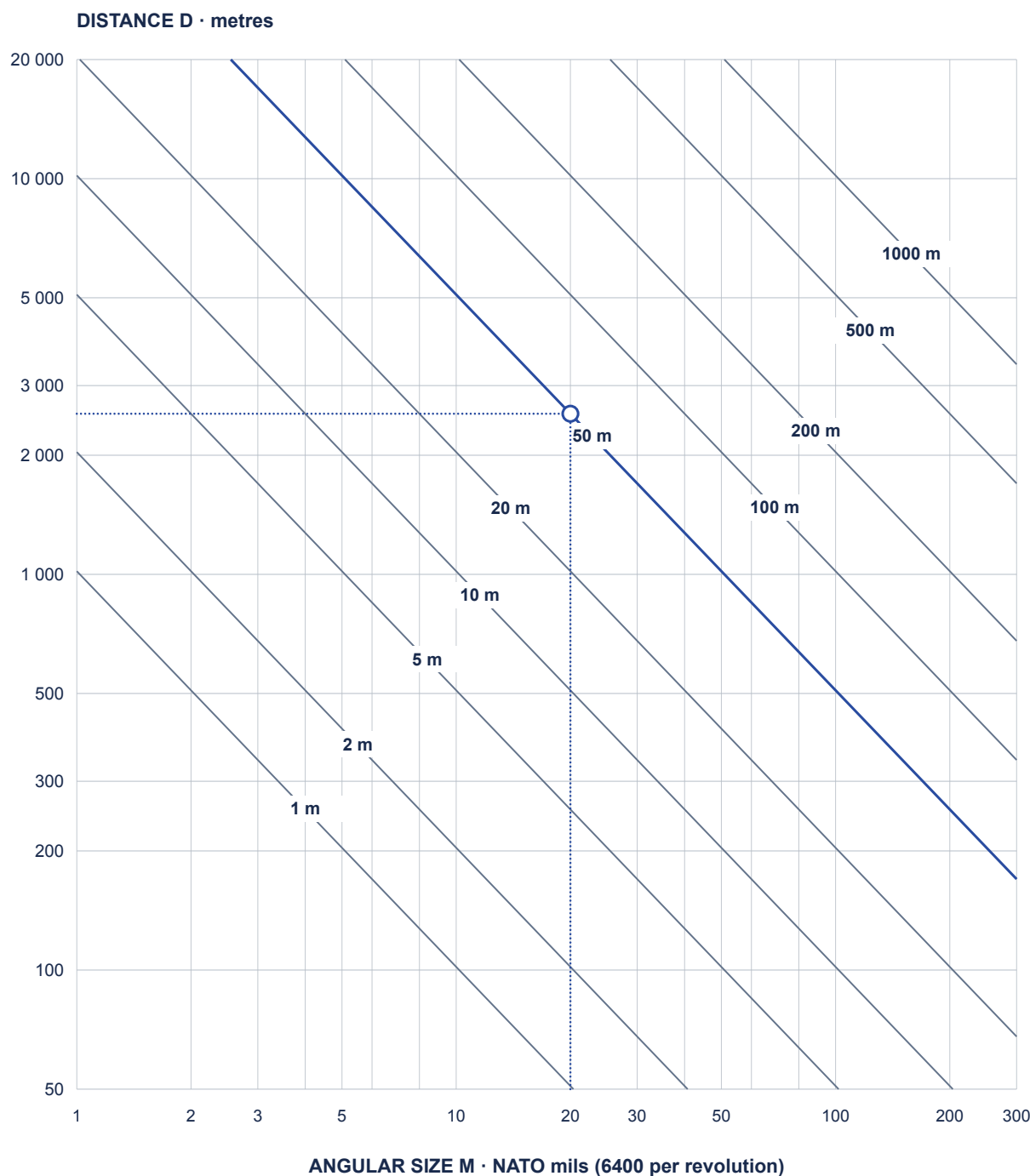


Major rings: 1 NM. Subdivisions: 0.1 NM. Outer ring: 10 NM. Angular marks: 20 mils; labels: 200 mils. The clear centre has a precise crosshair.

