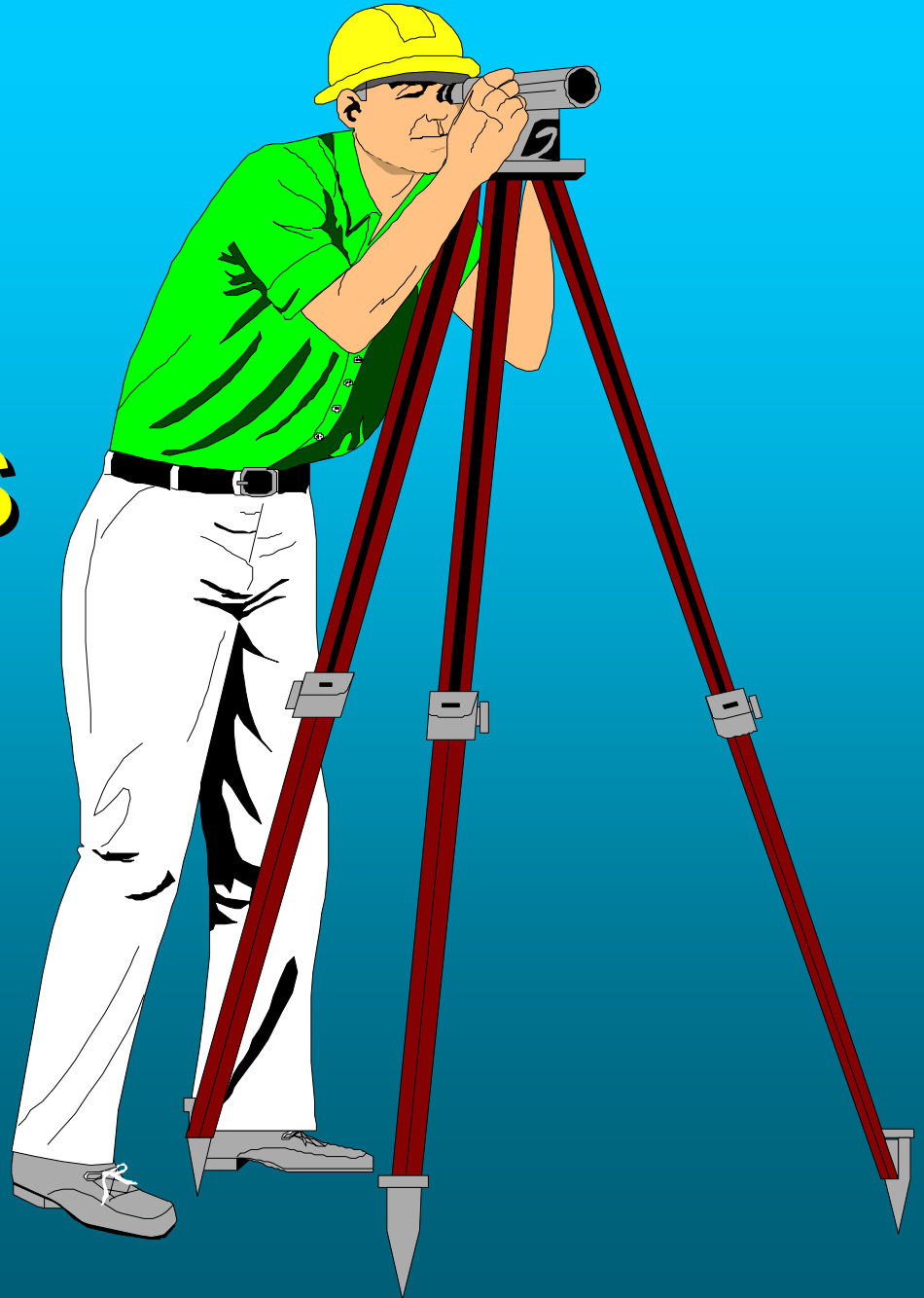


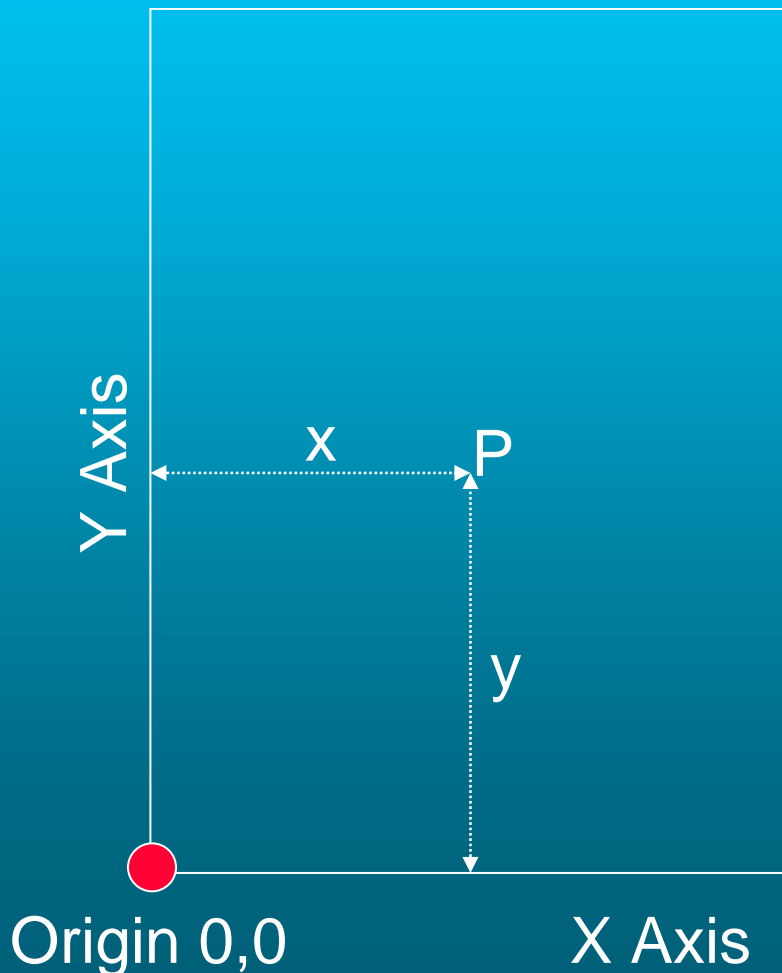
# Grids and Coordinates



# Contents

1. Rectangular Coordinates
2. Polar Coordinates

