Scottish Natural Heritage

Visual representation of wind farms

Consultation draft

May 2013

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

CONTENTS

Note – this is a consultation draft. This guidance should not be used for the production of wind farm visualisations until the consultation has been completed and the revised guidance published.

1 Introduction

1 'Pictures speak louder than words'. Images are an incredibly powerful medium in conveying information – both positive and negative, and in capturing our imagination. The landscape and visual assessment of wind farms, however, involves much, much more than just looking at pictures. It requires detailed site assessment of the landscape and visual resource while also considering data on the potential effects of a development.

2 This guidance is mainly aimed at landscape practitioners, those involved in producing the materials involved and planning officers / decision makers involved in the planning process. A condensed version aimed at members of the public will be produced following the consultation. The visualisations described within this guidance are designed for use by all stakeholders within the planning process.

3 While images are very useful in communicating information, they can never tell the whole story. They can never replicate the experience of seeing a wind farm in the landscape, whether they are photographs, maps, sketches or computer generated visualisations, prepared using the highest specification and skill possible. Similarly, however, assessment in the field will be considerably limited without the benefits of technical data such as visibility maps and visualisations that demonstrate the technical aspects of a proposed development.

4 Experience gained since this guidance was first published in 2006 has led to a better understanding of how to best visually represent proposed wind farm developments in a more accessible way. A new section on offshore wind farms has also been included. The methodology described below seeks to produce visualisations which are easier for both the public and decision makers to use.

5 Nonetheless, anyone using visualisations must be aware of their limitations and these are set out in section 4 and **annex A**. It is recommended that the standard text in **annex A**, should be inserted into the Environmental Statement and made available at public exhibitions. A standard 'health warning', to be placed on every visualisation, is also provided.

6 This guidance applies to wind farm developments in Scotland. Different landscapes, types of wind farms and conditions in other countries may require different approaches.

Landscape and Visual impact assessment

7 Visual analysis forms just one part of a Visual Impact Assessment (VIA), the process by which the potential significant effects of a proposed development on the visual resource are methodically assessed. In turn, VIA forms just one part of a Landscape and Visual Impact Assessment (LVIA) and the wider process of Environmental Impact Assessment (EIA).

8 Detailed information on the process of LVIA, together with a recommended methodology, are provided within the 'Guidelines for Landscape and Visual Impact Assessment' (GLVIA), produced by The Landscape Institute and Institute of Environmental Management and Assessment (2013).

9 A combination of illustrative techniques are used during the LVIA process. The most commonly used include computer generated visibility mapping, wirelines and photomontages, sometimes with supporting hand drawn diagrams and sketches. These show where a proposed development may be seen from and how it may appear in terms of its basic characteristics such as size, pattern and shape.

10 It is essential that a wind farm proposal is placed within the wider landscape and visual context. For those who visit the viewpoints described, the context will be visible in the field. However, many people, including members of planning committees and other decision makers will not be able to visit all of the viewpoints for themselves. It is therefore **essential** that visualisations which demonstrate the wider landscape and visual context are provided to **all** audiences throughout the development process. The combination of images proposed in this consultation seeks to achieve this.

Cumulative Landscape and Visual Impact Assessment (CLVIA)

11 As the number of proposed wind farms increases in Scotland, the issue of potential cumulative impacts becomes ever more important. Separate guidance from SNH describes how to assess cumulative impacts. The methodology described below takes account of the need to illustrate cumulative effects and recommends the use of additional tools to do so.

Scope of this guidance

12 This guidance is focussed on the production of visualisation-related materials to be included within an Environmental Statement (ES) and made available to the public to inform decision making. Other methods of visualisation using computer animation and video montage are not covered in detail in this guidance. These methods may be helpful to illustrate the effects of the proposal, in some situations adding value to the decision making process, although the outputs are difficult to verify. These methods are not currently considered appropriate as a replacement for hard copy visualisations in the ES for presentation within the ES, though advances in technology may facilitate this in the future.

13 This guidance applies to both onshore and offshore wind farms. However, slight differences in the methodology apply to offshore wind farms and these are described in section 4.

How to use the guidance

14 The guidance is divided into three sections:

- Zone of Theoretical Visibility (ZTV) maps
- Viewpoints
- Visualisations

Using different tools throughout the planning process

15 The tools described within this guidance can be used at various stages in the process of designing and assessing a wind farm. Draft ZTVs and wirelines will be most useful in the early stages of site assessment, planning and design. Viewpoints will be selected, assessed, revised and illustrated through the whole process. Finalised, high quality ZTV, wirelines and photomontages will be most useful at the later stages, presenting the proposal to stakeholders and within the Environmental Statement.

Production of visualisations in future

16 The previous version of this guidance made a series of recommendations and provided minimum requirements. It is intended that the final version of this guidance will be more prescriptive, especially on the size and number of images to be presented and the camera / lens to be used. All wind farm visualisations will be expected to conform to the standard requirements. This should increase confidence in the images and reduce the scope for confusion in the future. It should also lead to a consistent approach across Planning Authorities. Visualisations which do not conform to the standards will not be accepted by SNH.

Glossary of key terms

17 There are a number of key terms used throughout this document that need to be explained at an early stage:

Environmental Impact Assessment (EIA). The evaluation of significant effects on the environment of particular development proposals.

Equivalent Focal Length. Refers to the manipulation of the photograph (by cropping and enlarging) to reproduce the *equivalent* of a photograph taken with a different focal length lens when printed at a certain size.

Focal Length. Refers to the focal length of the actual lens used to take the photograph(s).

Landscape and Visual Impact Assessment (LVIA). This is the professional and methodical process by which assessment of the impacts of a proposed development on

the landscape and visual resource is undertaken. It comprises two separate and distinct parts - Landscape Impact Assessment and Visual Impact Assessment.

Landscape Impact Assessment. This is the process by which assessment is undertaken of the impacts of a proposed development on the landscape, its character and quality.

Panorama. An image covering a horizontal field of view wider than a single 50mm frame. Wirelines and photomontages may also be produced as panoramas.

Photomontage. A visualisation which superimposes an image of a proposed development upon a photograph or series of photographs.

Scoping. The process of identifying the likely significant effects of a development on the environment which are to be the subject of assessment.

Significant. This term is used to describe the nature of a change. VIA, LVIA and EIA aim to identify and assess significant effects.

Visual impact assessment. The professional and methodological process used to identify the visual effects, and assess their likely significance, of a proposed development. Visual effects are those on specific views and on the general visual amenity experienced by people (based on GLVIA, 2013).

Visualisation. Computer simulation, photomontage or other technique to illustrate the appearance of a development. This term is used within this guidance to include photographs, but not Zone of Theoretical Visibility (ZTV) maps.

Wirelines. These are also known as **wireframes** and **computer generated line drawings**. These are line diagrams that are based on DTM data and illustrate the three-dimensional shape of the landscape in combination with additional elements.

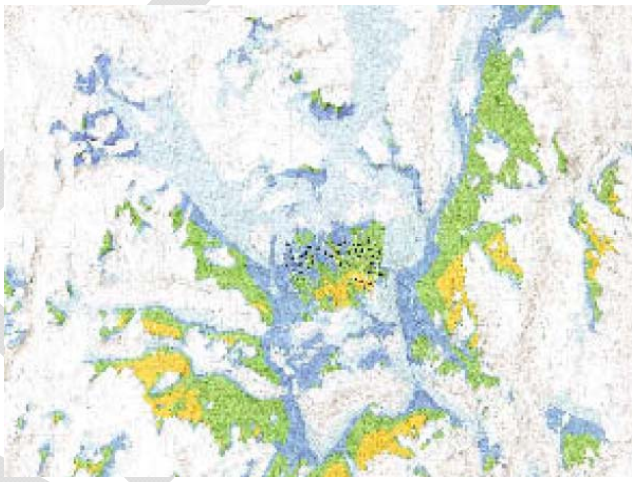
Zone of Theoretical Visibility (ZTV). Also known as a **Zone of Visual Influence (ZVI), Visual Envelope Map (VEM)** and **Viewshed**. This represents the area over which a development can theoretically be seen, based on a DTM. The ZTV usually presents a 'bare ground' scenario - that is, a landscape without screening structures or vegetation.

2 Zone of Theoretical Visibility

18 The term 'Zone of Theoretical Visibility' (ZTV) is used to describe the area over which a development can theoretically be seen based on a Digital Terrain Model (DTM) and overlaid on a map base. This is also known as a Zone of Visual Influence (ZVI), Visual Envelope Map (VEM) and Viewshed. However the term ZTV is preferred for its emphasis of two key factors that are often misunderstood:

- visibility maps represent where a development may be seen **theoretically** – that is, it may not actually be visible in reality, for example due to localised screening which is not represented by the DTM; and

- the maps indicate potential **visibility** only - that is, the areas within which there may be a line of sight. They do not convey the nature or magnitude of visual impacts, for example whether visibility will result in positive or negative effects and whether these will be significant or not.



19 ZTVs are calculated by computer, using any one of a number of available software packages and based upon a DTM that represents topography. The resulting ZTV is usually produced as an overlay upon a base map, representing theoretical visibility within a defined study area.

20 Production of ZTVs is usually one of the first steps of VIA, helping to inform the selection of the study area in which impacts will be considered in more detail. ZTVs provide the following information:

- where visibility of a wind farm is most likely to occur;
- how much of the wind farm is likely to be visible;
- how much of the wind turbines is likely to be visible if separate ZTVs are produced showing visibility up to blade tip height, and visibility up to the hub or nacelle; and
- the extent and pattern of visibility.

In combination with a site visit, possibly with initial wireline diagrams, this information enables the landscape architect or experienced specialist assessor to identify a provisional list of viewpoints. It also allows the determining authority and consultees to judge how representative these are and whether they include particularly sensitive vantage points.

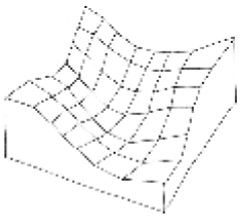
21 Importantly, **ZTVs indicate areas from where a wind farm may be seen within the study area, but they cannot show how it will look, nor indicate the nature or magnitude of visual impacts**.

USES OF ZTVs	LIMITATIONS
• A ZTV gives a good indication of the **broad areas** from where a wind farm might be seen • A ZTV predicts **theoretical visibility** • A ZTV is a useful **tool** as long as its limitations are acknowledged • The ZTV can be used to **identify viewpoints** from where there may be significant visual impacts, enabling an assessment to consider these with the aid of visualisations • A ZTV is a useful tool for comparing the relative visibility patterns of different wind farms or different wind turbine layouts	• A ZTV is only as accurate as the data on which it is based • A ZTV **cannot indicate the potential visual impacts** of a development, **nor show the likely significance of impacts**. It shows potential theoretical visibility only • It is not easy to test the accuracy of a ZTV in the field, although some verification will occur during the assessment of viewpoints.

ZTV preparation

ZTV data

22 A ZTV is produced using a computer-based software package. Several of these are commercially available and most wind farm design packages and many Geographical Information System (GIS) packages have this facility. However, operation of even the most user-friendly package requires a high level of expertise and understanding of all the specific features and assumptions applied by the software. The software used should be noted in the ES or on the ZTV itself.



Square grid DTM

23 ZTV production begins with a DTM that represents the ground surface as a mesh of points. This may form a regular grid of squares when seen on plan, known as a Square Grid DTM, or an irregular network of triangles, known as a TIN (Triangulated Irregular Network).

TIN

24 A Square Grid DTM is fundamentally incapable of representing terrain features smaller than the cell size, such as a small knoll or outcrop.

Such features are either lost between grid points or represented by one point only. A TIN can, in principle, represent finer detail than a Square Grid DTM as it can represent all the detail shown by contours. However, in practice, a Square Grid DTM with a suitably chosen cell size will represent almost as much detail and may interpolate better between contours on less steeply sloped land.

25 Both formats are acceptable. The choice between them is most likely to depend on the software being used and from where the data is sourced. It is common practice for a Square Grid DTM to be chosen if OS data is to be used, while a TIN is used when based on independent and/or detailed survey data, enabling high and low points to be better represented.

26 The Ordnance Survey (OS) supply data in two formats - gridded, which has already been interpolated into a Square Grid DTM, and as contours, which is the usual starting point for constructing a TIN.

27 The OS Square Grid DTM product, 'Landform Profile', uses a 10m cell size and is interpolated from the contours shown on OS 1:10,000 and 1:25,000 scale mapping. An earlier product, 'Landform Panorama', once temporarily withdrawn, but now re-launched, uses a 50m cell size and is derived from 1:50,000 scale mapping.

28 The 10m Landform Profile DTM provides a more precise representation of topography than the 50m Landform Panorama DTM although it is more expensive. Landform Panorama DTM is less precise not only because of the larger cell size, but also because the shape and detail of the 1:50,000 scale contours used as the source data are themselves more simplified than the 1:10,000 scale contours. If Landform Panorama DTM is used, it is important that the resolution at which it is provided is used and the grid is not down-sampled.

29 OS Landform Panorama DTM is considered an acceptable product, especially if the landform is simple. However the recommended preference is for OS Landform Profile, especially if the terrain is very rugged.

30 Although considered adequate for the purposes of VIA (given that ZTVs are just a tool for assessment), the accuracy of most DTMs is limited and they do not include accurate representation of minor topographic features or areas of recent topography change, such as open cast coalfields, spoil heaps and mineral workings. Known significant discrepancies between the DTM and the actual landform should be noted in the ES text. If survey information on recent topographic change is available, together with the necessary software to amend the DTM, it may be useful to include it. However, any changes to the DTM should also be noted in the text.

