

**Interim Advice Note 99/07**

**Implementation of Local Grid  
Referencing System for England**

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This IAN supersedes MCHW Vol 5 Section 1  
Part 2 SD12/96 Section 5.2.4

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### **Implementation of Local Grid Referencing System for England**

#### **1. Background**

This interim advice note concerns essential guidance relating to the implementation of a new local grid referencing system for England. The adoption of a new local grid system is in line with the work being completed under the Highways Agency Nationwide Framework Contract to Undertake LiDAR Surveys. This note includes details of the changes affecting work being carried out under the framework contract and other geodetic surveys using the SD12/96 MCHW or other specification documents. It is applicable ONLY to those surveys that require to be issued on a local grid.

Numerous large scale and smaller local surveys are currently being conducted under the Geodetic Survey Framework and by contractors working for MA/MACs. The interoperability and compatibility of this survey data for other users within the Highways Agency has become paramount.

In many cases, the Ordnance Survey National Grid referencing system of Easting and Northing coordinates is used with height values quoted above Ordnance Datum, Newlyn (AOD) to reference survey data. However, this national coordinate system for the whole of England is a mapping projection of the Transverse Mercator type. Measurements from this, or any other national mapping projection system, contain scale factor errors. These are variable according to where the measurements are made within the mapping projection. To allow precise engineering calculations, a local grid must be developed for a survey site.

This interim advice ensures that Highways Agency geodetic surveys are all referenced to a series of standardised local grids across England. This will ensure survey data can be converted between local grid and Ordnance Survey Grid in a standardised way and that the method of data conversion is not lost with the survey report, as has happened in the past. It also ensures that the numerous different survey contractors are all using the same standardised local grid systems for their work.

The HA have worked closely with geodetic experts, the RICS, the data archive storage service and the Geodetic Survey Framework contractors. Using standardised local grids will ensure consistent transformations between local and national grid systems and integration of different surveys from different contractors at different sites and different times. It will also ensure interoperability of survey data across the HA to guarantee best value.

#### **2. Interaction with SD12/96**

The current section of SD12/96 which relates to Local Grid referencing is MCHW Vol 5 Section 1 Part 2 section 5.2.4. This should no longer be used and any survey which uses SD12/96 should now refer to this IAN for the local grid referencing.

#### **3. Implementation**

This IAN applies only to surveys being carried out within England

This Interim Advice Note should be implemented on all topographical/geodetic surveys being carried out from the date of this IAN, for all projects and schemes where a local grid is required. It is not applicable to surveys being carried out to OS grid coordinates. For surveys already underway this IAN should be implemented if a local grid transformation has not

already been established and data to that grid has been produced. There should be no design change or cost implications, where it is felt this may however be an issue discussions and agreement is required from the Highways Agency's Project sponsor with advice if necessary from SSR APD PGSG Geotechnics.

Where the decision is made not to implement the IAN the decision should be recorded by the Project Sponsor in accordance with the procedures in the www.

It is also intended to update the Manual for Construction of Highway Works and other notes for guidance in due course. This amendment will be incorporated within the revision to SD12/96 currently underway

#### 4. Technical Commentary

##### Mapping Projections

Each country in the world has a mapping projection which provides coordinates typically in an Easting and Northing format. For Great Britain, this is a Transverse Mercator Projection and this contains variable scale factor errors as outlined above. The errors are variable depending where the survey site is located in the country. There is a scale difference between a true measured ground distance and the corresponding distance measured between the coordinates of the two items. For example; the true ground distance between two drainage gullies on the M25, near Junction 28, might be 256.45m. The distance between the two gullies measured from the difference in their coordinates in the Ordnance Survey National Grid mapping projection at this point would be 256.39m. Therefore, measurements at this point in the mapping projection are too short.

This is due to the scale factor of the mapping projection being some 0.999762 at this location. In other locations, further east and further west from the central meridian of the country the scale factor means distances from the mapping projection become too long. The reason is due to the shape of the mapping projection which can be seen in Figure 1 below.