# Rectangular Coordinates



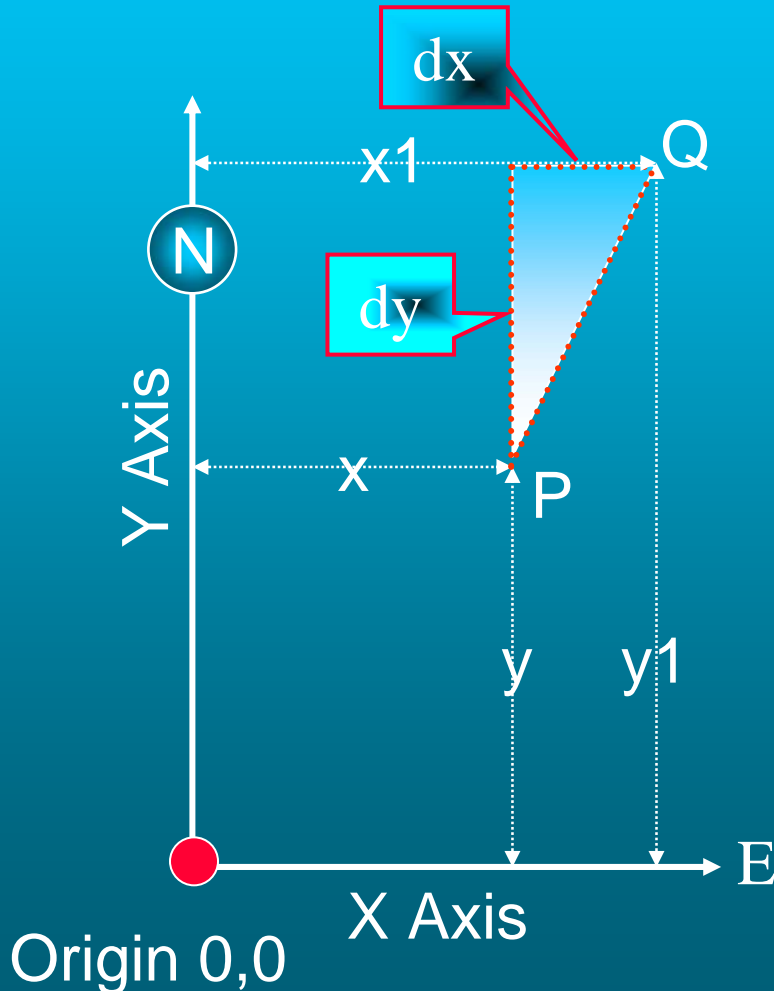
In a 2 dimensional plane coordinate system as shown, the point "P" can be perfectly described by the coordinates  $x$  and  $y$