31 The OS provides accuracy figures for each of its data products (expressed statistically as root-mean-square error (RMS) in metres). Where the DTM is obtained from another

source, the expected accuracy can also usually be obtained from the data supplier. These accuracy figures should be stated within the ES.

32 ZTV production also requires **accurate data** on the locations and heights of the proposed wind turbines. For the purposes of ZTV calculation, it is sufficient to represent each proposed turbine as a single point in space, located directly above the centre of the proposed base of the turbine. The height specified is usually that at either hub/nacelle height or at a blade tip pointing straight up, but can be at any other point on the turbine depending on the ZTV analysis required.

33 It is recommended that separate ZTV calculations are run for the overall height (to blade tip) and for the height of the turbine to its hub (representing the nacelle that houses the generator on top of the tower). This is a useful comparison that helps to identify areas where turbine blades may be visible, but not the tower or nacelle. For a single proposed turbine, it can also be useful to run ZTVs with other targets, such as 1m above the ground and at the base of the rotor sweep which, in combination, provide an indication of where almost all the turbine or just the rotor sweep may be visible.

ZTV calculation

34 Some software packages offer both a standard and 'fast' option for ZTV calculation. 'Fast' implies the use of mathematically approximate methods in order to speed up the computation, which tends to result in greater errors. It is recommended that this is only used to obtain a quick, provisional result which will be later superseded by a more comprehensive calculation for presentation in the ES. It is also important that users of ZTV software ensure that they are clear about the technical limitations inherent in their chosen package.

35 Visibility is affected by earth curvature and the refraction (bending) of light through the atmosphere, particularly at greater distances. This effect should be included in the ZTV calculation as its absence will tend to overestimate visibility. **Annex B** describes this issue in more detail and includes a table of the vertical difference introduced by earth curvature and refraction with distance. At 10km, the vertical difference is enough to hide a single storey house and it increases more rapidly thereafter.

36 These limitations, inherent in the data and in the method of calculation should always be acknowledged and, if possible, quantified. Note that these limitations may either over or under-represent visibility. As a general rule, **ZTVs should be generated to err on the side of caution, over-representing visibility**.

37 A ZTV usually represents visibility as if the ground surface was bare; that is, it takes no account of the screening effects of intervening elements such as trees, hedgerows or buildings, or small scale landform or ground surface features.

38 In this way, the ZTV can be said to represent a 'worst case scenario'; that is, where the wind farm could potentially be seen given no intervening obstructions and favourable weather conditions (while accepting that the DTM data can sometimes understate visibility at the very local level). To understand how this might be affected by typical visibility conditions within a particular area, Met Office data on visibility conditions can be obtained.

39 Some software does allow the use of more sophisticated datasets, enabling some screening effects to be taken into account. Examples are the application of data which applies different 'thickness' to various land uses such as forestry and urban areas, and the use of digital surface data obtained from laser-based aerial surveys which represent the tops of vegetation and buildings. At present, for most projects, this data does not make a considerable difference to the pattern of visibility, while tending to be very expensive; therefore, its use should be limited to specific projects where the benefits will be notable. For example, it may be used to examine visibility in detail within a property listed in the Inventory of Gardens and Designed Landscapes.

40 Care needs to be taken when assessing this kind of information, as its accuracy is limited by data availability and the constant change in landscape conditions. The results will also be closely tied to the specifications used, for example the height of trees; as a consequence, these should be noted within the ES. Particular care is required when representing forestry, which will be felled and replanted on varying timescales, and should not be considered a permanent screening feature.

Question 1: ZTVs that illustrate the screening effect of some land cover types (i.e. forestry or buildings) are now feasible. Would these be useful in addition to 'bare ground' ZTVs?

41 In some situations, it might be useful to map other characteristics such as the number of wind turbines seen against the skyline or what proportion of the horizontal field of view is likely to be occupied by the visible part of a wind farm, known as the 'horizontal array angle'. This information is particularly useful for considering the impact of a very large wind farm or several wind farms where they would be seen together within panoramic views. However, for most wind farms, the width of view can usually be more simply judged by considering the distance to the development in combination with wireline diagrams from specific viewpoints.

42 Any analyses that calculate characteristics other than simple visibility over base ground should be produced in addition to bare ground visibility, not as an alternative to it. Although these currently have various limitations as described above, improvement and development of this kind of data is likely to occur in the future.

Viewer height

43 As the ZTV calculates the number of wind turbines visible at each of a number of points just above the ground, a measure of viewing height is required. Often this is set at 1.5–2m. The rationale for this height is usually given as relating to viewer height and/or camera height to maximise correlation between the ZTV and visualisations. However, although viewer height is an important element of the ZTV calculation, the error inherent in the DTM is of about the same magnitude (1.5m RMS error for Landform Profile, 2.5m RMS error for Landform Panorama). **It is therefore recommended that a standard viewing height of 2m is used.**

Extent of ZTV

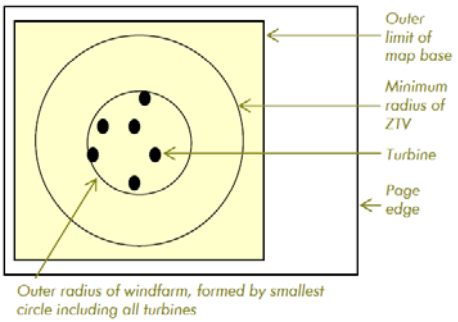
44 A ZTV map illustrates locations within a study area from where a development is potentially visible (the LVIA "search area"). However, just because a development can be seen, it does not automatically follow that this will result in significant visual impacts. This creates a circular process of decision-making. That is: **the finalised distance of a ZTV should extend far enough to include all those areas within which significant visual impacts of a wind farm are likely to occur; (LVIA "study area")** yet the significance of these visual impacts will not actually be established until the VIA has been completed; and the VIA process needs to be informed by the ZTV. As part of this cycle of assessment, the recommendations given within the table below act as a starting point.

45 The extent of ZTV required may need to be adjusted inwards or outwards according to the specific characteristics of a landscape and/or proposed development. The extent of the ZTV should be discussed and agreed with the determining authority and consultees. In some situations where cumulative effects are being assessed the ZTV may not be circular in shape, but may be extended to include a specific transport route, for example.

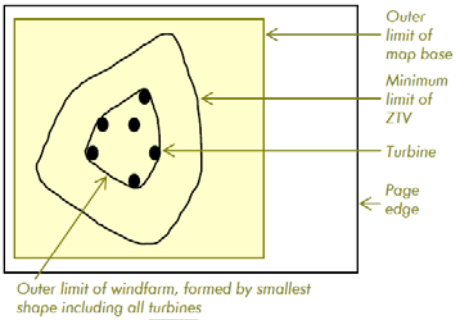
Height of turbines including rotors (m)	Recommended ZTV distance from nearest turbine or outer circle of wind farm (km)
up to 50	15
51-70	20
71-85	25
86-100	30
101-130	35
130+	45

Question 2: This table has been adapted to reflect the use of increasingly large turbines. Do you agree with the distances proposed?

46 The extent of a ZTV is typically defined as a distance from the outer turbines of a wind farm. This can be to the nearest turbine or as incorporated within a specific shape, as shown opposite. The most suitable option will usually depend on the layout of the wind farm as shown in the diagram.



47 If a wind farm is very small and concentrated in layout, typically 5 wind turbines or fewer, it may be reasonable to measure the extent of the ZTV from the centre of the site. However this should always be agreed with the determining authority and consultees.



48 Some practitioners have suggested that, as it usually becomes difficult to see turbines clearly when over 30km away, extending a study area further than this is unlikely to ever be necessary. Although there is obviously some validity to this argument, some exceptional visibility conditions occur at times in Scotland. Turbine heights are also increasing, making them visible over greater distances.

49 Combined with the fact that some key vantage points in Scotland, such as the tops of mountains or hills, are of very high sensitivity in terms of scenic and/or recreational value, some wind farms could clearly be seen at certain times from very sensitive locations at much greater distances away. Some wind farms in Scotland have been viewed at greater than 60km. This means it is feasible that, in exceptional circumstances, visibility of a wind farm or wind farms could result in significant effects well beyond 30km.

50 The reasons for establishing the eventual radius of a wind farm ZTV for use in an Environmental Statement should be clearly documented in the supporting text.

Cumulative ZTVs

51 Representing cumulative ZTVs can be difficult when there are large numbers of wind farms involved. A sensible and pragmatic approach is required to illustrate the **significant cumulative effects which are likely to affect decision making**. Reproducing very large numbers of overlapping cumulative ZTVs does little to assist decision making. The combination of ZTVs should therefore be discussed and agreed with the planning authority and SNH at an early stage.

Question 3: Presenting cumulative ZTVs in a sequence of pairs or trios can help avoid too much confusion: do you agree or do you have alternative suggestions?

Presentation of ZTV information

Base map

52 A ZTV should be superimposed on a clearly legible base map at a recognised standard scale, such as the 1:50,000. For an ES in A3 format (420 x 297mm), showing a ZTV extending from a site up to a 30km radius, a scale of 1:250,000 will be required to fit a single page. At this scale, the ZTV can only provide an overview and a more detailed ZTV is required for use as a working tool for VIA, consultation and design. This should be provided on a hard copy 1:50,000 OS base (copied at either 1:50,000 or 1:100,000) to be able to illustrate sufficient detail. However a ZTV at this scale obviously results in a much larger map than A3. Conventionally, this is presented as either a single fold-out plan or as separate A3 sections (with minimum 1km overlaps).

53 Single maps are usually clearer as they show the whole study area on one sheet, but they may be more difficult to handle and require folding and insertion within a wallet in the ES. Separate A3 maps will divide the study area, and possibly the site, into sections, so a supplementary and overlapping site-centred map may also be required (see table below on page sizes).

ZTV extent (from single point)	Size of single map				Number of A3 separate sheets*	
	1:100,000		1:50,000		1:100,000	1:50,000
	Image size	Paper size	Image size	Paper size		
15km	300x300	A2	600x600	A0	2	6
20km	400x400	A2	800x800	A0	2	6
25km	500x500	A2	1000x1000	-	4	12
30km	600x600	A0	1200x1200	-	6	15
35km	700x700	A0	1400x1400	-	6	24

54 For a ZTV to be clear and legible when overlain with colour shading, the base map needs to be in greyscale. This is to prevent confusion of overlays, for example a yellow overlay upon blue coloured lochs will appear as green, and this could be confused with woodland. To maximise legibility, it is also important that the base map is of a high quality resolution and not too light or dark.

55 Each individual wind turbine should be clearly marked upon the ZTV, usually shown as a small circle or ‘dot’, depending on the base map against which it has to be distinguished. Although it is recommended that the ES includes a map that shows individual turbine numbers and their grid coordinates, and that the ZTV should include reference to this map, it is best not to include this information on the ZTV itself in order to keep this map as clear as possible.

56 Numbered viewpoint locations should also be shown on the ZTV, although it is important to label these carefully to avoid obscuring vital ZTV information.

57 For ease of legibility it is recommended that the ZTV shows concentric rings to indicate different distances from the proposed development, for example 10, 20 and 30 km. However, the areas encircled by these rings should not be shaded or coloured as this may imply a direct relationship between distance and relative visibility or visual impact that would be misleading. To maintain legibility, the number of rings should also be limited.

58 Where ZTVs need to show potential visibility of different components of the wind turbines, this should be clearly explained as follows:

- a ZTV 'to blade tip' shows potential visibility of any part of a wind turbine up to its highest point (but not all of the wind turbine would necessarily be seen);
- a ZTV 'to hub' or 'to nacelle' shows potential visibility of any part of a wind turbine up to the height of its hub or nacelle (but not all of the wind turbine tower would necessarily be seen); and
- Comparison between ZTVs to blade tip and nacelle/hub allows identification of those areas from which the turbine towers might not be visible, but the blades (or part of these) would.

59 Presentation of digital ZTVs can be useful, in addition to paper copies, as it allows viewers to enlarge the ZTV on screen to focus in on specific areas of concerns. In some cases ZTVs 'draped' over 3-d modelling or aerial photographs can be a useful addition.

Colour Overlays

60 Areas of potential visibility should be illustrated by a colour overlay. This should be slightly transparent so that the detail of the underlying map can be seen. Transparency within most software is expressed as a percentage – the amount of colour dots to clear space per unit area. The level of overlay transparency chosen should ensure that the detail upon the base map remains clearly discernible and no single colour appears more prominent than another.

61 If a range of colours is to be used, the shades and tones should be chosen carefully. Darker colours tend to read as portraying greater visibility than lighter colours whilst several colours of similar tone tend to convey information of equal importance. Using different shades of only one colour should generally be avoided as the distinctions between bandings usually appear merged and this can also imply a gradation of impacts represented by the decreasing shades that is misleading.

62 Legibility of a ZTV map tends to decrease with greater numbers of colours. For this reason, 7 colours should typically be the maximum used on any one map. It is recommended that these are bright and strongly contrasting.

63 When selecting the colour palette to be used on a ZTV, it is important to consider how the colours would be seen by different viewers. One of the most important considerations is how the same colour will be represented differently according to the specification of different computer screens and/or printers. It is recommended that practitioners always print out draft copies to check that any discrepancy between these still produces a clearly legible map, and then print out the final copies on the same printer.