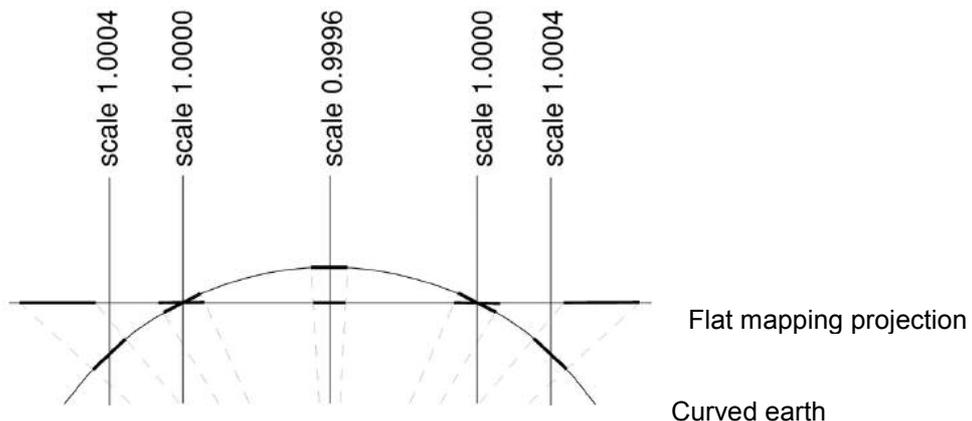


Figure 1: Scale Distortions Caused by Mapping Projection, Cross Section View

In order to overcome this effect the HA have split the country into a series of local grid zones. These are variable in width from some 9km wide at the east and west extremes of the country in East Anglia and Cornwall. However, the central zone covers some 78km as it spans the central meridian area of the country. The diagram showing the variable widths can be seen in Figure 3 below. The widths are such that the maximum distortion is kept below 5cm per 1km. That is to say, a distance measured between two points from their local grid coordinates will be correct to the ground distance to within 0.5%. Therefore, in the case of the M25 gullies example above, the true ground distance of 256.45m will be 256.45m

$\pm 0.01\text{m}$  in the local grid. In this case, the mapping projection data is scaled up in the local grid and made larger to fit the true earth. However, at the east / west extremities of England the mapping projection data is scaled down to fit the true earth, where the scale is in excess of 1.0000. All the local grid parameters and zone definitions can be found in Table 1 below.

### Height Factors

In addition to the scale factors caused by the mapping projection in Great Britain, the site height also causes an effect. With a site at sea level, i.e. with a site height of 0m above Ordnance Datum Newlyn, any distances measured on the ground will be the same as those measured within the local grid; within the 0.5% accuracy explained above. However, as the site height increases, the true distances measured on the ground increase with respect to those measured at sea level. This effect is caused by the curvature of the earth and the fact that the points on the earth are slightly further apart the higher up the points become. An exaggerated view is shown in Figure 2 below. For example, a distance of 1km measured at 100m above sea level will be 2cm shorter when reduced to sea level.

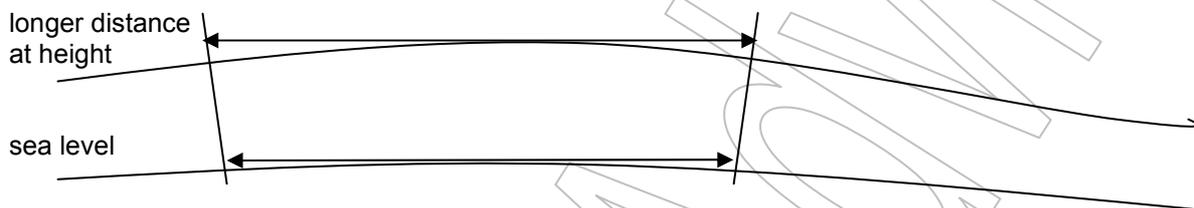


Figure 2: Scale Distortions Caused by Site Heights, Cross Section View

Therefore, a series of height bands have been generated with a spacing to also keep distortion due to height below 0.5%. This then ensures that distances measured from the local grid coordinates of points are also accurate to those measured on site, depending to the site height. For the case of the site at 100m, this falls within height Band 1 and the mapping projection data is also scaled up by an additional amount in the local grid to fit the true earth distance measurements at this height. The height bands can be found in Table 2 below, the formulae and method of generating the combined scale factor for each zone can be seen in the section which follows Table 1 and Table 2.