The third dimension  $z$  is the elevation

The origin is chosen to avoid negative coordinates

# Coordinate Calculations

By convention, the Y axis is assumed to be local grid North  
And X values are often called Eastings, Y values Northings



If  $dx = x1 - x$ , and if  $dy = y1 - y$

Then  $(P \text{ to } Q)^2 = (dx)^2 + (dy)^2$

And  $\tan^{-1} (dx/dy)$  is the angle  
between grid north and P to Q.

# Coordinate Calculations

- It can be seen that the calculations are simple and the numbers are meaningful
- The bigger the X value, the further to the right, (or East), the point is.
- The bigger the Y value, the further upwards, (or North), the point is.
- The bigger the Z value, the higher the point is.

# Rectangular Coordinate Advantages

A point whose coordinates are known can be set out from any other point whose coordinates are known providing that the two points are intervisible.

# Advantages

The method is particularly suitable for use with a theodolite and tape over short distances on level surfaces, or a Total Station over longer distances and uneven surfaces.

# Total Station

A surveying instrument which measures angles in the horizontal and vertical planes, and also measures distances by infra-red or laser beam.

Angles and distances are measured electronically and can be recorded in digital format.

# Leica Total Station



A Total Station has internal software for converting observations to rectangular coordinates and vice versa.

There is also an internal data recording facility.

# Disadvantages

Refraction, earth curvature, and residual instrument errors limit the accuracy of elevations obtained.

However, if as often happens, the setting out is limited to X and Y, as on a new concrete slab, then levels are not taken anyway.