64 When choosing a colour palette, it is also important to consider colour blindness. It is estimated that around 7-8% of males and 0.4-1% of females in Britain have some form of colour blindness. To them, legibility of maps depends on the type of colour blindness they have, the shade and brightness of the colour, and on the contrast and combinations of colours used. This requires careful consideration and is not just a simple issue of avoiding the juxtaposition of red and green.

65 While it would be useful to specify a standard range of colours consistently legible to colour blind people, it is impossible to develop this without also standardising computer screens and colour printer reproduction. Thus, as an alternative, it is recommended that individual maps shown within each ES are checked for colour blind legibility using a quick clarification tool such as Vischeck.

Visibility bands

66 The theoretical visibility of different numbers of wind turbines (within a single development, or different wind farms within a cumulative ZTV) is usually distinguished upon a ZTV as different coloured bands. It is important to highlight that these bands differentiate between the visibility of different numbers of wind turbines as a tool for assessment. They are in no way intended to imply that greater numbers of turbines will necessarily result in higher levels of visual impact. These bands are particularly useful for identifying potential viewpoints where the visibility of the wind farm varies considerably within an area.

67 The number of visibility bands should be high enough for each band to represent just a small range of turbine numbers, whilst low enough to avoid the need for too many colours which can appear confusing. For example, with 30 turbines, it is better to have 6 bands each covering 5 turbines (1-5, 6-10, etc) rather than 3 bands of 10 turbines which would provide limited resolution, or 10 bands of 3 turbines which would appear confusing. It is recommended that **no more than 7** colour bands should be used upon a ZTV.

68 Where equal banding is impossible (for example 11 turbines), then the widest band size chosen should apply to the lower end of the scale – for example 1-3, 4-5, 6-7, 8-9, 10-11, as greatest resolution is then retained where visibility is least.

Recording ZTV information

69 It is vital within an ES to include information on all the key assumptions made in ZTV production, and to summarise these within the VIA. This should include the following information:

1	The DTM data from which the ZTV has been calculated, including original cell size and whether this has been sampled down.
2	Confirmation that it is based on a bare ground survey, or provision of information on the specifications of additional land use data if this has been incorporated.
3	The viewer height used for the ZTV.
4	Confirmation that earth curvature and light refraction has been included.
5	The extent of the ZTV overlay as a minimum distance from the development, in addition to the frequency of any distance rings shown
6	The numbers of wind turbines represented for each colour band.
7	The height used for the turbine and whether this is to hub or blade tip.
8	Confirmation that the ZTV software does not use mathematically approximate methods.

3 Viewpoints

70 The term viewpoint is used within VIA to define a place from where a view is gained and represents specific conditions or viewers (visual receptors). During the VIA process for a proposed wind farm, a number of viewpoints are chosen in order to assess:

- the existing visual resource;
- the sensitivity of this resource to wind farm development;
- the proposed design (incorporating mitigation measures to minimise any adverse impacts); and
- the predicted appearance of the proposed development.

This section addresses the selection of viewpoints and the information that should be provided for them.

71 It is important to stress that **viewpoint assessment forms just one part of VIA**. Because of the 'powerful' nature of viewpoint images and the widespread recognition of some of the locations from where these are taken, there is often over-emphasis of their role. But VIA also includes assessment of the following:

- the extent and pattern of visibility throughout the study area (thus considering those areas from where a wind farm will not be seen, as well as those areas from where it may);
- views of the proposed wind farm from areas of potential visibility other than the selected viewpoints; and
- sequential views.

72 The viewpoints used for VIA must be carefully selected to be **representative of the range of views and viewer types** that will experience the proposed development. They should also form part of the "description of aspects of the environment **likely to be significantly affected** by the development" (PAN58 , paragraph 65). However, it is essential that a **proportionate number of viewpoints are selected**. This should include consideration of the form of visualisations: full photomontages may be required only where impacts are likely to be significant. For other important viewpoints that may be further away, or less valuable for design iteration, the use of wirelines may be sufficient.

73 In addition to representative viewpoints, **specific viewpoints** may also be chosen for their importance as key viewpoints within the landscape. Examples are local visitor attractions, settlements, routes valued for their scenic amenity, or places with cultural landscape associations. These will be supplementary to the range of representative viewpoints and will usually be identified through consultation with the planning authority and SNH, although they may also be confirmed by local people and special interest groups at public meetings and/or exhibitions.

74 Separate assessment of impact on residential properties is increasingly common. The production of visual materials for individual properties may be appropriate to assist this, but they will not normally form part of the LVIA.

USES OF VIEWPOINTS	LIMITATIONS
• Carefully chosen viewpoints enable representation of a diverse number of views within a study area • Carefully chosen viewpoints enable representation of a diverse number of viewers who experience the landscape in different ways • Viewpoints enable consultees to assess specific views from important viewpoints for example tourist attractions, mountain tops and settlements • By considering a range of views at different viewpoints, the designer can consider how the wind farm image varies in appearance, informing design development • Views from numerous viewpoints can be assessed to determine sequential effects that occur as one moves through the landscape • By assessing viewpoints in combination with ZTV maps, it is possible to consider the potential pattern of visibility for a wind farm in 3 dimensions • Viewpoints which show no visibility of the proposal should not be shown in the ES – the rationale for this should be given in the supporting text of the ES	• Whilst the choice of viewpoints is very important, it must be remembered that VIA should also be based on other aspects. An over-heavy emphasis on viewpoint selection and assessment may create the erroneous assumption that this is the only aspect of VIA • There may be a tendency to focus on the particular characteristics of specific viewpoints, rather than considering these as being just broadly representative of a wider area. Consequently, it is usually inappropriate to make design modifications to change the visual effects of the proposed wind farm from a single viewpoint. This is because this may have negative 'knock-on' effects a small distance away or from other viewpoints. A more holistic approach considers the overall wind farm image from separate viewpoints in relation to the design objectives. • A point, and thus viewpoint, is by its very nature static whilst views tend to be experienced on the move as well as when stationary. • Some viewpoints may be difficult to access and require lengthy walks to reach them. As a result, some people might not be able to assess the viewpoint on site. They will therefore need to rely on the landscape architect or experienced specialist assessor's assessment and visualisations to indicate predicted visual effects. It is therefore essential that sufficient landscape and visual context is provided on visualisations • On account of the limitations of DTM data, several provisionally identified viewpoints may need to be visited before finding a location that is suitable • Information on the exact location and conditions of individual viewpoints is required to be able to create accurate visualisations • Some requested viewpoints might be judged inappropriate due to unacceptable health and safety risks

Selection of viewpoints

75 Viewpoints are initially selected as being those places from where a proposed development is likely to be visible and would result in **significant** effects on the view and the people who see it (receptors). This is informed by the ZTV and other maps, fieldwork observations, and information on other relevant issues such as access, landscape character and popular views. This data enables a provisional list of viewpoints to be developed that can be later refined through further assessment, consideration of provisional wireline diagrams and discussions with the determining authority and consultees. Interested members of the public may also advise on sensitive local vantage points at public meetings and/or exhibitions held by the applicant.

76 It is important to stress that, even though a ZTV is very useful in focusing upon those areas with potential visibility of a proposed development, the ZTV is only one source of information used to inform the selection of viewpoints. Over-reliance on a ZTV to highlight viewpoints can result in over-concentration on open locations with the greatest visibility of a site, often far from the proposed development. This may be at the expense of potential viewpoints where visibility is less extensive, but from where views of the site are more typical.

77 Nevertheless, during early consultations regarding the provisional list of viewpoints, it is essential that the determining authority and consultees are provided with a copy of the draft ZTV. A selection of provisional wireline diagrams may also be helpful to give an impression of possible impacts from viewpoints.

78 During the initial stages of VIA wirelines are used to inform the design development of the proposed wind farm. Some of the viewpoints will be described and assessed within the main ES report; however others may ultimately be omitted, for example because they show very similar results to another viewpoint. Nevertheless, details regarding these original viewpoints should be included within the ES appendices if they have informed the design process. Likewise, during the VIA process, it may be found that some of the originally identified viewpoints will not actually have a view of the wind farm due to local screening or changes to the wind farm design. These should also be documented within the ES.

79 The issues discussed above regarding the selection of viewpoints highlight that a flexible approach needs to be adopted. This also reflects the iterative nature of VIA and the way in which parties will gradually become more familiar with a site and proposed development. Consequently, the developer must be aware that additional or alternative viewpoints may need to be considered throughout the VIA process if more information is required by either the landscape architect or experienced specialist assessor, or the determining authority and consultees.

80 The range of issues that influence the selection of viewpoints is listed in the table below. The aim is to **choose a representative range of viewpoints from where there is likely to be significant effects**.

View type	•	**Various landscape character types** (separate and combinations of type)
	•	**Areas of high landscape, scenic or recreational value** – for example designated areas,;wild land; longer distance routes; view points; tourist routes, local amenity spaces
	•	**Visual composition**, for example focused or panoramic views, simple or complex landscape pattern
	•	**Various distances** from the proposed development
	•	**Various aspects** (views to the north will result in a very different effect to those facing south)
	•	**Various elevations**
	•	**Various extent of wind farm visible**, including places where all the wind turbines will be visible as well as places where partial views of turbines occur
	•	**Sequential** along specific routes
Viewer type	•	**Various activities,** for example those at home, work, travelling in various modes or carrying out recreation
	•	**Various modes of transport,** for example those moving through the landscape by road, train, ferry or on foot

Question 4: The table above refers to examples of viewpoints that should be chosen. Are any aspects missing?

81 The assessment of viewpoints should not involve unacceptable risks to health and safety. Examples of these situations could include viewpoints from motorways, railway lines, scree slopes or cliffs.

82 Viewpoints within the local area surrounding the wind farm are particularly useful to understand and develop the wind farm layout and design. They also represent the likely effects on residents living, travelling and working within the areas. Local residents will experience the wind farm on a regular basis (often daily) in different weather, lighting and seasonal conditions. It is important that these effects are assessed in detail and that the assessment recognises the varying conditions in which residents will experience the wind farm.

83 In addition to representative viewpoints, **specific viewpoints may also be important to represent key views within the landscape**, for example local visitor attractions, scenic routes, or places with cultural landscape value.

84 In identifying viewpoints, it is important to consider whether a Cumulative Landscape and Visual Impact Assessment (CLVIA) is also required as part of the ES. If it is, the choice of all viewpoints should be informed by the cumulative ZTV as well as the individual ZTV. In most parts of Scotland many of the viewpoints chosen will be used to represent cumulative effects. Although it is possible to add supplementary viewpoints as part of a cumulative VIA, it is preferable to use the same viewpoints for both the individual and cumulative VIA to enable direct comparisons to be made.

85 Likewise, it is also useful to choose viewpoints already used for other wind farm LVIAs in the surrounding area. The use of these may allow direct comparisons and also assist the determining authority, consultees and the general public who are already familiar with these viewpoints. **Some planning authorities have standard viewpoint lists and these should be referred to at an early stage**.

86 The reasons for selection or omission of viewpoints recommended by consultees, should be clearly justified and documented within the ES.

Number of viewpoints

87 The number of viewpoints for separate projects will vary greatly depending on how many are required to represent likely significant effects from the range of views and viewers of a development. The initial list of provisional viewpoints will be high. This is necessary to enable identification of the required viewpoints during the early stages of the VIA, and to ensure that no key viewpoints have been omitted. This process will involve the production of wirelines, as one will need to be produced for each viewpoint and for every layout and design option.

88 After reducing the number of viewpoints down to only those that are required to represent potential significant effects on views and viewers, it is common for there to be around 10-25 viewpoints within a VIA in Scotland. However, this number will vary depending on the specific circumstances of a proposal. **Over-provision of viewpoints can be as unhelpful as under-provision**. This is because an excessive number of viewpoints may distract attention from the smaller number of viewpoints where impacts are significant.

Question 5: The number of viewpoints per assessment is commonly 10-25 for wind farm proposals in Scotland. Do you think that number is reasonable ? If not, how many viewpoints would you expect in an assessment ? Should there be a cap ?

89 A high number of viewpoints will also require more time to be assessed by the determining authority and consultees and result in a more expensive ES – both for the developer and people that wish to purchase the report. As a consequence, **an appropriate balance must be struck through the VIA consultation process in terms of providing sufficient, but not excessive, numbers of viewpoints**.

Viewpoint siting

90 Following agreement on the general location of viewpoints through consultation, the selection of the precise viewpoint site should be considered carefully. If, on visiting a potential viewpoint, it is apparent that there will be no view of the proposed development, for example due to localised screening, this location should be amended or withdrawn and recorded in the ES.

91 The siting of viewpoints needs to balance two key factors:

- the likely significance of impacts; and
- how typical or representative the view is.

For example, in choosing a viewpoint along a stretch of main road it may be difficult to choose one location to represent the range of views experienced. It may also be difficult to find a safe location for the viewpoint. Laybys and junctions are often used but may not always represent the 'worst case' views – where this is the case it should be noted in the ES. In all cases, judgement needs to balance these factors and the decision-making process must be documented.

92 Most importantly, **the location chosen must avoid the view of the wind farm being misrepresented by the inclusion of atypical local features, such as a single tree in the foreground,** as illustrated in **figure 1** below. Where this has mistakenly occurred, the viewpoint location should be revised and the photographs retaken. Conversely, it is also unacceptable to wander too far from the most prominent viewpoint in order to avoid typical foreground objects, for example moving into a neighbouring field when the view is intended to be from a road, in order to avoid the inclusion of the roadside fence or hedgerow. An alternative location may be required.