Object	Bearing, mils	Distance, NM	Measured / estimated

02 / Graphical range calculator

Known size S + measured angular size M → estimated distance D. The diagonal lines represent known widths or heights in metres. Both axes are logarithmic: the spacing between numbers is not uniform.

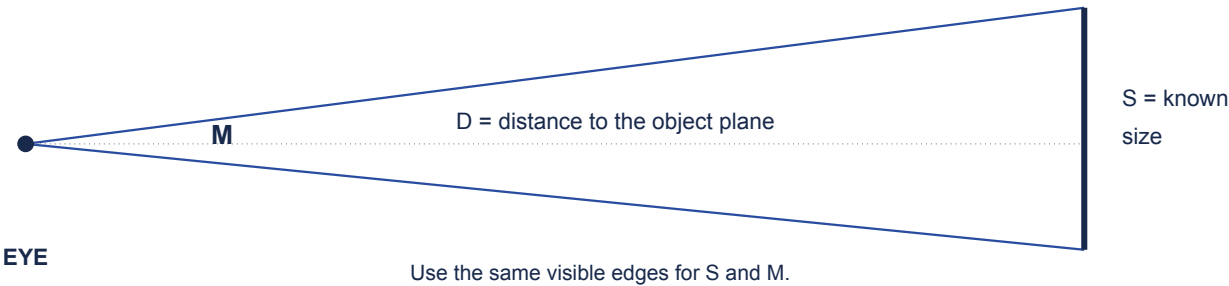


Example: A building face is 50 m wide and spans 20 NATO mils. Its intersection with the 50 m line gives about **2,550 m = 1.38 NM**. Blue guide lines show the reading.

Calculation: $D \approx 1018.6 \times S / M$. Reverse use: a known distance and measured angle give size along the diagonal lines. View the measured face approximately square-on. For large angles or oblique surfaces, use the geometry on page 3.

03 / Mils, metres and method

A bearing tells you **where** an object is. Angular size tells you **how large** it appears. The range calculation uses the angle between two known edges, not the bearing to the object.



Three useful calculations

Distance in metres: $D \approx 1018.6 \times S / M$
Size in metres: $S \approx D \times M / 1018.6$
Angle in NATO mils: $M \approx 1018.6 \times S / D$

These are small-angle calculations for NATO 6400. The familiar field rule **$D \approx 1000 \times S / M$** is easy to remember, but gives a distance about 1.8% shorter than the 6400-based small-angle result. This pack uses **1018.6** in its graph and table.

Symbol / unit	Meaning in this pack
NATO	North Atlantic Treaty Organization; here identifying the 6400-mil system.
mil / NATO mil	Angular unit: 1/6400 of a revolution. Not a unit of distance.
mrاد	Milliradian: 1/1000 of a radian. One revolution is about 6283.185 mrاد.
D / S / M	Distance in metres / known transverse size in metres / angular size in NATO mils.
H / h	Summit height / eye height above the same water or height reference.
α / β / θ	Angles: elevation to the top / to the bottom / total angular span.
NM / m / km	Nautical mile = 1852 m / metre / kilometre = 1000 m.
$\approx$ / tan / π	Approximately equal / tangent / pi. $K = 6400/(2\pi) \approx 1018.6$.

When you need more precise geometry

Square-on width, symmetrical sight lines: $\theta = M \times 2\pi/6400$ radians; $D = S / (2 \times \tan(\theta/2))$. D is the perpendicular distance to the midpoint of the face. If one edge lies on the central sight line, use $D = S/\tan(\theta)$.
Two elevation angles: $D = H / (\tan(\alpha) - \tan(\beta))$, where H is the vertical separation of the two visible points. Measure angles from true horizontal; β is negative below horizontal. This is plane geometry.
Instrument scale: 1 NATO mil = 0.981748 mrاد = 0.05625°. 1600 mils = 90°. Check the binocular scale: 6400, mrاد and 6000 are different systems. Match your calculator's angle mode. An mrاد reticle uses 1000 in the small-angle calculation, not 1018.6.

04 / From your vessel to shore

Buildings, lighthouses and landmarks

Choose a clear object with a known dimension: two corners, a building face or the visible part of a tower. Use a documented dimension for the exact edges you can see. A light's elevation above the sea is not necessarily the visible height of its tower.