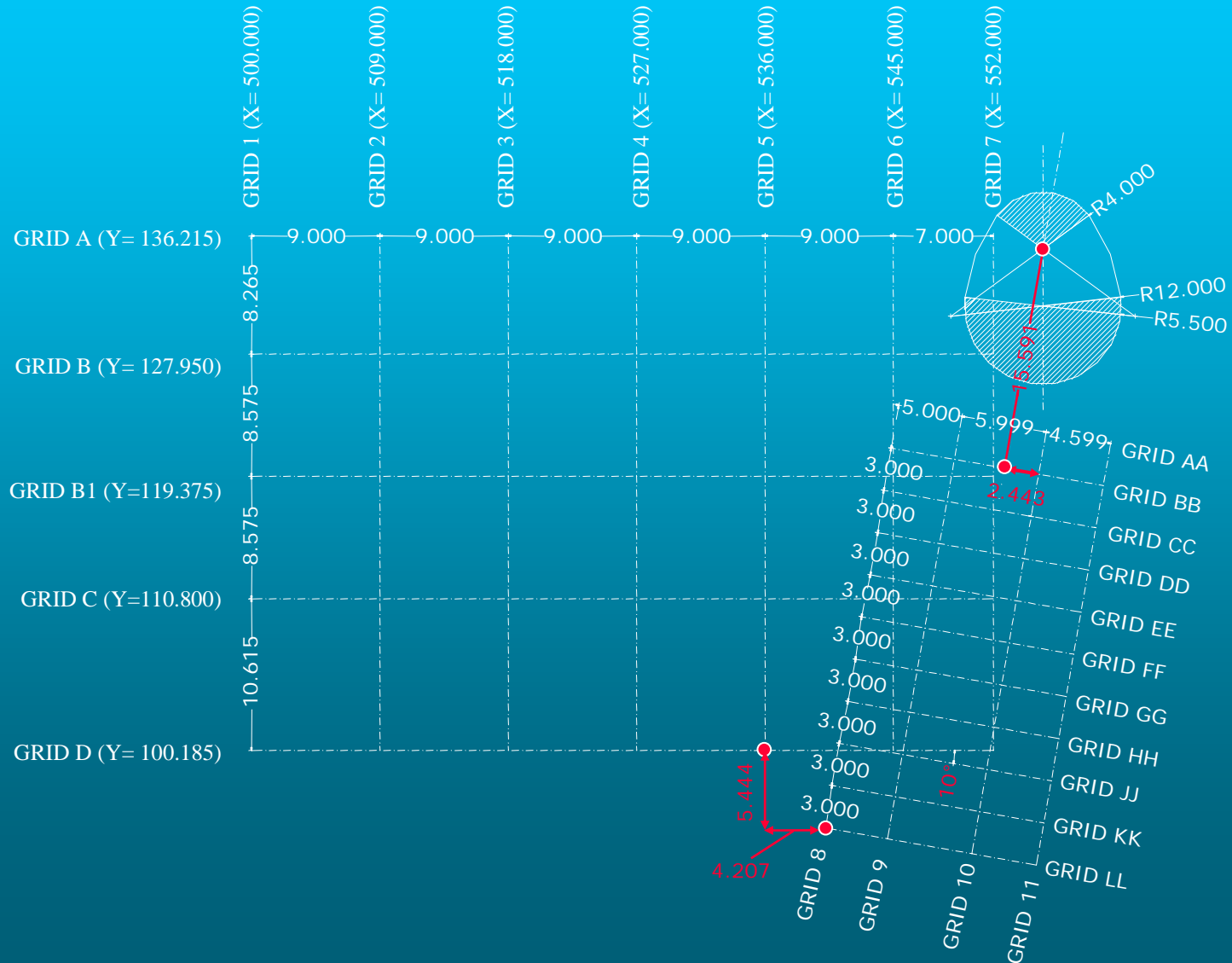
# Construction Grids

- It is common practice on construction sites for the coordinate grid to be parallel with a major part of the structure.
- In this case it is unlikely that local grid north points toward the North Pole.

In Addition;