Figure 1: Deliberate positioning of distracting or screening features within a photograph

a:

b:

c:

d:

e:

f:

These photographs were all taken within 50m of each other and all show essentially the same distant view of an existing windfarm, with only the foreground detail differing. **a** shows the view seen adjacent to a house. **b** is from the public road immediately outside the house. **c**, **d**, **e** are successively more open views from the same road. **f** is from the road verge adjacent to the tree visible in the middle of **a**.

If the purpose of the viewpoint is to illustrate the view from one specified important view, one window in a house perhaps, then it should include whatever foreground obstruction happens to be in the view, as in **a** above. Otherwise, if a viewpoint is to represent potential views from a locality, then it should be as unobstructed as possible, as in **f** above.

Use of viewpoints

93 Viewpoints are used within VIA as sample locations from where to assess the existing visual resource, the design and siting of the proposed development, and potential visual impacts. Further information on their use is included within the Guidelines for Landscape and Visual Impact Assessment produced by the Landscape Institute and Institute of Environmental Management and Assessment (2013).

Recording viewpoint information

94 It is important to record the field conditions in which a viewpoint is assessed, including information as listed below.

no	**Viewpoint**	**Specification required**
1	Precise location	12 figure OS grid reference, measured in the field, ideally using GPS or a large-scale map.
2	Viewpoint altitude and Viewing height	Viewpoint altitude in metres Above Ordnance Datum (m AOD) (May be better interpolated from map or DTM than relying on GPS height). Viewing height in metres.
3	Nature of view	Horizontal field of view (in degrees).
4	Distance to wind farm	Approximate distance (in km) to the nearest turbine
	Conditions of assessment	
5	Date of assessment	
6	Time of assessment	
7	Weather conditions and visual range	

95 This information is essential to allow others to visit precisely the same viewpoint and make on-site checks or assessment. It also helps others to understand the conditions under which professional judgements have been made.

96 As part of VIA, viewpoint assessment will involve recording baseline conditions 360˚ around the viewpoint. However, most attention will be paid to the main focus of the view and its setting, the direction of the proposed wind farm, and any other existing and proposed developments.

97 All viewpoints should be numbered and their location shown upon separate maps as follows:

- The ZTV overview map(s) based upon a greyscale 1:50,000 OS base. The viewpoints should be marked using discrete symbols and numbering to avoid obscuring or confusing the ZTV information.
- The detailed ZTV map(s) based upon a greyscale 1:50,000 OS base. The viewpoints should be marked using discrete symbols and numbering to avoid obscuring or confusing the ZTV information.
- A detailed map extract on each viewpoint visualisation sheet which indicates the location and direction of the view on a 1:50,000 or 1:25,000 OS base map

(although not necessarily the proposed wind farm), potentially reduced to another ‘standard’ scale, to enable those assessing the view on site to locate themselves in relation to local landscape features.

- Each visualisation should include a detailed location map and short description to make it easy for members of the public to find the exact viewpoint location.

98 **Viewpoint numbering needs to be clear**. It is recommended that the original viewpoint numbers are retained right up until the point at which all the viewpoints are finalised and agreed and the VIA has been completed, to keep track of which viewpoints have been added or withdrawn during the VIA process. At this point they can be re-numbered in a continuous and more logical manner. Where material developed during the early stages of the VIA process information is included within the ES and its appendices, to show the development of the VIA, this should show both the original and new numbering so these can be easily cross-referenced.

99 To ease legibility, viewpoint numbering should follow a clear system. Some people number viewpoints in order of distance from a development, which is useful when considering the effect of distance on impacts, while others number a wind farm in relation to how it tends to be experienced, such as from key routes, leading to isolated vantage points, which is useful when considering sequential impacts. Alternatively, numbering in a set direction, such as clockwise, may be the most appropriate method in terms of being clearly objective and transparent. Of these options, all are acceptable as long as the system chosen is clear and described within the VIA.

100 If a developer is proposing an extension to an existing wind farm, the same numbering of viewpoints should be used as in the original application. This allows consultees to more easily directly compare the impacts of the new proposal. Similarly, if a developer is proposing several different wind farms concurrently in a distinct area, viewpoint numbering should be the same in each separate application.

4 Visualisations

101 Visualisations are illustrations that aim to represent the view of a proposed development. Visualisations of wind farms most commonly comprise photographs, computer generated wireline diagrams and photomontages.

102 Visualisations are powerful in communicating information – 'Pictures speak louder than words'. This means that people often jump to the visualisations within an ES to gain an impression of a scheme, in a way that they rarely adopt for other specialist information. However, it is important to stress that visualisations represent just one source of data that informs a LVIA.

103 Considerable debate on visualisations in the past has revolved around making them 'true to life'. **Visualisations, whether they are hand drawn sketches, photographs or photomontages can never exactly match what is experienced in reality.** They should, however, provide a representation of the proposal that is as accurate as possible, so that the potential impacts are fully understood.

104 Ideally the assessor, consultees, members of the public and decision makers **should visit the viewpoint(s)** where visualisations can be compared to the 'real life' view. It is acknowledged this is not always possible – time, weather and accessibility will restrict the number of viewpoints which can be visited.

105 It is important to stress that, whatever the circumstances, interpretation of visualisations will always need to take account of information specific to the proposal and site which cannot be shown on a single 2-dimensional image. Factors include variable lighting, movement of turbine blades, seasonal differences and movement of the viewer through the landscape. Therefore **visualisations in themselves can never provide the answers, they only inform the assessment process by which judgements are made**. They are, however, a very important and valuable tool in this process.

106 Accordingly, it is **essential** that the visualisations produced contain sufficient landscape and visual context. Viewing a single frame image provides a good indication of the scale of the proposed turbines in the landscape (see below) but the overall impact of the development in both landscape and visual terms requires wider contextual information. Members of the public and decision makers **must be provided with the broader landscape and visual context** in the form of a panorama and should not form a judgement on the basis of a single frame image alone.

Key issues affecting visualisations

107 Photographs are important visualisations, not only in their own right, but also as a component of other visualisations such as photomontages. To understand how

photographs represent what we see, it is important to highlight that the eye is not directly sensitive to the outlines of objects or details in a scene. Instead it relies upon a degree of contrast to make those edges, and therefore the objects they define, visible. Thus there is always a trade-off between detail and contrast. This effect is replicated in photography, where visual representation on screen or the printed page is affected by the resolution of the image (to ensure that sufficient detail is captured) and contrast in the image (to ensure that the detail is visible). This is why holiday snaps of mountain ranges often look disappointing when viewed on screen or as printed photographs – neither the screen nor the printed image can capture the contrast you see in real life.

108 **A key limitation of photographs in replicating the visual experience is that it is generally impossible to reproduce the full contrast range visible in a scene to the human eye**. This means that while, on a bright day outdoors, we may experience a brightness ratio of 1000:1 between the brightest and darkest shades, a good quality computer monitor is only likely to achieve a ratio of about 100:1 and a printed image is only likely to manage 10:1.

Viewing distance

109 In the previous version of this guidance it was recommended that images should be viewed at a correct viewing distance. This was to compensate for the relatively small image sizes which were common at that time and to ensure a repeatable process. However, several factors have greatly reduced the importance of the viewing distance:

- The photographic method described below results in larger images, for which an accurate viewing distance is less important;
- An equivalent focal length of 75mm (see below) provides a better representation at a comfortable viewing distance;
- The availability of high quality digital cameras with high resolution sensors facilitates printing at large image sizes.

110 Experience has also shown that expecting members of the public to view images at a 'correct viewing distance' is not easy, especially when provided with a cylindrical projection (which should be viewed curved). The method described below uses a planar (flat) projection which is easier to view both in hard copy and on screen.

111 **As a result, it is now recommended that photomontages are simply viewed at a 'comfortable' distance, at arms length**. This will vary depending on the length of the viewer's arms and their eyesight / age. However, the difference in viewing distance which results will have little impact on the impression of scale / depth in the image (due to the increased size of the images).

Question 6: Given the larger size of images proposed below (260mm in height) and the increased focal length, do you agree that the exact viewing distance is no longer important?

112 Some technical users of the visualisations will, however, wish to view the images at an exact distance (such as the landscape architect during field assessment) for technical reasons. To enable this, the theoretical viewing distance (or principle distance) for the image should be provided on the images. For the 75mm equivalent focal length images presented in the format described below and printed at the sizes recommended, this will be 750mm (the principal distance). Holding an image at exactly this distance (if required) may be difficult for some users but can be achieved as described in para 144 below.

113 If transparencies are required (see options below) the correct viewing distance, which should be stated clearly on the relevant images, is important for aligning transparencies with the landscape beyond. This will also apply to transparencies and wirelines. Very accurate viewpoint locations are also required so that the image can be accurately lined up with the landscape.

114 **It is essential, however, that the image is printed at the size specified below. Users must not print off the images (e.g. from a planning authority or the developers website) and view these, unless they are printed at the exact dimensions outlined below.** If a different size is used it may result in an unrealistic impression of the proposal.

Making visualisations more accessible to the public

115 Due to the importance of viewing the correct image, **it is essential that members of the public, decision makers and consultees are provided with (or have access to) a paper copy of the visualisations, printed at the correct size**. To facilitate access to these images:

- **The developer** should provide the planning authority with additional, loose leaf hard copies which can be made available (on short loan if required) to members of the public at each location where the ES is made available for public viewing;

- **Members of the public** should either:

  1) print images at the correct size (an A1 printer is required for the panoramic images[1]) using the images available online; or

  2) visit local facilities where the ES and images are available; or

  3) borrow hard copies from the planning authority to view these in the field.

[1] A1 printers are relatively widely available in most cities at photo processing shops and commercial printing establishments.

116 Visualisations are usually presented to the public at exhibitions and meetings organised by the developer as part of the pre application consultation process (described further in para 219 below). Providing spare copies of visualisations for the public should be considered. The A1 size panoramas described below should be equally suitable for presentation at a public exhibition as in an ES.

Question 7: Do you think that the above measures will make visualisations sufficiently accessible to the public?

117 **Visualisations are complementary to ZTVs and vice versa and neither can be interpreted satisfactorily without the other**. While a ZTV shows where a proposed wind farm will or will not theoretically be seen (subject to surface screening) and the number of wind turbines (or parts of turbines) likely to be seen from any location, it cannot indicate what the wind farm will look like. A visualisation, on the other hand, simulates the appearance of the wind farm from a particular location, but gives no indication of whether this is characteristic of views over a wider area or peculiar to a specific site. Used carefully together, a ZTV and a set of visualisations can provide information on all of these aspects.

USES OF VISUALISATIONS	LIMITATIONS
• Visualisations give an impression of the appearance of a proposed wind farm • Applied carefully in the field, a visualisation can be used to help assess the likely visual impact • Visualisations can aid development of the wind farm layout and design • Presented carefully, visualisations can help illustrate to members of the public the location and nature of a proposed wind farm (and may be the basis on which this audience will assess a project) • Wirelines provide objective data, while photomontages present an illustration of visual impacts that incorporates artistic interpretation	• Visualisations provide a tool for assessment that can be compared with an actual view in the field; they should never be considered as a substitute to visiting a viewpoint in the field • Neither photographs nor visualisations can convey a view as seen in reality by the human eye. • Visualisations are only as accurate as the data used to construct them • Visualisations can only represent the view from a single location • Visualisations are inherently limited in the field of view and detail they can represent • Visualisations presented upon paper cannot convey the effect of turbine blade movement

Photography

Objectives

118 Photography has two main roles in EIA. One is as a simple record and aide-memoir of site visits and on-site assessment work. The other, on which this guidance focuses, is in producing visual material for inclusion in an ES.

119 Photography for presentation in conjunction with wirelines or other visualisations, or as the basis for photomontage, requires high quality specification. This is because the perspective geometry of the resulting photographic image is necessary in order to use a computer program to generate an image with exactly matching perspective. This implies considerable care in the selection and use of appropriate photographic equipment.

120 Representing landscape conditions through photography (and thus photomontages) has its limitations and, while some of these effects can be ameliorated and/or compensated for by using presentation techniques discussed in the following section, other effects are less easy to counteract. One of the most significant difficulties of photographing wind farms, in contrast to other types of development, is that they often appear on the skyline where there is little contrast between the light-coloured turbines and a light-coloured sky.

121 It is essential that all photographs are taken in clear weather.

Field of view

122 The term ‘field of view’ is used to describe the height and width of a view as represented by an image. These constitute the horizontal field of view and vertical field of view and are expressed as angles in degrees. (The terms 'angle of view', 'included angle' and 'view cone angle' are equivalent but can be ambiguous in some contexts.)

123 The single frame visualisations described below have a horizontal field of view of 27 degrees. The panoramic visualisations described below have a horizontal field of view of 53.5 degrees. In most situations this will capture the whole wind farm and provide sufficient landscape and visual context. In some situations, however, it may be necessary to provide a wider horizontal field of view. These include:

- Viewpoints which are very close to the wind farm;
- Very large wind farms
- Locations where cumulative effects require detailed representation (e.g. two wind farms on the same ridge).

In these circumstances it will be necessary to provide a wider horizontal field of view. This will entail longer panoramas, which will require longer paper sizes. To maintain consistency in image height and focal length, **the resulting panoramas must retain the same focal length and image height**. These images will not fit on a standard A1 sheet

and will need to be printed from a roll of A1 width paper. Printers of this nature are widely available in Scotland's cities. However, the practicalities of larger images are such that longer than A1 images should be avoided where possible.

124 To ensure that the photographs taken for each viewpoint (which may be taken by someone other than the landscape architect or experienced specialist assessor) are able to accommodate the required horizontal field of view, it is recommended that a series of photographs is taken from each viewpoint that includes the entire width of open view. This may be 360° for some viewpoints. Detailed instructions on producing these images are provided below.