### Working in Multiple Zones

The local grid zone boundaries have been manipulated to fit with some historic local grid zones (see below) and also to fit with the road network. The design minimises roads crossing zones, particularly in the north/south direction. Where a site crosses between two zones, if the site and overlap is small, it can extend up to 1km into the next zone. For larger sites, the data should be split at the zone boundary. A single shift can then be applied to move one area to the next, this should be a shift of the data in the zone to the east to fit the data in the western zone. For example, a project on the M25 spanning zones A20H1 and A22H1, the data in zone A22H1 should be moved to fit the data in zone A20H1 at the eastern boundary of that zone.

### Historic Local Grid Zones

There are several historic local grids that have been developed for projects commissioned under the Geodetic Survey Framework. The design of the new local grid referencing system has taken into account these historic systems. In particular, the design has ensured the origin points and the zone boundaries of the larger systems have been retained.

## 5. Local Grid Parameters

### Zones and Projection Scale Factors

The table below provides the start point of each Zone, which is the bottom left hand corner of each zone. The origin point of each local grid zone (i.e. the Ordnance Survey grid coordinates of the zero/zero point of each local grid zone) together with the associated projection scale factor and height bands that will be applicable. The first stage in using the Local Grid Referencing system for England is to locate in which zone your survey is taking place. Each of the zone start values and the map of the zones below (see Figure 3) should be used to determine the appropriate local grid zone(s).

Zone	Zone Start E	Zone Start N	Zone Origin E	Zone Origin N	Projection SF	Height Bands
A1	148000	29000	138000	-171000	1.000354	1
A2	157000	29000	147000	-171000	1.000300	1
A3	166000	29000	156000	-171000	1.000249	1,2
A4	175000	39000	165000	-171000	1.000199	1
A5	184000	39000	174000	-171000	1.000149	1,2
A6	194000	39000	184000	-171000	1.000098	1,2
A7	204000	59000	194000	-171000	1.000050	1,2
A8	214000	39000	204000	-171000	1.000001	1,2
A9	225000	39000	215000	-171000	0.999952	1,2
A10	237000	39000	227000	-171000	0.999901	1,2
A11	251000	39000	241000	-171000	0.999847	1,2,3
A12	266000	39000	256000	-171000	0.999797	1,2,3
A13	282000	59000	272000	-171000	0.999749	1,2
A14	299000	79000	289000	-171000	0.999700	1,2
A15	322000	79000	312000	-171000	0.999647	1,2
A16	356000	79000	346000	-171000	0.999602	1,2
A17	434000	98000	424000	-171000	0.999633	1,2
A18	468000	98000	458000	-171000	0.999686	1,2
A19	498000	98000	488000	-171000	0.999740	1,2
A20	515000	98000	505000	-171000	0.999788	1,2
A21	532000	98000	522000	-171000	0.999843	1,2
A22	549000	98000	539000	-171000	0.999906	1,2
A23	566000	98000	556000	-171000	0.999958	1,2
A24	575000	98000	565000	-171000	1.000001	1,2
A25	586000	98000	576000	-171000	1.000049	1,2
A26	596000	98000	586000	-171000	1.000097	1,2
A27	606000	119000	596000	-171000	1.000147	1,2
A28	616000	119000	606000	-171000	1.000198	1,2
A29	625000	119000	615000	-171000	1.000248	1
A30	634000	119000	624000	-171000	1.000300	1