- Multiple grids are not uncommon on construction sites

# Multiple Grids Example



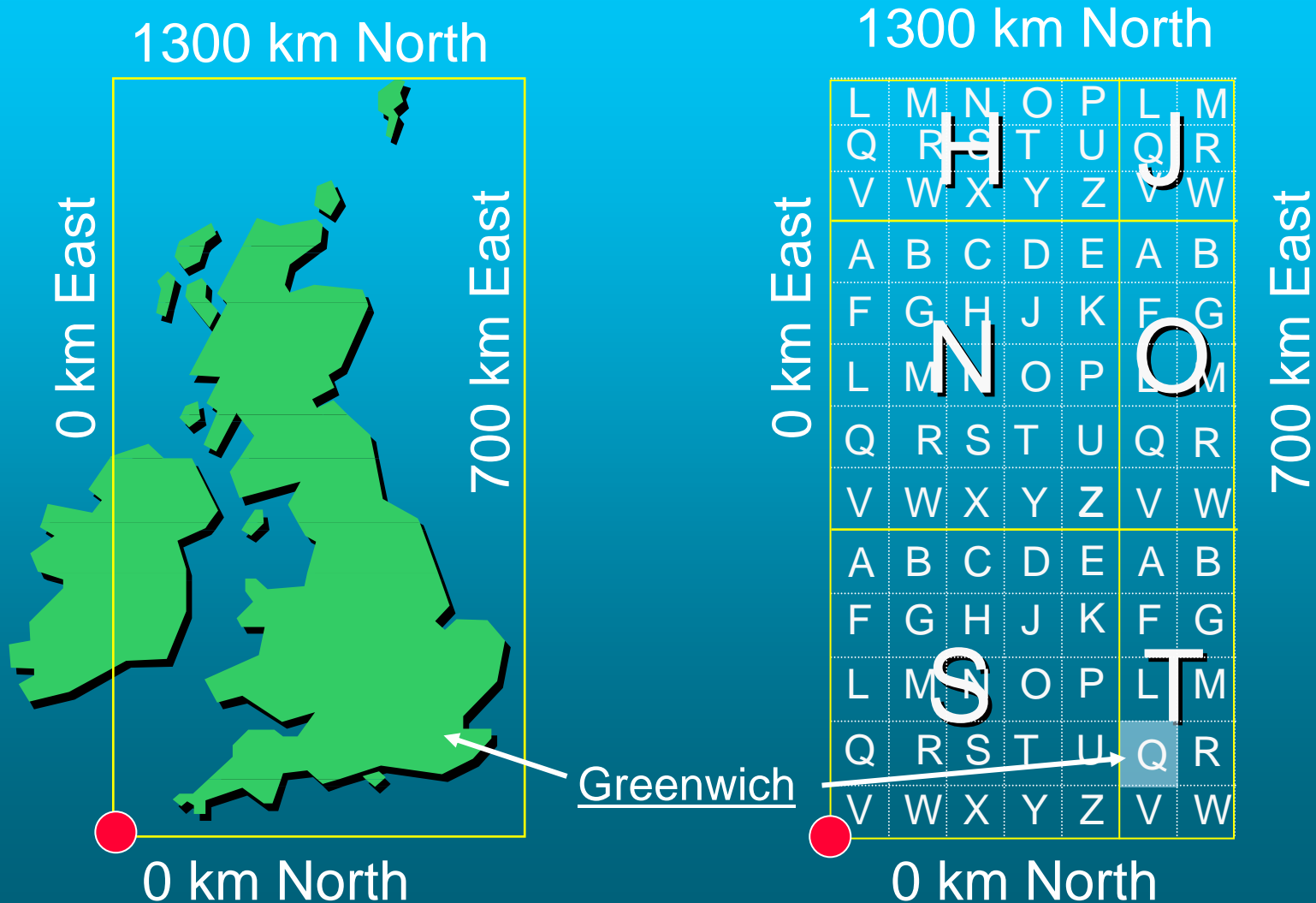
# National Grid Coordinates

- Some construction sites e.g. motorways, mines and quarries, rail networks, and features of large extent, do not use local grids, but instead use the Ordnance Survey National Grid.
- This is a grid system which covers the whole of the UK.