Verification

125 In some cases the determining authority or members of the public may wish to 'verify' the accuracy of the image produced. This is possible using the original image data recorded by the camera and a simple template to check that the focal length and image height have been correctly adjusted (by cropping and then enlarging). This process is described in **annex C**.

Choice of camera

126 A high quality camera is required to produce satisfactory results for ES purposes because the lenses need to be of high quality both in terms of resolving power (the ability to capture detail) and in freedom from excessive distortion. To produce images of the quality required and to enable verification, a high quality digital SLR with a **full frame sensor size** is required.

127 For most of the images described below a **50mm fixed focal length** camera lens is required. The *equivalent* of a 75mm focal length image will be extracted from the 50mm photograph (see below). However, we have provided two options on lenses to produce the larger format panoramas required (35mm and 50mm) and these are explored further below. Feedback is sought on these options through the consultation process. The relationship between lenses and the images proposed is shown in **annex E**.

128 Various other technical photographic considerations are discussed further in **annex D.**

Post photographic processing

129 Several photomontages from each viewpoint will be required. The production of these is described below. Note – a photomontage may not be required from every viewpoint, in some cases wirelines may be sufficient.

Construction of baseline panorama

130 The first image required from each viewpoint is a baseline panorama. This shows the existing view and captures the overall landscape and visual context. This information is essential to underpin the LVIA and to provide those who cannot visit the viewpoint with an understanding of the wider context within which the wind farm would sit.

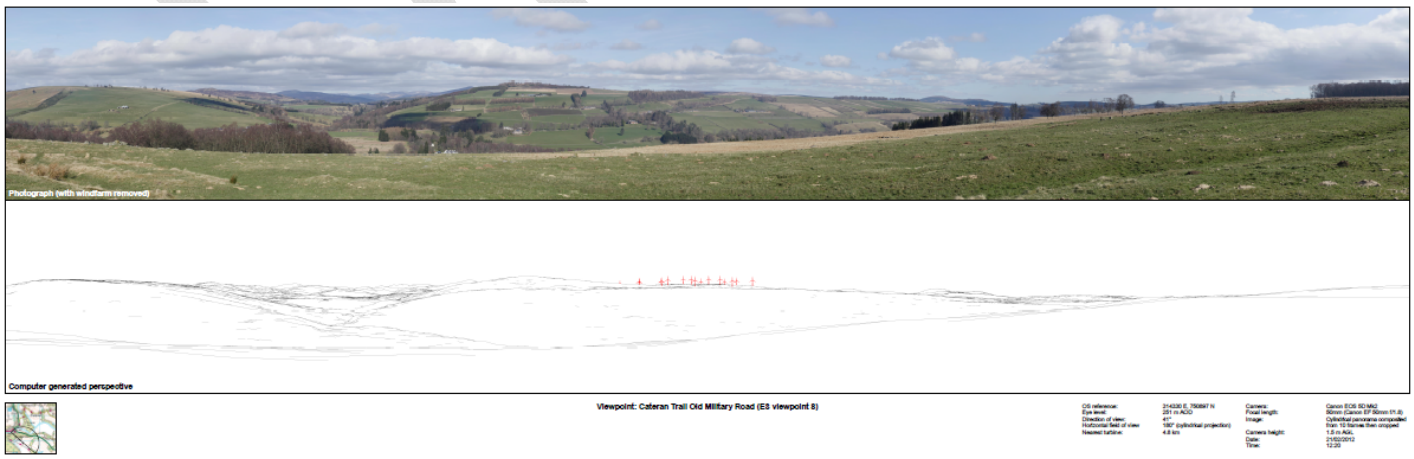
131 In some cases (such as a popular Munro summit, or viewpoint) it may be necessary to provide a 360° panorama. In most cases 180° should be sufficient. If 360° is required this will need to be presented on two separate sheets.

132 To construct the panorama it is recommended that a series of frames are taken which cover the full 360° from each viewpoint. A decision whether to present 180° or 360° can be taken later. The images should be stitched together by a competent professional using suitable software. Each 180° image should be presented as shown in **figure 2** below. To present images with this wide angle of view cylindrical projection is recommended – however, it is not important to view this image as a cylinder, they are provided to illustrate the wider landscape and visual context only. **The wind farm proposal should <u>not</u> be represented on this image, in order to avoid confusion**.

Construction of matching wireline

133 A wireline with matching dimensions and geometry should be constructed for either 180° or 360° as required. The wireline will be particularly helpful to illustrate cumulative effects, which cannot be captured in the photomontage described below. **The wind farm proposal and all other wind farms included in the cumulative assessment should be included on the wireline** – but not the baseline panorama.

Figure 2 Baseline panorama and matching wireline



Question 8: The baseline panorama and wireline can either be presented on a single A1 width sheet, or on several A3 pages – do you have a preference?

Turbine image

134 The turbines shown on a visualisation should represent reasonably faithfully the shape of the intended turbines for a project. Ideally, they should be based upon detailed line drawings of the actual turbines proposed; but they should at least have the correct hub height and rotor diameter. This will allow the proportions of the turbines to be understood from the visualisation as well as confirm actual visibility.

135 Some practitioners prefer to depict all turbines with the rotors set to have one blade pointing straight up, whereas others prefer these set at random angles, helping to simulate more realistically the fact that the turbine blades will be moving. The disadvantage of setting blades at random angles is the risk of 'losing' turbines behind the landform because the blade angle happens not to put a tip high enough in its arc to be seen. On the other hand, having all the blades at the same angle can produce a very 'regimented' effect that appears less realistic.

136 It is recommended that, for all 'working' copies of wireline diagrams, turbines are always shown with one blade positioned straight upwards, while photomontages, as illustrations, can show turbines at random positions. However, even accepting the more illustrative quality of photomontages, it should be ensured that all the wind turbines that could potentially be seen from a viewpoint are shown within the image, even if their highest blades are on the diagonal.

137 Turbine direction can be shown in two different ways:

- Every turbine facing the same direction, face forwards towards the viewpoint; and
- Every turbine facing the direction of the prevailing wind at each viewpoint (if required).

Image enhancement

138 **Enhancement of images is an inherent part of photographic production**. Photographic processing involves judgements - there is no process by which a 'pure' photo can be produced without the application of human decision-making, from exposure timing to the specification of the camera, and whether this is applied manually or automatically.

139 Although enhancement, for example to maximise clarity, has traditionally occurred within the photographic darkroom, this practice has often raised concern with regards to producing digital photographs and photomontages. This may be because it is difficult to quantify the level of enhancement in a way that is easy to understand, raising the suspicion that an image has been 'doctored', and is consequently misleading. In reality

there is no way to avoid a photograph being ‘doctored’ as this is an integral part of photograph and photomontage production.

140 The only way to ensure that this is to acceptable standards is to require the use of extreme care by a suitably experienced professional. The extent of enhancement must also be limited to that which would conventionally occur in a darkroom to improve the clarity of an image, not change its essential character. For example, it is important that any enhancement, such as sharpening elements within a view, is carefully balanced throughout an image, not just the wind turbines; otherwise other features may seem less prominent in comparison.

141 Sharpening an image slightly can also help fine detail visible in the field, be visible on printing. This operation works by identifying areas of high contrast in the image, which correspond to the detail we see, and locally further increasing the contrast so that the detail becomes more apparent. However this operation must be applied carefully as over-sharpened images can result in a hard dark line that appears at the skyline and a corresponding light edge to the sky above it, while miniscule details can appear unrealistically prominent and fussy.

Wirelines

Use of wirelines

142 Wirelines are computer generated line drawings, based on a digital terrain model (DTM), that indicate the three-dimensional shape of the landscape in combination with additional elements. They are a valuable tool in the wind farm LVIA process as they allow the assessor to compare the position and scale of the turbines within the wireline to the existing view of a landscape.

143 Wirelines are particularly useful to the landscape architect or experienced specialist assessor as they strictly portray objective data. This means that, by comparing wirelines with a view on site, the assessor can make clear and transparent judgements on the likely visual impacts in a variety of environmental conditions, safe in the knowledge that the wirelines have not been subject to manipulation that cannot be quantified. They can also reveal what would be visible if an existing screening element, for example vegetation or a building, is removed.

144 The assessor may find that wirelines produced at 75mm equivalent focal length (see below) difficult to use in the field. Accurately lining up the image with features in the landscape will require the image to be held at the right viewing distance (750mm). Three options can address this:

- Use shorter focal length wireframes (e.g. 50mm) for field work, but present 75mm in the ES

- Two people visit each viewpoint so that one can hold the image at the correct distance to allow scaling

- A tripod or similar apparatus (such as a Perspex holder with clamp) can be used to hold the image further away than the users arms might allow.

For all other users it is unlikely to be necessary to hold the wirelines at an exact distance – a comfortable arms length will suffice.

145 Wireline diagrams are extremely valuable in the wind farm design process, as they are relatively quick and easy to produce. Many sets will usually be generated as a wind farm layout evolves. The benefit of these wirelines is that, not only do they clearly convey the overall wind farm image that results from the layout and siting, but they also show how this is affected by the position of individual wind turbines, which can be easily identified and re-positioned in an attempt to improve the effect.

Data

146 The accuracy of a wireline depends on the accuracy of the data used to create it. In general, this data will be the same as that used for calculation of the ZTVs, commonly the OS Landform Panorama or Landform Profile DTM products.

147 It is important that, for each project, sufficient DTM data is used to enable the full landform background to the turbines to be seen and thus easily matched to a view on site or photographs of the existing landscape. For some views, DTM data may need to extend further than the LVIA study area because the distant horizon extends beyond this limit.

Geometrical properties

148 To allow direct comparison (and reduce confusion) all wirelines should be provided using the same equivalent focal length and image height to the panoramic images described below. They should also be presented in **planar projection**.

Drawing style

149 Wirelines consist of little more than simple line-drawings of the DTM and the wind farm. However, there are a range of graphic styles used to depict these which can affect the clarity and legibility of the finished image. A number of options are acceptable; however it is important that the same format is used within a single ES.

150 The DTM is most commonly drawn as a mesh seen in perspective. While this is a faithful depiction of the landform as represented by the DTM, it can often result in the more

distant parts of the scene becoming unreadable as the grid lines get closer together, eventually merging into solid colour. This is not helpful and **grid lines should be removed to maintain a simple image**. Only the outline of the topographic features in the scene, approximating to the lines one might draw as a sketch of the scene should be shown.

151 Colour is useful to highlight the wind turbines in contrast to the landform lines, especially in distant views where the effect of merging lines noted above often occurs and where some turbines may only just be visible against the landform. There are a number of options, such as those listed below:

- Green turbines on a black DTM;
- Red turbines on a black DTM;
- Black turbines on a grey DTM;
- Blue turbines on a grey DTM; and
- Grey turbines on a green DTM.

The use of pale colours, such as yellow, is not advised as these have insufficient contrast with the white paper background and cannot be seen clearly

152 Using the same colour and/or shade for the turbines and DTM grid is not recommended due to the lack of distinction between them. All the other options listed above are acceptable with the caveat that care must be taken to ensure that the type of colouring does not produce an illusion that the turbines are closer (or further away) than the landform on which they are sited.

153 Varying colours of turbines can be used to distinguish separate wind farms within a view or existing turbines from proposed turbines planned as an extension.

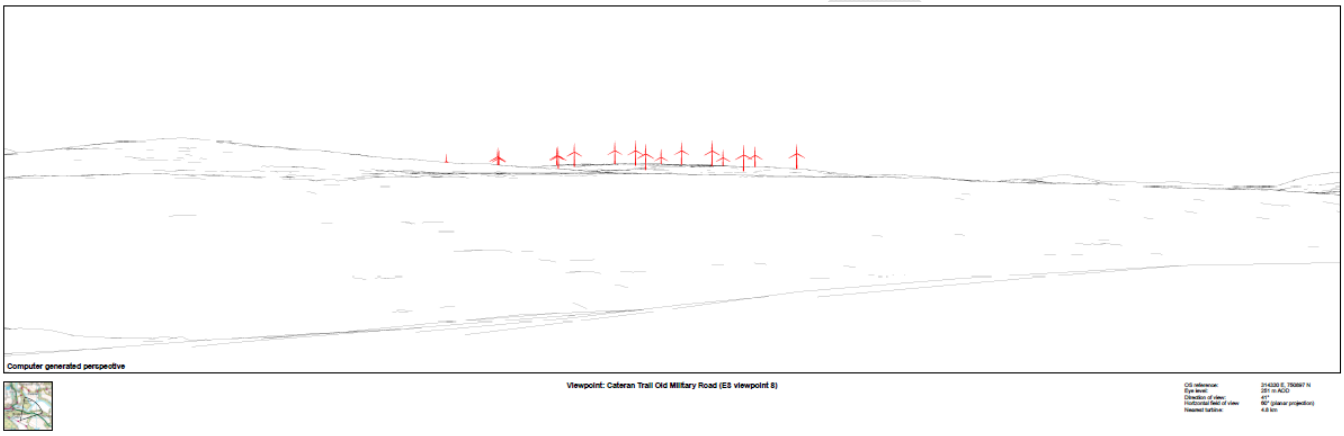
154 Turbines should be numbered so that the individual turbines visible can be directly referred to a layout plan also showing the turbines numbered. Unless the wind farm comprises a small number of turbines, however, this information will usually take up a large amount of space upon the wireline image and, similar to any other labelling, may reduce clarity and distract from the wireline image itself. It is preferable to label duplicate wirelines within an appendix (a selection of key viewpoints may suffice).