Zone	Zone Start E	Zone Start N	Zone Origin E	Zone Origin N	Projection SF	Height Bands
B15	322000	239000	312000	-211000	0.999647	1,2,3
B16	356000	239000	346000	-211000	0.999602	1,2,3,4
B17	434000	239000	424000	-211000	0.999633	1,2
B18	468000	239000	458000	-211000	0.999686	1,2
B19	498000	239000	488000	-211000	0.999740	1
B20	515000	239000	505000	-211000	0.999788	1
B21	532000	239000	522000	-211000	0.999843	1
B22	549000	239000	539000	-211000	0.999905	1
B23	566000	239000	556000	-211000	0.999958	1
B24	575000	239000	565000	-211000	1.000000	1
B25	586000	239000	576000	-211000	1.000049	1
B26	596000	239000	586000	-211000	1.000097	1
B27	606000	239000	596000	-211000	1.000147	1
B28	616000	239000	606000	-211000	1.000198	1
B29	625000	239000	615000	-211000	1.000247	1
B30	634000	239000	624000	-211000	1.000299	1
B31	643000	278000	633000	-211000	1.000353	1
B32	652000	278000	642000	-211000	1.000408	1
C13	282000	498000	272000	-226000	0.999748	1
C14	299000	458000	289000	-226000	0.999700	1,2,3,4
C15	322000	449000	312000	-226000	0.999647	1,2,3,4,5
C16	356000	449000	346000	-226000	0.999602	1,2,3,4
C17	434000	449000	424000	-226000	0.999633	1,2
C18	468000	449000	458000	-226000	0.999686	1,2
C19	498000	449000	488000	-226000	0.999740	1,2

**Table 1 Local Grid Zones, Origins, Projection Scale Factors and Height Banding**

The origin coordinates have been selected to ensure the local grid values have a five figure easting value and a six figure northing value. Both values are therefore distinct and widely different to the Ordnance Survey National Grid.

### Height Bands

In addition to the correction necessary from the mapping projection, the site elevation also has an effect as outlined above in the Technical Commentary. The table below provides the banding that should be used according to the mean project height. Therefore, the second stage is to determine the mean site height of the survey. This should then be rounded up or down to the nearest height band shown in Table 2 below. For example, a survey site with a mean site height of 55m would be Band 1, as would a site at 155m.

Height (m)	Elevation Scale Factor	Height Bands
0	1.0000000	
80	0.9999875	000m to 160m (mean site height 80m) - BAND 1
160	0.9999750	
240	0.9999625	160m to 320m (mean site height 240m) - BAND 2
320	0.9999500	
400	0.9999375	320m to 480m (mean site height 400m) - BAND 3
480	0.9999250	
520	0.9999125	480m to 640m (mean site height 520m) - BAND 4
640	0.9999000	
720	0.9998875	640m to 800m (mean site height 720m) - BAND 5
800	0.9998750	

**Table 2 Local Grid Zone Height Banding Values**

### Conversion Formulae

Firstly the combined scale factor (CSF) should be computed using the appropriate zone projection scale factor (PSF) and the elevation scale factor (ESF) used by each height band. This computed using equation 1 below:

$$\text{CSF} = \text{PSF} \times \text{ESF} \quad (1)$$

Secondly the local grid can be computed using the formulae 2 and 3 below

$$\text{Local E} = \frac{\text{OS E} - \text{Origin E}}{\text{CSF}} \quad (2)$$

$$\text{Local N} = \frac{\text{OS N} - \text{Origin N}}{\text{CSF}} \quad (3)$$

As an example for a site at 345m along the M62, the appropriate zone is B16 and the height band is 3. The Ordnance Survey coordinates of the point in the zone are, for example; 397895 E, 414760 N, 350m AOD. These can be converted to the equivalent local grid values using the following steps:

1. CSF = 0.999602 x 0.9999375 = **0.9995395**
2. Local E = (397895 – 346000) / 0.9995395 = **51918.91 E**
3. Local N = (414760 + 211000) / 0.9995395 = **626048.30 N**

To shift an entire drawing on the Ordnance Survey grid system to the local grid the following procedure should be carried out. Take the spatial data to be transformed and insert a suitable OS PGM coordinate near the area (for QC checking). Shift it by the relevant Origin Easting and Origin Northing given in Table 1 above. Save this as a drawing block. Open the local grid drawing/model and import the saved block. Scale x and y ONLY by the reciprocal of the CSF for the appropriate local grid zone (e.g. 1.0004609 for zone B16H3 given above). Check the local grid coordinates of the control point to ensure transformation has been achieved correctly.

### Zone naming

Each zone should be named as the appropriate zone and height banding. For example in the above case, the local grid referencing system is: B16H3.