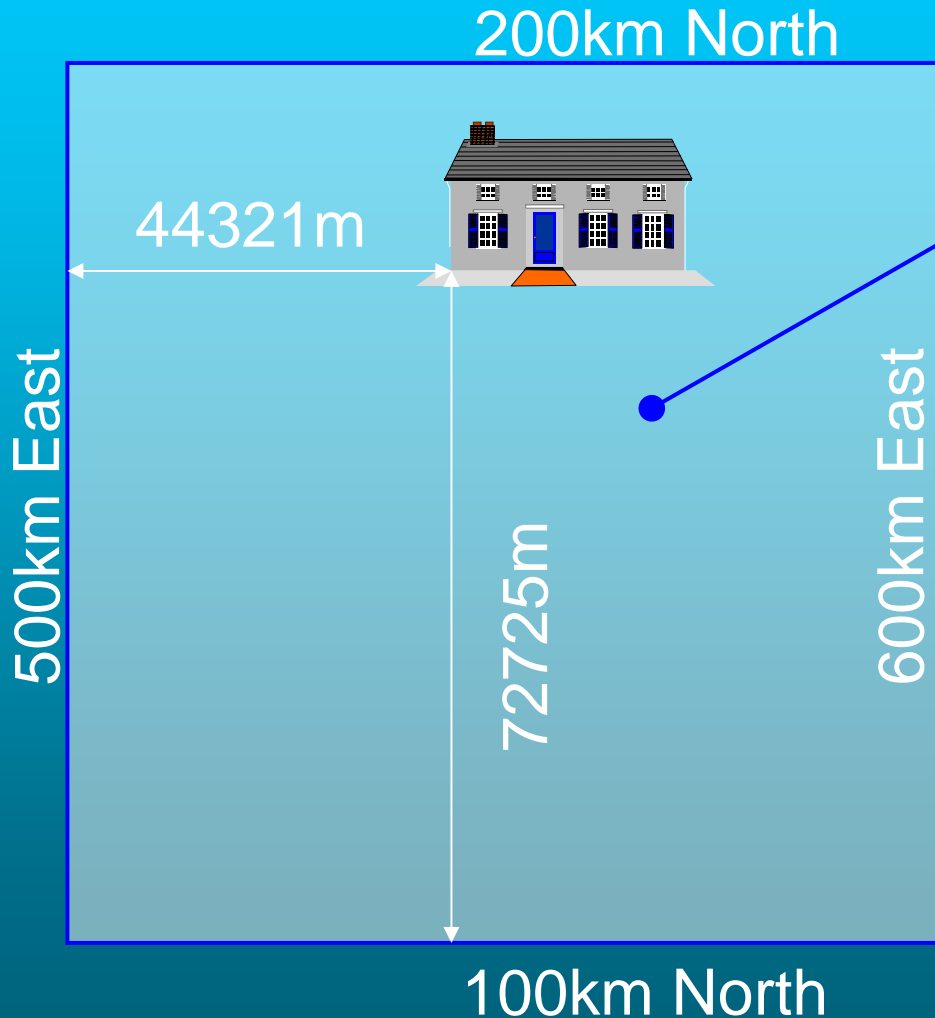
# National Grid Coordinates

The origin,  $(X=0, Y=0)$  lies off the South West coast of Cornwall and the grid extends 700 km. East and 1300 km North

# National Grid Coordinates



# National Grid Coordinates



This is square "TQ"

The coordinates of the house corner are: -  
TQ44321,72725 or  
544321,172725  
(to the nearest metre)

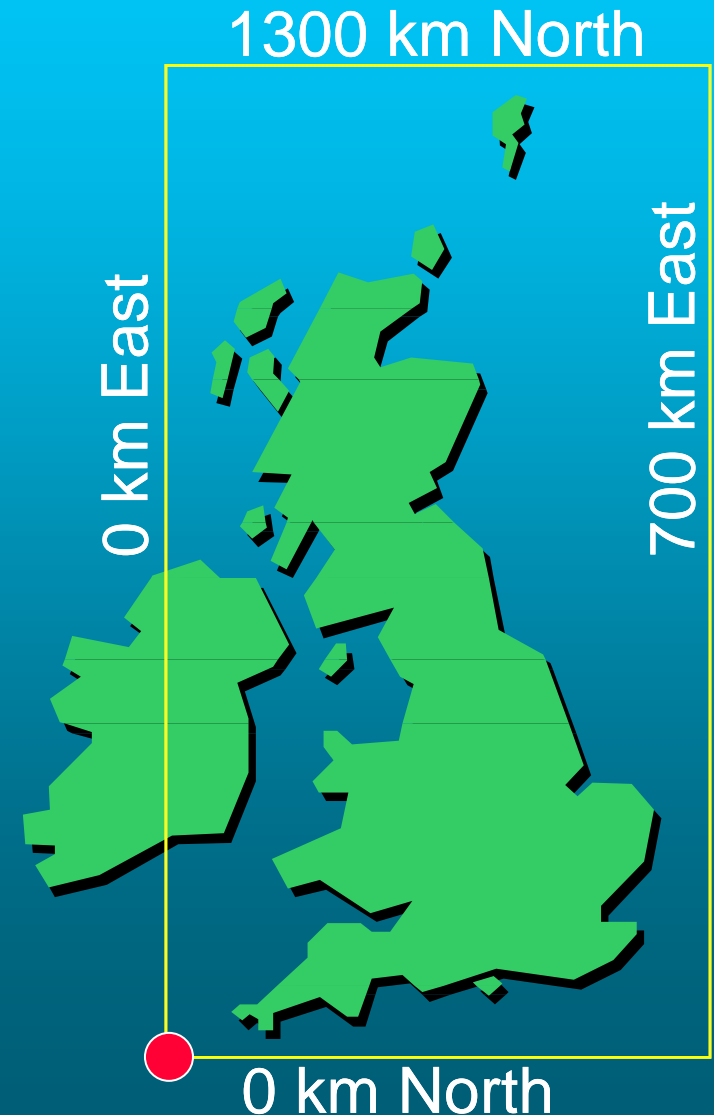
# National Grid Coordinates

Do you find the lettering system confusing?