155 Features other than wind turbines can also be modelled into the wireline, depending on the software being used. Existing landscape features can be shown, such as pylons or distinctive buildings, which will help direct comparison with the photograph of the existing view (as long as these do not obscure the wind turbines). Other elements of the wind farm development can also be shown, such as the route of access tracks and other ancillary infrastructure.

Construction of 75mm equivalent focal length panoramic wireline

156 The production of wireline images is well understood, using standard software and detailed guidance is not provided here. The key objective is to provide a wireline of the same geometry and image height as described for the panoramic photomontage below. **Planar projection** is required. The wireline should be 820mm x 260mm on the printed page and have an equivalent focal length of 75mm.

Figure 3: Example wireline



Photomontage

The use of photomontages

157 The basic concept of photomontage is simple; it combines a photograph of an existing view with a computer-rendered image of a proposed development. In this way, **photomontages are used to illustrate the likely view of a proposed development as would be seen within a photograph (not as it would appear to the human eye in the field)**.

158 **Although photomontages are based on a photo of the existing landscape, it is important to stress that they are not a substitute to visiting a viewpoint in the field**. This is because they are only a tool for assessment. They provide a 2-dimensional image that can be compared with an actual view of the landscape to provide information, such as the scale of a proposed development, but they cannot convey other qualities of the landscape experience, such as tranquillity, that can only be appreciated in the field.

159 Several visualisations are required from each point. **Annex E** summarises the images required at each viewpoint and the optional extra images that the Planning Authority may require. The production of each is described below.

160 Given the limitations of depicting turbines in photos or photomontages of the landscape their production will usually be of most value for views within 20km[2] of a wind farm site for turbines up to 150 metres high to blade tip. However this will depend on the specific wind farm design and environmental conditions and, consequently, this parameter should usually be discussed and agreed with the determining authority and consultees. Beyond 20km, wirelines are likely to be sufficient.

Question 9: The original guidance recommended photomontages are used only for viewpoints within 15km of a wind farm. The proposed revised guidance suggests 20km, because of the increase turbine heights. Do you agree with this approach?

Rendering of photomontages

161 In order to address the difficulty of representing wind farms clearly within photos, it is common practice to exaggerate the prominence of the turbines to ensure that they stand out in the finished photomontage. When done poorly, this results in a level of visibility unwarranted by the conditions seen in the photograph. However, where done sensitively, this can improve the clarity of an image, comparable to the conventional processing of photographs within a darkroom. It is recommended that the rendering of photomontages is carried out extremely carefully by a suitably experienced professional. The degree of enhancement should be limited to that which would conventionally occur in a darkroom to improve the clarity of an image, without changing its essential character. The nature of the enhancement should also be noted within the ES.

162 Where a project involves an extension to an existing wind farm, it has sometimes been the case that existing turbines have been 'painted out' in the photo of existing conditions and re-montaged back so that the images of both existing and proposed turbines match. This effectively changes the record of baseline conditions and is not recommended. However, in some conditions it may be necessary to enhance the existing turbines if they are not clear in the photographs taken.

163 **Enhancement and rendering cannot compensate for photographs that have been taken in poor light or weather conditions**, for example the blue colouring of white skies because of cloud conditions at the time of the assessment. In these circumstances, the photos should be retaken.

[2] At distances greater than this it can be difficult to represent the turbines well on a photomontage and it can be more difficult to achieve sufficiently good weather conditions for photography in the time available.

Accuracy of match to photography

164 In order to create a photomontage the geometry of the overlain rendered image of the wind farm must exactly match that of the base photography. The viewpoint location, height and direction of the view must be **identical**, as must the horizontal field of view. Both the resulting panoramic photograph and the rendered image must also be planar projections. In most cases, to achieve an accurate match, the images will need to be produced in cylindrical projection, thus allowing a much wider horizontal field of view and providing more features to achieve a match. Once a good match is achieved, the image can then be converted to planar projection for presentation in the ES.

165 The most reliable method of obtaining this accurate match is to generate a wireline image that matches the photograph. If the wireline can be accurately overlaid onto the photograph, then the fit is good. However, where there are few landform features, this process may require the matching of specific structures identified and mapped on site. A transparency copy of the image can also be used to check this.

166 A GPS position, taken when the photography was carried out, is almost always sufficient for wind farm applications (viewpoint location errors usually manifest as a mismatch in the horizontal position of elements in the photograph and wireline and are always more apparent in closer objects or landscape elements). If it is impossible to obtain a simultaneous match on both near and distant landform features, then the viewpoint position is incorrect and will need to be either re-measured on site or worked out through iteration.

167 Matching of photographs and wirelines can usually be satisfactorily achieved through knowing the exact location of the viewpoint and wind farm and then adjusting the direction of view to align distinctive features shown within these images. In certain landscapes, where there are few distinctive topographic features, it is necessary to use man-made features such as masts, pylons or buildings in addition. Even when features of these types are clearly visible in photographs, it is often difficult to identify them on the map.

168 Adjustments should be made until a satisfactory match between topographic features in the wireline and the photograph are achieved across the whole width of the panorama to ensure that there are no errors of scale. If this cannot be achieved, then the fields of view do not exactly match and the parameters must be adjusted further. It is often the case that a small rotation needs to be applied to the panorama to compensate for residual errors in levelling the camera.

169 Once a satisfactory match has been achieved, it is then possible to use the parameters for the wireline as perspective parameters for rendering the turbines for photomontage. Many packages combine wireline and rendering and some also include the facility to overlay the wireline on the photograph while adjusting parameters. However, the best quality is usually obtained using a separate computer program designed for high-quality

rendering. Note that most rendering programs do not include the effect of earth curvature, so it may well be necessary to make vertical adjustments to the turbine positions accordingly before rendering.

170 The rendered wind farm should be overlaid on the photograph using a matched wireline for reference, to ensure that the position is correct.

Accuracy of lighting

171 The lighting model used to render wind farm images for photomontages should be a reasonably faithful match to the lighting visible in the base photograph. Consequently it is recommended that the date and time that the photographs were taken should be recorded by the photographer/assessor to enable an exact sun direction to be calculated although, in practice, so long as the direction of light is correct to within about 10 degrees, a convincing match can be obtained. The effect of light and shade on wind turbines is an important aspect of their visual character and should be represented well.

Associated infrastructure and land use change

172 Wind farm proposals include elements other than wind turbines, including access tracks, borrow pits, crane pads, site compounds, cabling, and a substation. A wind farm development may also be both directly and indirectly responsible for vegetation and land use change. If these elements are likely to result in significant impacts, either individually and/ or collectively, they should be included in photomontages.

173 Some of these elements may be difficult to model well, particularly changes in vegetation. In these circumstances, it may be necessary to render them directly onto the photomontage, guided by a wireline or other computer generated image to ensure that the positioning, perspective and scale of these elements is correctly represented.

Single frame images

174 Two single frame images are required from each viewpoint. The first is a 50mm single frame, printed at 390mm by 260mm. This will fit on an A3 page. The second is a 75mm single frame (extracted from the 50mm) printed at the same size.[3] This will have an *equivalent* focal length of 75mm, but will be derived from the original 50mm focal length photograph.

175 Each single frame should contain the same information as displayed on every photomontage. If the full extent of the wind farm cannot be contained within the single frame(s), the image should be centred on the nearest turbines.

[3] The single frames described here comply with the Highland Council Visualisation Standards for Wind Energy Developments (2010).

Figure 4: 50mm single frame (left) and 75mm single frame (right)

Construction of 75mm equivalent planar projection photomontage

176 It is essential that a panoramic photomontage is provided from each viewpoint where visualisations are required. There are two options to create an appropriate panorama. In addition, optional extra formats are described below and views are sought on their usefulness in different circumstances.

Option A – stitched from 50mm frames

177 The first option involves stitching several 50mm photographs together to form a panorama with a horizontal field of view of around 53.5º and vertical field of view of around 18º. The image should then be enlarged to 260mm in height and 820mm in length. The image should be adjusted to provide the *equivalent* of a 75mm focal length.

178 This option has one main advantage – it utilises the 50mm photography required to produce the single frame images above. The disadvantages include: it is more difficult to verify a composite image of this nature and obtaining a good quality finish, at this scale, is difficult. Stitching images introduces a higher risk of human error in production.

Figure 5: Panorama stitched from 3 x 50mm photographs

Option B – crop from single 35mm frame

179 The second option involves the use of a fixed focal length 35mm lens. The same panorama as described in paragraph 177 above can be cropped from a single 35mm frame (see illustration in **Annex F**). This involves cropping the image to the equivalent horizontal field of view of around 53.5º and vertical field of view of around 18º. The image should then be enlarged to 260mm in height and 820mm in length. It will have the *equivalent* of a 75mm focal length, as the image will have been cropped and enlarged.

180 The main disadvantage of this option is the requirement for a second lens and second set of photography. However, the advantages are: it is easier to verify, easier to produce and therefore less prone to human error and concerns about the 'accuracy' of the image.

Figure 6: Panorama derived from single 35mm photograph

Question 10: the two options above (A and B) result in the same panoramic image, they differ only in the lens used to produce this. Either is acceptable for landscape and visual impact assessment. However, do you have a preference for the use of a 50mm lens (with stitching) or a 35m lens to produce the panorama required ?

Question 11: Do you think that this image size (A4 in height, A1 in length) is practical to be used in the office and in the field ?

181 More detailed guidance on the exact production process will be provided once the consultation is complete and a consensus is achieved on the method to be used. A template for use in verification of the 35mm derived image (if chosen) will also be provided.

Optional extra images

182 In addition to the images described above, Planning Authorities may request additional images depending on the site, the viewpoint and the characteristics of the development. All of these images can be derived from the same 50mm photography used above.

Single frame transparency

183 In some cases it can be useful to produce a transparency of the 50mm single frame, printed on A3, to check the images at the viewpoint(s). The transparency should be generated following the approach set out in The Highland Council Standards (2010), printed in black and white, with the turbines shown in black, at the same image dimensions as the 50mm single frame described above.

A3 panorama

184 A 50mm panorama can also be printed on an A3 page. Printed at this size, the correct viewing distance should be clearly displayed on the image. The panorama should have a horizontal field of view equivalent to a 28mm lens.

Digital viewer

185 Some Planning Authorities have access to digital viewer systems which can create a panoramic image composed of a series of single frames. To do so, they will require the original 50mm photographs and metadata from the applicant.

Question 12: Do you think that the optional extra images described above are helpful ?

Offshore wind farms

186 Offshore wind farm visualisation presents slightly different challenges to onshore situations. As well as having different environmental factors to consider, developments are usually larger in turbine size and number. Views of offshore wind farms are generally from coastal areas, which means that they are seen to extend across a flat, linear horizon.

187 In general terms, given good meteorological conditions, visibility is higher on the coast than inland; frequent periods of exceptional visibility occur in north and west Scotland. However, in the coastal and marine environment, light quality and weather conditions change more rapidly and are more highly variable than onshore, so it is difficult to represent these varying conditions in a single image. Practitioners should aim to prepare visualisations representing the worst case scenario; thereby assessing the specific time of day and season, when there is optimum visibility and clarity. The reasoning and

background to choosing this seasonal/diurnal 'window' should be explained, for example by supporting Met Office data.

Specific photographic requirements

188 It is difficult to judge the distance of an object when it is out at sea. Equally, it is difficult to judge the scale of a single turbine, or of a wind farm, where there is no scale indicator giving a familiar, comparative size. Thus, it helps to include a local landmark or familiar feature within a photograph. Where existing offshore features are present, such as oil platforms, existing turbines or lighthouses they may aid in estimating the scale of the turbines, as well as the overall size and extent of the wind farm's location.

189 Photography at sea can be difficult because of wave action so in some instances relaxation of photography standards/expectations to reflect this may be appropriate, supported by wirelines. This approach has been tested in England and Wales. It can help to illustrate aspects of development, such as busyness of a seaway, different sunset qualities, and different sea conditions. However, developers should only use this approach when it is really necessary.

190 Scotland's east and west coasts differ markedly in terms of their light, aspect, temperature, weather and coastal character. This needs to be considered when planning photography and visualisations. In winter, a temperature gradient exists between east and west (rather than north-south), the North Sea being considerably colder than western seas; with the consequence that clarity is greater in the east. Conversely, the *haar* (coastal fog) can arise in eastern coastal areas and the Northern Isles, most commonly between April – September, so it is important to pay attention to weather patterns.

191 Where a proposal lies on a principal low-level flight path approaching a major airport, providing aerial views may be relevant to the overall context of experiencing an offshore wind farm.

Question 13: Do you think that aerial views for large offshore wind farms could be helpful?

Viewpoint choice for offshore wind farms

192 Because of the way offshore wind farm proposals are progressed through the marine planning system[4] it is common to require the preparation of multiple visualisations depicting different development options, from any single viewpoint[5]. This results in visual impact assessments containing large numbers of visualisations, which is onerous for the

[4] using the Rochdale Envelope approach (which is designed to demonstrate the potential maximum extent of a project, and can involve the presentation of many different scenarios)
[5] See Marine Scotland/SNH Advice Note: Offshore Wind farm SLVIA and Cumulative Assessment. Annexe 2 in *Offshore Renewables guidance for Scoping an Environmental Statement.*

consultant to produce and for consultees/assessors to process. It is essential, therefore, to select viewpoints carefully, to maximise the range of landscape sensitivities and receptors, and to represent the range of scenarios, as seen from one viewpoint. Agreement on viewpoint choice may be needed between a variety of parties.