## 6. Local Grid Map

The map shown below provides the layout of the local grid zones for England. Note how the widths of the zones vary according to the location of zone within the national mapping projection of Great Britain.

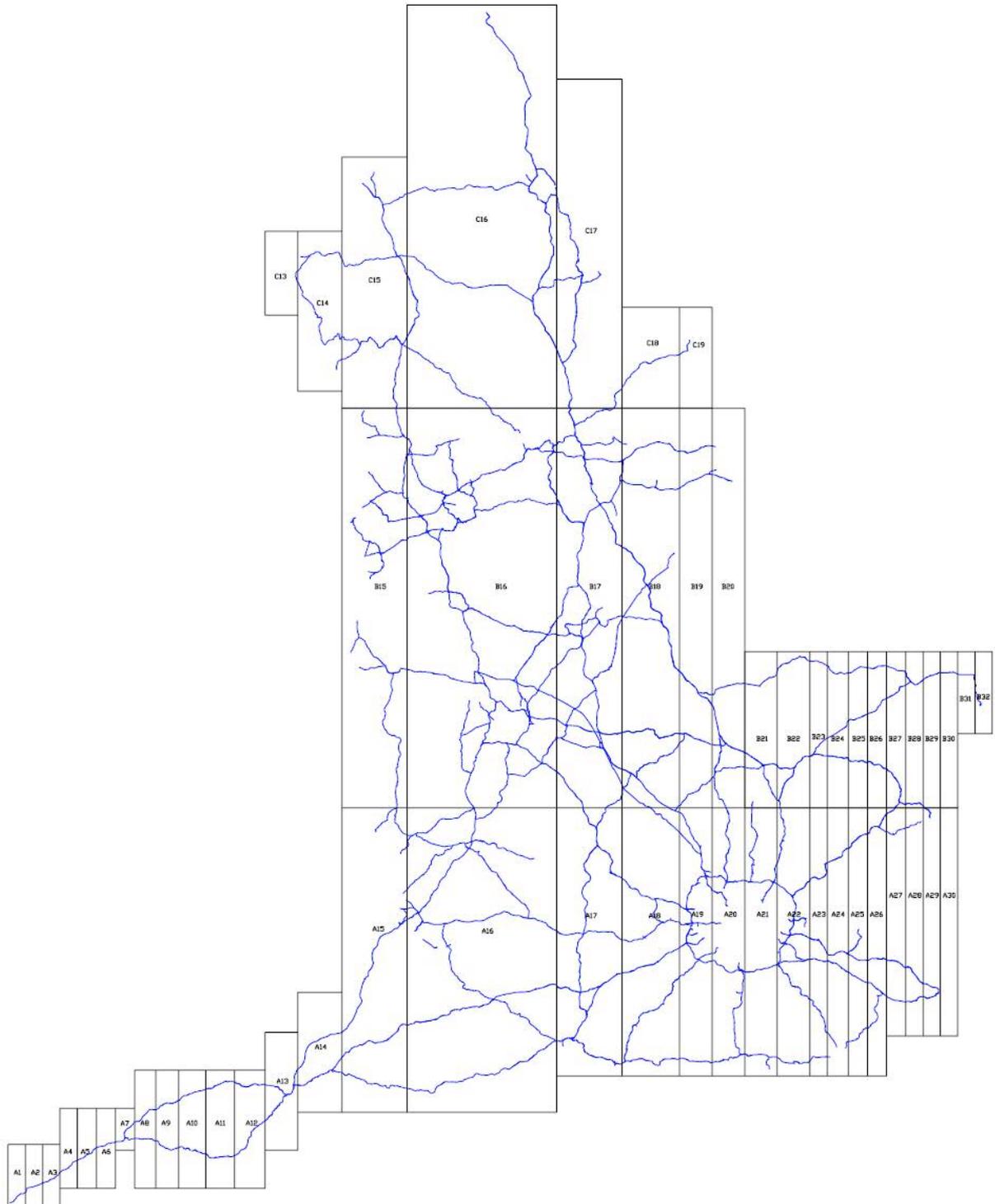


Figure 3: Highways Agency Local Grid Layout for England