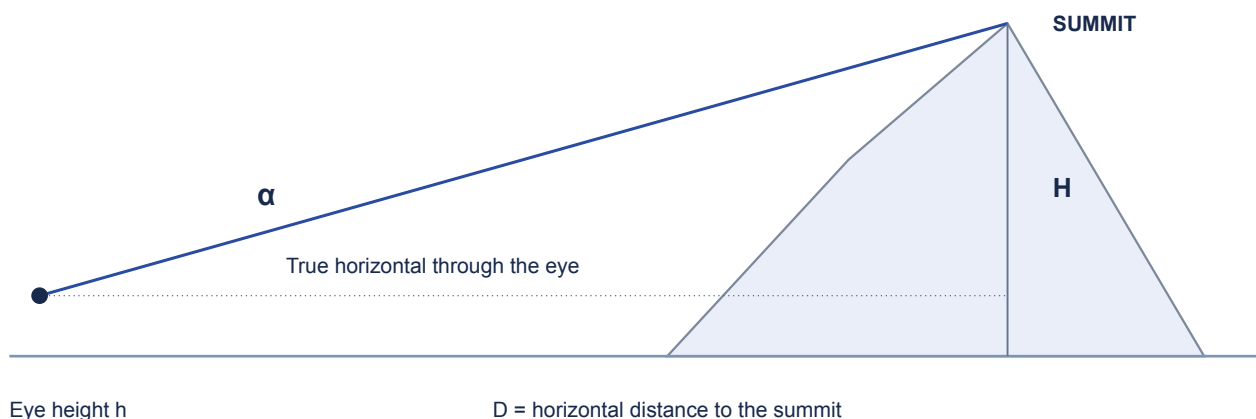
Worked example — building: $S = 24 \text{ m}$ and $M = 12 \text{ mils}$.

$D \approx 1018.6 \times 24 / 12 = \mathbf{2037 \text{ m} \approx 1.10 \text{ NM}}$.

Reverse calculation: At a known distance of 1852 m, an angular span of 20 mils represents a width of about **36.4 m**.

An oblique face looks narrower and may overestimate distance. Use a square-on face, a known visible section or another object. Points on a mountain skyline or bay may be at different ranges; do not assume a common transverse width.

Mountain summit with a known elevation



Plane approximation: $D = (H - h) / \tan(\alpha)$. Measuring α requires an angle instrument with an established horizontal reference through the eye. The visible sea horizon is not this line.

Example: $H = 300 \text{ m}$, $h = 3 \text{ m}$ and $\alpha = 120 \text{ NATO mils} = 6.75^\circ$. Then $D \approx \mathbf{2510 \text{ m} = 1.36 \text{ NM}}$ horizontally to the summit. This is a hypothetical example. The chart's height datum, water level, eye height and summit identification must agree.

At long ranges, or when the base is hidden beyond the horizon, Earth curvature and refraction affect the result. An angle between the summit and the visible sea horizon needs a separate method with horizon correction, such as Bowditch Table 15. Do not insert that angle directly as α above.

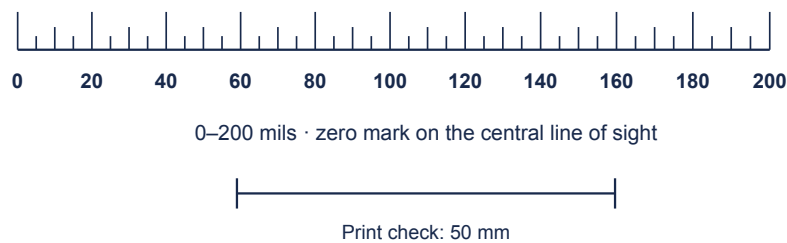
Practical ways to improve an estimate

- Measure three times, record the spread and support the binoculars from a steady position.
- Choose the largest clear angular span between known edges. Small angles magnify relative reading errors.
- Distinguish horizontal distance from slant range to a summit. The difference increases with elevation angle.
- Light, haze, background and object size affect visual impressions. Check against a known object and an independent chart or radar distance.