193 Factors affecting viewpoint choice include:

- Choosing key viewpoints to illustrate design options and evolution adequately.
- Importance of representing land to sea/sea to land and sea to sea views, including the coastal sea/land interface.
- Choosing viewpoints which represent recognised circulation routes, such as ferry routes (reflecting the type of boat and therefore viewing height from which the view will be seen), cruising routes, popular sailing competition areas, other sea users, beaches, onshore roads and footpaths, even if these may not be the most easily accessible points.
- Use of inland viewpoints to see offshore proposals in context of onshore foreground.
- Representing a variety of lighting conditions, e.g. side-lit, back-lit and front-lit.
- The need to choose viewpoints to show tidal differences in inshore locations.

Elevation of viewpoint

194 The horizon is the most distant point seen on the sea surface – this distance increases with the elevation of the viewpoint, and decreases the lower your position (because of the curvature of the earth). Under special weather conditions, on many days of the year from high points, it is possible to see the horizon up to 80+km distance[6]. Whereas on a clear day viewed from a beach, the horizon is in the order of 3 nautical miles (approx. 6km) distant. This means that the nature of views of offshore wind farms will vary significantly according to the elevation of the viewer and any visual assessment should examine a range of viewpoints, from different elevations.

Photomontage for offshore wind farms

195 In the production of offshore wind farm photomontages:

- It is important to recognise that the greater distances involved are a technical challenge. There may be a need to 'zoom in' for detailed design assessment.
- It is often difficult to represent turbines on the horizon as they may appear quite small and this zone is often hazy. The horizon may need to be rendered back in to the image in such situations.
- It may be necessary to prepare images wider than 180^{o}.
- It will be necessary to show the visual impacts of any ancillary infrastructure (including offsite implications), such as on-shore grid connections, converter stations,

[6] *An assessment of the sensitivity and capacity of the Scottish seascape in relation to wind farms.* SNH Commissioned Report 103 (2005), p 12

associated tracks, access routes or buildings, fencing, car parks, lighting, borrow pits and service platforms.

Wirelines for offshore wind farms

196 The use of wirelines is especially useful in offshore visualisation where photography is very difficult. There is also a role for rendered wirelines or computer modelling in replacing photomontages in some instances.

Visual representation of offshore turbine lighting

197 All offshore wind energy development will require lights for marine navigation and aviation safety. It is commonly one of the major visual issues relating to this type of development, although it is difficult to show on visualisations. Generally the turbines are proposed in areas currently appreciated for their darkness.

198 Precise lighting requirements are not usually known until late in the design process. This is due to the wide spectrum of different design variations (the so-called 'Rochdale Envelope' in planning schemes) which make it difficult to finalise Civil Aviation Authority, Ministry of Defence and Northern Lighthouse Board requirements.

199 Therefore, it is difficult to accurately represent likely lighting effects. Nevertheless, it is recommended that night time visuals are provided to illustrate the likely effect of turbine and any other lighting requirements (such as substations).

Question 14: Are there any other factors to take in to account for offshore wind farms? Is the same focal length of 75mm appropriate for photomontage?

Small scale wind farms and single turbines

200 It is recognised that smaller scale wind farm proposals (up to 3 turbines) and single turbine applications do not require the same level of visual representation described within this guidance. Once a method has been agreed for the visualisations in this document, a tailored approach will be identified for smaller scale / single turbine developments. This is likely to include:

- Fewer viewpoints
- Fewer visualisations per viewpoint
- Less exacting photographic standards.

Other visualisation techniques

Hand drawn illustrations

201 Drawings and paintings have been used for centuries to illustrate proposed landscape or architectural change. However, it is the digital production of these that has resulted in radical changes to the way images are conventionally presented, with an associated demand for these to be based on technical data for which accuracy can be measured.

202 There are instances, however, when hand drawn illustrations remain an invaluable tool to the process of visual analysis and the illustration of impacts within an ES. This is because they can offer the following:

- a clarity of image, by omitting some of the distracting details that might be prominent within a photograph but which are actually overlooked on site;
- they can incorporate an element of interpretation by highlighting prominent focal features; and, finally,
- their limitations are obvious – they are clearly not trying to replicate an exact view as it would be seen by the human eye.

203 However, for these same reasons, hand drawn illustrations also have disadvantages, chiefly that their quality is closely linked to abilities of the illustrator and they may be distrusted for incorporating 'artistic licence'. Hand drawn sketches are commonly included within ESs in two different formats as discussed below.

Diagrammatic sketches and annotated visualisations

204 Diagrammatic sketches allow the key visual elements of the visual composition to be drawn out and highlighted. This may be in relation to the landscape or the wind farm development, highlighting the main visual characteristics and principles of design. The advantage of using this medium is that important points can be stressed without these being clouded by insignificant details.

205 It is useful to include within an ES visualisations that are annotated to show the position of key elements of the wind farm proposal, such as access tracks and borrow pits, in addition to the turbines. It is also useful to include turbine numbering on some of the visualisations so that individual machines can be easily identified and cross referenced.

Animation

206 Wind turbines are intrinsically dynamic objects, with large moving parts and variable orientation, so static images are in many ways an unsatisfying medium of illustration. Computer animation, videomontage and virtual reality techniques are being used to some extent to address this issue.

207 To date, most animation and videomontage has been used principally as a means of conveying a general impression of a development to the determining authority and the

public, rather than as a tool for carrying out VIA or as part of an ES. However considerable scope exists for their use in the future as various techniques are developed and presented, and then tested against wind farms once these have been built (similar to the scrutiny applied in the past to wirelines and photomontages). At present, the application of these techniques requires specialist contractors.

208 The provision of animation may well assist in the decision making process. However, they cannot replace the need for professionally produced photomontage / wirelines from selected viewpoints.

Choice of visualisation

209 This section considers when photographs, wirelines and photomontages should be used, and by whom.

210 To record the baseline conditions of a view, a photograph is required to be presented within the ES. In addition, a wireline diagram is required to indicate the position, scale and shape of proposed wind turbines. Photomontages can also be useful, to provide an impression of visual impacts and help people to interpret the judgements of the landscape architect or experienced specialist assessor.

211 The choice of viewpoints to be illustrated using photomontages may be impossible to determine until after the initial stages of VIA. It is recommended that the local planning authority and SNH are consulted regarding the final choice of visualisations for each viewpoint. In some cases (including distant views, or broadly similar viewpoints), a wireline alone may suffice. If large numbers of additional viewpoints are requested (such as from specific properties) a wireline should also suffice for these, assuming that a nearby, representative viewpoint exists.

Question 15: Do you think a photomontage is required from every viewpoint (within 20km), or will wireframes alone from some locations be sufficient?

Additional techniques for cumulative assessment

212 Additional guidance on further techniques to illustrate cumulative effects is provided in our guidance on Assessing the cumulative impact of wind farms.

Question 16: Presenting sequential cumulative impacts as ‘bar charts’ tallying with the relevant coloured sections of roads has been found useful. Do you agree or do you have alternative suggestions?

Presentation of visualisations

213 It will usually be appropriate to present the photograph, wireline and photomontage such that the proposed wind turbines are centralised in the horizontal field of view. However, at certain viewpoints, it may be appropriate to centre the view on an alternative feature, or part way between two or more foci. These additional foci may or may not be wind farms. In these circumstances, it is important that the proposed wind farm does not appear at the far edge of the image. This is because sufficient context/ horizontal field of view needs to be provided for each of the foci.

Information to provide on the visualisations

214 Information provided on the specification of a visualisation should be sufficient for the reader of either an ES, or viewer of a visualisation on a display board, to understand the basis of the visualisation, but not so much as to be overwhelming. Some of this information should be shown upon the visualisation sheet itself, while the remainder can be put within the VIA or appendices. The information provided should include:

1	Overall 'health warning' summarising how the photomontage should be used and its limitations (see **annex A**)
2	Information on viewpoint location, altitude and horizontal field of view
3	Direction of centre of photograph as a bearing
4	Principle distance
5	Distance to nearest visible turbine in kilometres

215 Additional information on the production of the visualisations is important (for example the camera specification and date and time of photograph). However this is not required to interpret the visualisation, and thus can be provided elsewhere within the VIA text or in a clearly referenced appendix.

Paper and printing

216 There is an extremely wide variety of different printers and paper types available with which to print visualisations. To obtain the best results in relation to the size and type of visualisation, it is recommended that advice is sought from specialist providers.

217 The quality of a printed visualisation will depend significantly on the printing process and set-up. Colour inkjet printers tend to show more detail than other machines because of their higher colour range and resolution. However, it is generally difficult to produce large numbers of pages in this way; so, for mass printing, either colour laser printing or professional printing may be advisable.

218 Paper copies of all ES materials will be required by SNH and the Planning Authority, including one set of loose leaf visualisations for each party to use in the field. The number of copies should be agreed for each application. Additional copies for members

of the public will also need to be provided. The number of copies should be agreed with the Planning Authority.

Public Exhibition display

219 Exhibitions provide an opportunity to present visualisations to the public. Given the changes in focal length and image height adopted by this guidance, it is recommended that **the same visualisations**, printed at the same image height should be used for public exhibitions. The limitations of visualisations should be clearly marked on all of the material and the information in **Annex A** clearly displayed at the exhibition.

Presentation to council planning committee

220 Visualisations will be presented to the planning committee making a decision on the application. It is for the Planning Authority to determine which images are presented to the committee. All images should be printed at the correct size and members should be discouraged from viewing these on a computer screen only.

221 Projection of a selection of the visualisations on powerpoint slides or similar may be helpful to the planning officer and committee members. However, **it is essential that members are also provided with hard copies of the images, printed at the right size** to aid their decision making and that they read the supporting text assessment in the ES. Visualisations viewed in isolation are not the whole assessment of affects.

222 Wherever possible, committee members should **visit a good selection of representative viewpoints** as part of the decision making process.

Accessibility online

223 The development of e-planning has revolutionised public access to planning application information. All of the information, including visualisations, should be readily available from Planning Authority web sites, although large file sizes can make downloading difficult for those with slow broadband connections.

224 It is important that members of the public have access to wind farm visualisations. However, large panoramic visualisations (like other technical drawings and maps) do not lend themselves well to viewing on screen. Given the wide variety of screen sizes (including portable devices) it is impossible to control the way in which images presented online will be viewed.

225 To reduce the risk of members of the public being mislead it is proposed to add a clear health warning to every image which sets out the limitations of visualisations and encourages the user to view a correctly printed hard copy at a local location. Nonetheless, some people will still only view these images on screen.

226 There are ways of improving access to the images on line. The single frame image is more readily accessible as it tends to open to the full size of the screen. The limitation, of course, is that the single frame does not provide the full landscape and visual context required to assess the impact of the development. A panorama, on the other hand, tends to open as a much smaller image, as the software seeks to fit the whole image on screen. The image can of course be enlarged to compensate for this.

227 One way of reducing this risk of under representation is to provide an interactive version of the image which opens full screen. A mock version of a webpage to achieve this is available at: www.consense.co.uk/examples/panorama/flash.htm

Question 17: Do you think it is reasonable to expect members of the public to visit local libraries, Council offices or public exhibitions to view images correctly (as is current practice)?

Question 18: If viewed on screen, do you think it is important to provide an accurate representation of the wind farm, or is a 'reasonable representation' sufficient?

Question 19: Do you think an interactive viewer, such as the one in paragraph 227, to view images on screen is helpful? Should developers be required to produce images in this way, or is this disproportionate in terms of time and cost?

Question 20: Are there other techniques that you think offer a useful alternative for the production of ZTV's, visualisations and cumulative assessment?

Annex A Information to be included in ES and displayed at public exhibitions.

Visualisations of wind farms have a number of limitations which you should be aware of when using these to form a judgement on a wind farm proposal. These include:

- A visualisation can **never show exactly** what the wind farm will look like in reality due to different lighting, weather and seasonal conditions which vary through time;
- The images provided give a technically robust impression of the scale of the turbines and the distance to the turbines, but **can never be 100% accurate**;
- A static image cannot convey turbine movement or flicker / reflection from the sun on the turbine blades as they move;
- To form the best impression of the impact of the wind farm proposal these images **are best viewed at the viewpoint location shown**;
- The images **must** be printed at the right size to be viewed properly;
- It is not necessary to view the images at an accurate viewing distance, you should hold them at a **comfortable arms length**. If viewing these images on a wall or board at an exhibition, you should stand at arms length from the image presented.

Using visualisations in the field

Using hard copies of any printed material in the field can be difficult in windy or wet conditions. To obtain the best view of the proposed development it is desirable to try and visit the viewpoint on a relatively clear, dry day. All images taken to the viewpoint should be **printed at the correct size**. In windy or wet conditions it may be beneficial to fold the images to make them easier to use. The wider context provided on the panorama will be less important when used in the field.

It can also be helpful to place the images in a clear Perspex holder, either at A3 (with the image folded) or at A1 (with the Perspex cut to match the size of the images). Planning officers and members of the public who regularly visit viewpoints may find it helpful to purchase a holder for this purpose.

"Health warning" to be provided on every image

To minimise the risk of images being viewed incorrectly on screen, every photomontage should contain the following health warning: "This image should be viewed printed at the correct size (xxxmm by xxxmm). Hard copies are available at [*insert addresses for locations where the ES and visualisations are available to view*]"

Annex B: Earth Curvature and Refraction of Light

OS co-ordinates are not fully 3-dimensional. The northing and easting define a point on a plane corresponding to the OS transverse Mercator map projection and the altitude above OS datum is measured above an equipotential surface passing through the OS datum point at Newlyn. In reality, the earth is round, so a correction has to be made in order to position geographical features correctly in three dimensions for ZTV calculation and for visualisation.