To use the lettering system with National Grid Coordinates you must have a key map showing the squares with their labels

# National Grid Coordinates

Because of the substantial earth curvature over the UK, National Grid Coordinates require corrections to be applied to convert map distances to ground distances. This correction is known as the “Local Scale Factor”.



# Local Scale Factors

Easting	Scale Factor	Easting
400	0.99960	400
390	0.99960	410
380	0.99961	420
370	0.99961	430
360	0.99963	440
350	0.99965	450
340	0.99965	460
330	0.99966	470
320	0.99968	480
310	0.99970	490
300	0.99972	500

- Ground distance = Grid distance/Local scale factor

# Local Grids

A theodolite measures angles in the vertical plane from a plumb line determined inside the theodolite by a pendulum device called a “Compensator”

Therefore angles in the vertical plane are absolute values

They are always measured from zero<sup>0</sup> at the Zenith

Therefore 180<sup>0</sup> points to the centre of the earth

It follows that 90<sup>0</sup> and 270<sup>0</sup> are horizontal

# Local Grids

Unfortunately there is no easy way of aligning the horizontal circle of a theodolite with the National Grid North

This is why Local Grid North is usually aligned with the main features of the structure to be built and often bears no relationship to true North

# Local Grids

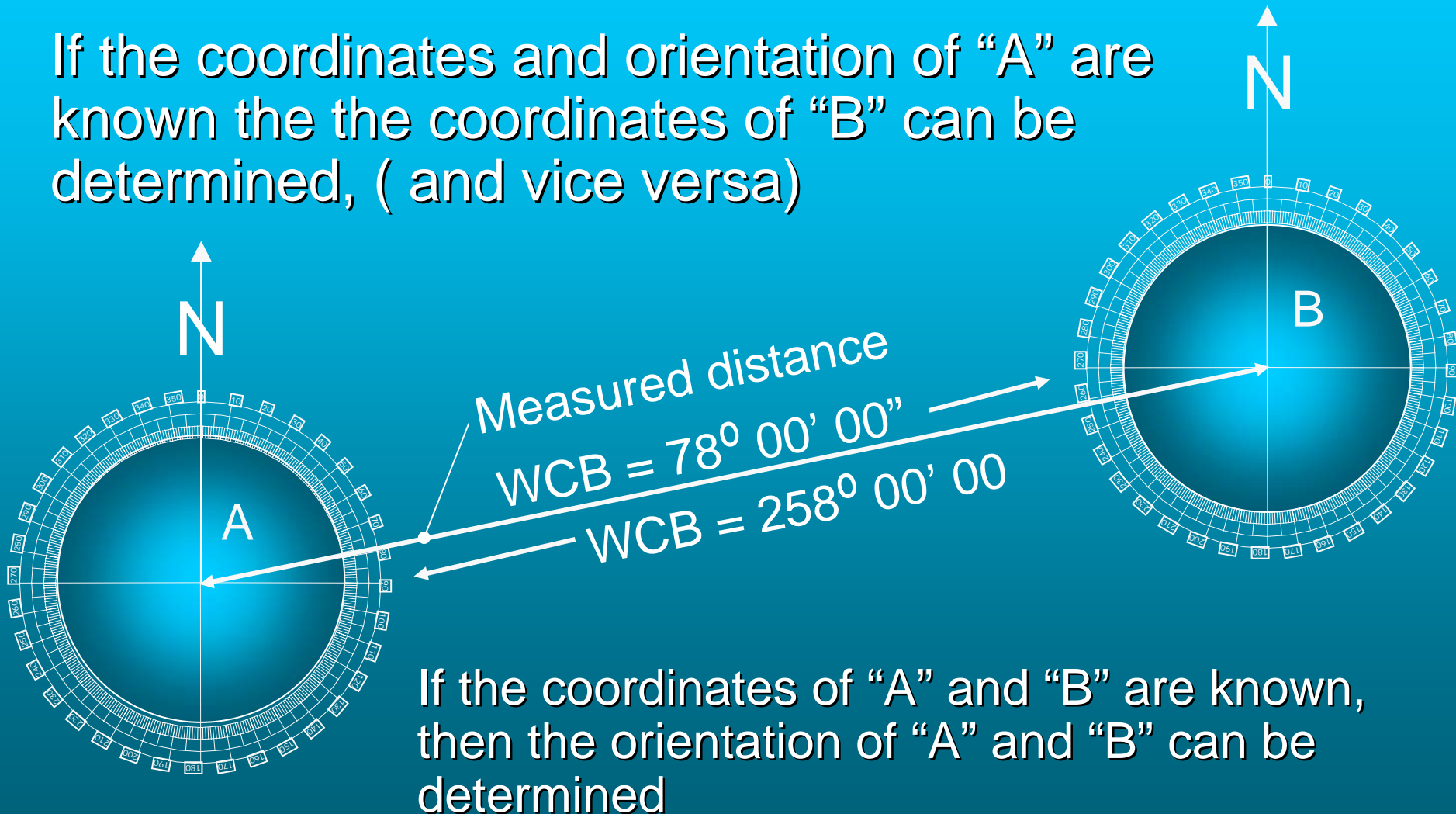
The angle between grid North and any line is known as the “Whole Circle Bearing”, and is the angle used on site for setting out.