05 / Field ruler and quick calculations

This scale provides a simple measuring tool without mil-reticle binoculars. Hold it **500 mm from the eye**, perpendicular to the sight line through its zero mark. Use one eye: align zero with one edge and read the other. Measure between the object's edges, not across its background.

NATO MILS · HOLD RULER 500 mm FROM THE EYE



Print at 100% / actual size. The check line must measure 50 mm. Keep 500 mm between the eye and the scale itself, for example with a measured cord. Keep the sheet flat. An error in holding distance produces a corresponding error in the small-angle reading.

Quick table: distance in kilometres

Left column: known size S in metres. Top row: angular size M in NATO mils. Values are small-angle estimates rounded to 0.01 km. **NM = km / 1.852.**

S / M	5 mil	10 mil	20 mil	40 mil	80 mil	160 mil
5 m	1.02	0.51	0.25	0.13	0.06	0.03
10 m	2.04	1.02	0.51	0.25	0.13	0.06
20 m	4.07	2.04	1.02	0.51	0.25	0.13
50 m	10.19	5.09	2.55	1.27	0.64	0.32
100 m	20.37	10.19	5.09	2.55	1.27	0.64
200 m	40.74	20.37	10.19	5.09	2.55	1.27

Your hand is a personal angle gauge

Calibrate finger width, a closed fist and finger span against a known object or a binocular reticle. Use the same hand position, eye and extended arm each time. Hand measurements are personal: do not assign a fixed mil value to a finger without calibration.

Calibration: S = 1 m at D = 20 m gives about 50.9 NATO mils. Note which parts of your hand cover that span. You can use a greater reference distance with a proportionally larger known width.

Use a range when measurements vary

An object is 50 ± 2 m wide and the reading is 20 ± 2 mils.
Shortest estimate: $1018.6 \times 48 / 22 \approx$ **2220 m**.
Longest estimate: $1018.6 \times 52 / 18 \approx$ **2940 m**.
Result: about **2.2–2.9 km**, rather than a metre-precise distance.

One angle cannot determine two unknowns. You need a known size to find distance, or a known distance to find size.

06 / Observation and calculation sheet

Vessel / location: _____ Date / time: _____
 Instrument: _____ Scale checked: ☐ NATO 6400 ☐ other: _____

Object	
Visible edges	Which two points did you measure?
Known size / source	S = _____ m. Source: _____
Angle readings	M ₁ = _____ M ₂ = _____ M ₃ = _____ NATO mils
Selected angle	M = _____ mils. Spread: _____
Range calculation	$D \approx 1018.6 \times \frac{\text{_____}}{\text{_____}} = \text{_____ m}$
Result / interval	_____ to _____ m = _____ to _____ NM
Cross-check	Chart / radar / other: _____

For a summit: H = _____ m, h = _____ m, α = _____ mils above true horizontal.

$D = (H - h) / \tan(\alpha \times 2\pi/6400) = \text{_____ m}$. Height reference: _____

Across north: the shortest angle between 6380 and 0020 mils is 40 mils.

Sources and calculation basis

- 1. US Army, ATP 3-09.30, paragraphs 3-18–3-21 (2017).** 6400-mil division, bearing references and the mil relationship. Army original.
 - 2. US Marine Corps, MCTP 3-01C, page 2-8.** Relationship between size, angle and range. Marine Corps original.
 - 3. NGA, The American Practical Navigator, Volume II, Tables 15–17.** Vertical angles, eye height, sea horizon and assumptions for ranges to shore objects. Bowditch at NGA.
 - 4. NIST, Guide to the SI, footnotes.** Definition: 1 nautical mile = 1852 m. NIST unit reference.
- Sources checked online on 2026-10-29. Diagrams, table and examples were prepared for Vesdoc. The 6400 factor, logarithmic axes, ruler and plane formulas are mathematically derived; the sources do not constitute approval of this design.

Intended use

A printable aid for **distance estimation at sea**. The range graph and table use a small-angle approximation and known transverse dimensions. Geometry and visible points must match the selected method. Check the instrument scale, physical print dimensions and readings aboard your vessel. Every numerical object in the examples is hypothetical, not a surveyed landmark.