This means of course that the theodolite used for setting out the bearings must be aligned with the Local Grid North.

Local North is usually calculated from the rectangular coordinates of two setting out points or survey stations on or near the site.

# Angles/Bearings

If the coordinates and orientation of “A” are known then the coordinates of “B” can be determined, ( and vice versa)



# Polar Coordinates

The whole circle bearing and horizontal distance are known as “Polar Coordinates”, and are obviously relative to the position of the theodolite, whereas rectangular coordinates are absolutes within the grid system.

# THE END



**Slide 6**

- For example, it is not necessary to set up on the tangent point of a highway curve to set out the curve.

**Slide 10**

- It is a comparatively easy procedure, (and highly recommended), to check the adjustment of a Total Station every day

**Slide 12**

- The grid covering the largest area is the main sports hall / swimming pool.
- The bottom right grid is the consulting rooms block.
- The egg shaped grid is the restaurant. It is aligned with the main grid but dimensioned from the consulting grid.

**Slide 15**

- The 500 km squares are labelled "H J N O S T"
- The 100 km squares are labelled "A" through "Z" excluding "I"
- Thus the bottom left hand, (South West), square is labelled "SV"
- And the bottom right hand, (South East), square is labelled "TW"
- Greenwich is in square "TQ"

**Slide 16**

- Eastings or X values are always quoted before Northings or Y values

**Slide 17**

- If you use the numeric system such a map is not necessary, but map retailers might not understand you

**Slide 19**

- The remainder of the Local Scale Factors are listed below.

Easting	Scale Factor	Easting
290	0.99975	510
280	0.99978	520
270	0.99981	530
260	0.99984	540
250	0.99988	550
240	0.99992	560
230	0.99996	570
220	1.00000	580
210	1.00004	590
190	1.00014	610
180	1.00020	620
170	1.00025	630
160	1.00031	640
150	1.00037	650
140	1.00043	660
130	1.00050	670

**Slide 21**

- Magnetic compasses are not accurate enough
- Gyroscopes are too expensive
- The Ordnance Survey can supply National Grid Coordinates of points local to most construction projects but
- Most people adopt the attitude “Why pay for something we can manage without”

**Slide 23**

- $XB = XA + (\text{Distance} \times \sin(\text{WCB}))$
- $YB = YA + (\text{Distance} \times \cos(\text{WCB}))$
- Correct Surveying terminology is “Whole Circle Bearing”, or “Azimuth”.
- Navigation terminology is “Heading”.
- “Bearing” is often used but should be avoided due to confusion with “Quadrant Bearing”, (Points of the compass).
- Install 2 pegs “A” and “B”.
- Set the theodolite at “A” and align zero on the circle with North.
- The theodolite horizontal circle reading is 78 degrees = “WCB”.
- Move the theodolite to “B”, sight “A” and set the horizontal circle to 258 degrees.
- Zero on the circle is now aligned with North, and all circle readings are now WCB's.