If it wasn't for the presence of the Earth's atmosphere, a simple allowance for curvature would be sufficient. The formula for this can be worked out quite easily from Pythagoras' theorem.

Consider an observer at a point ***A*** looking towards point ***B*** at a distance ***c***. The difference ***h*** between the vertical position of ***B*** measured along a true horizontal and along the surface of the earth is the height correction required. Points ***A*** and ***B*** and the centre of the earth (or radius ***r***) form a right-angled triangle. Applying Pythagoras:

$$
\begin{aligned}
c^2 + r^2 &= (r+h)^2 \\
c^2 + r^2 &= r^2 + 2rh + h^2 \\
c^2 &= 2rh + h^2 \\
&= 2(r+h)h \\
c &= \sqrt{2(r+h)h}
\end{aligned}
$$

h is very small in comparison with ***r***, so the formula can be approximated with:

$$c = \sqrt{2rh}$$

Rearranging for ***h***, we get:

$$
\begin{aligned}
\sqrt{2rh} &= c \\
2rh &= c^2 \\
h &= \frac{c^2}{2r}
\end{aligned}
$$

r, ***c*** and ***h*** must all be in the same units, either metres or kilometres.

Note that although the local vertical at ***B*** is very different from the local vertical at ***A*** in the diagram, in reality these points are very close together compared to the size of the earth and assuming that the height ***h*** correction is vertical does not introduce significant errors. (The horizontal correction increases with the square of distance, as in the same way that the vertical correction does, but at 45km from the viewpoint, it is still only about 1m.)

In practice, rays of light representing sightlines over long distances are also curved downwards as a result of refraction of light through the atmosphere, allowing one to see slightly beyond the expected horizon. (The atmosphere reduces the vertical correction due to curvature alone by about 15%.) The standard formula used in surveying work is modified from the one derived above as follows:

$$h = \frac{c^2(1-2k)}{2r}$$

Where: ***h*** is the height correction in metres
c is the distance to the object in metres
k is the refraction coefficient
r is the radius of the Earth in metres

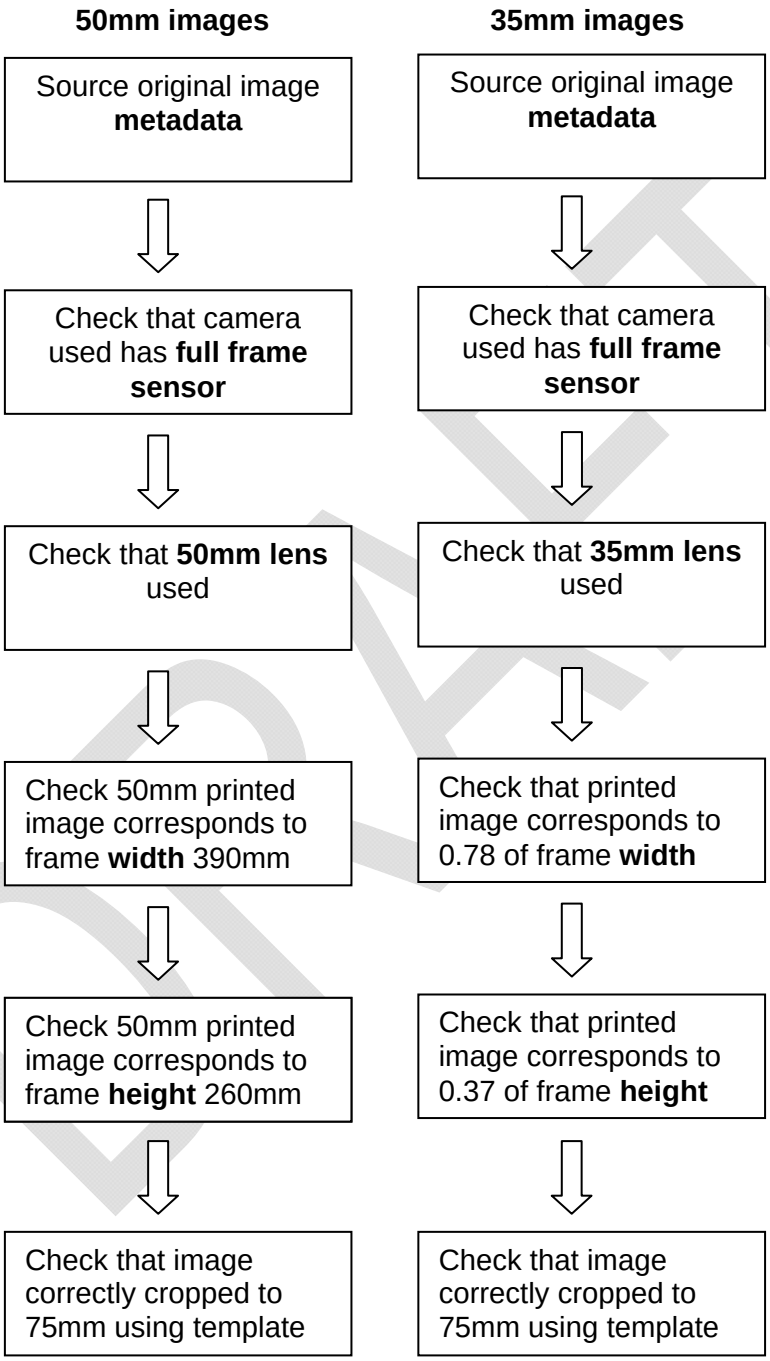
The parameter ***k*** is not constant but varies with temperature and barometric pressure (and therefore also with altitude). For precise geodetic surveying work both these quantities would have to be measured at both ends of a line of sight. Visualisation and visibility analysis do not require such precision, therefore a representative value may be used. 0.075 is a reasonable average for inland upland observations, but very slightly different values may be found quoted in surveying or navigation textbooks. (***k*** is a numerical coefficient and therefore has no units.)

Taking ***k*** = 0.075 and ***r*** = 6,367,000m, the following example values are obtained:

Distance c	**Vertical correction for Earth curvature and atmospheric refraction h**
5 km	1.7m
10 km	6.7m
15 km	15.0m
20 km	26.7m
25 km	41.7m
30 km	60.1m
35 km	81.8 m
40 km	106.8 m
45 km	135.2 m
50 km	166.9 m
55 km	201.9 m
60 km	240.3 m

Annex C Verification of images

Some users of visualisations may wish to 'verify' the images provided, should the accuracy of these be called in to question. Should this verification be required the following method can be used:



Question 21: Should the applicant be required to provide camera metadata as standard? Or should it be provided only on request from the determining authority?

Annex D: Taking Good Photographs

This appendix is not intended to be a general manual of photography; there are plenty of good books available on that subject. Rather, it sets out briefly the main issues relating to photography aimed at constructing panoramas suitable for photomontages and ES work.

Camera and lens

A good quality camera is essential. A digital SLR with **full frame sensor** is required to capture sufficient information and produce a verifiable image. A **fixed focal length 50mm** lens should be used to produce photomontages. A fixed focal length a) reduces the risk of inaccuracies and b) enables verification of the image should this be required. A fixed focal length of **35mm** is required to produce the panorama in option B, described in paragraph 179.

To produce the baseline panorama (either 180º or 360º) lens choice is less important, though most practitioners will use a series of 50mm frames. 35mm or 50mm lenses can be used for this purpose.

Tripod

A stable tripod is essential. As a minimum, a head with independent tilt adjustments for both pitch and roll should be used. (Ball-head tripods cannot be levelled satisfactorily.) A panoramic head should be used, allowing a single adjustment to be made for an entire panorama.

Levelling

In order to obtain photographs which will splice together satisfactorily to make the baseline panorama, it is essential that they be levelled accurately. A simple, cheap spirit level will do this quite satisfactorily and, with care, can produce images levelled to an accuracy of about 0.2°. A tripod head with a built-in sprit level and adjusting screws is better.

Focus

The camera lens should always be focussed on infinity both for consistency and to ensure that the focal length and principal distance are equal. On auto-focus lenses, the focussing should be set to manual or locked on infinity.

Aperture and Exposure

If at all possible, exposure should be metered once for a complete panorama and then used for all frames either by using a manual setting or by locking the exposure.

For greatest depth of field in the images, aperture should be set to the minimum available on the lens (typically f/16 or f/22). If it is necessary to obtain slightly more resolution, it may help to use a slightly wider aperture: f/5.6 or f/8 are often the optimum settings.

Shutter speed should be selected to obtain the correct exposure consistent with the aperture selected. If there are existing wind turbines in the view, the shutter speed will affect the degree of blurring seen in the photograph due to the movement of the blades.

Recording Photographic Details

As a minimum, the following details should be recorded at each viewpoint used as a photo location:

- Position as an OS National Grid Reference. A hand-held GPS is generally sufficient for this purpose. However, take note of the EPE (Estimated Position Error) figure, which is a measure of accuracy, when taking the reading. An EPE of 8m or more may indicate that there was a poor configuration of satellites, possibly because part of the sky is hidden by buildings or landform. If this happens, the EPE may improve by waiting a few minutes or alternatively it may be necessary to change the location. EGNOS and other supplementary technologies may usefully improve the accuracy of GPS.

- Camera lens focal length. This is obvious but important if more than one lens is being used.

- Camera altitude above OS datum. The GPS altitude should be noted as a check, but in general a more accurate altitude will be obtained by reference to the OS 1:10,000 or 1:25,000 map and estimating from the contours with reference to the features actually visible on site. The height of the camera above ground level should also be recorded, but will often be a constant determined by the photographer's height and the need to be able to see through the camera viewfinder.

- Approximate direction of the centre of the panorama as a bearing in degrees. Also, in some situations, particularly on flat or otherwise featureless terrain, it is useful to take accurate bearings to identifiable objects in the scene using a suitable sighting compass. It is sometimes worthwhile also noting the approximate angular separation of frames in a panorama, although it is often convenient to do this by eye, judging the overlap through the viewfinder, or to rely on the indexing on a panoramic tripod.

- Date and time of photography. In conjunction with the position, this will allow the direction of the light to be calculated for photomontage.

- Wind direction is sometimes also useful if there are existing wind turbines in the photograph and it is desired to match their orientation in a photomontage.

Key environmental factors affecting the quality of a photograph are the angle of the sun, the direction of the sun and the level of humidity (creating haze, cloud or rain). If a photograph is taken in fine conditions, the most important issue tends to be the direction of the sun, although low light can emphasise the vertical element of the landscape. Conventional wisdom states that the sun should be behind the photographer for the best lighting in a scene. In practice however, having the sun directly behind the camera can make some landform shapes less apparent and side lighting often gives the best impression of the topography. Looking directly into the sun, especially in the winter when it is low in the sky, is to be avoided, unless sunset views need to be illustrated.

Whilst it is appropriate to consider a range of weather conditions in the VIA, the viewpoint photographs should be taken in weather, visibility and lighting conditions that would allow operational wind turbines to be captured on a photograph (which requires greater light intensity, clarity and contrast than when viewed with the naked eye). This is more likely to be achieved by maximising the contrast between the turbines and their background. This requires taking account of the effect of lighting, background and turbine colour as shown in the table below.

It is rarely possible to achieve the desired photographic contrast in grey and overcast conditions, unless the turbines would be back-lit or in shadow. Land with heavy snow cover gives a background similar to brightly lit clouds and can present similar problems in achieving the required contrast.

Turbines	Back-ground	Weather	Ideal lighting
Near/ middle distance	land	Bright sunshine	Front or side lit
	sky	Blue sky, bright sunshine	Front or side lit
		Cloudy, bright	Back lit or in shadow
		Dark storm clouds, bright sun	Front or side lit
Distant	land	Bright sunshine	Front lit
	sky	Blue sky, bright sunshine	Back lit or in shadow
		Cloudy, bright	Back lit or in shadow
		Dark storm clouds, bright sun	Front lit or in shadow

Source: Kay Hawkins, E4environment Ltd and Phil Marsh

Realistically, it is not always possible to arrange for the photography from each viewpoint to be taken under ideal conditions when there is a tight project timescale. However, photographic expeditions should be planned (by reference to weather forecasts, web cams and local information) as far as is practical to coincide with good conditions, with visits to viewpoints to the east of the site in the morning, and to the west in the afternoon.

Whatever the weather and light conditions, the minimum requirement is for photographs to clearly show the proposed wind farm site and its context and, if they are to be used as the basis for photomontage, they should be able to have wind turbines clearly illustrated upon them.

Information to record at each photo location

To assist with the construction of visualisations back in the office or studio, the photographer should keep a record of important information about the viewpoint location, equipment used etc, as listed in the table below. This information is best recorded in a photo log for each photo point. The records of information within this log may be made by separate assessors and photographers on different days and, as a consequence, should be sufficiently comprehensive for both parties to understand the conditions under which all visits occurred. Some of this information also needs to be included on the final visualisation.

It can also be useful to take a photograph recording the position of the tripod location in relation to local features such as a cairn or signpost. This can be helpful both during the production of the visualisations and in the event that the location has to be re-visited.

Information to be recorded at each photograph location)
• Camera type (SLR, digital) • Lens focal length • Spacing between the frames (for example 30 degrees for 50mm shots) • Compass bearings to distinctive elements in the view that will assist with the scaling and placement of the turbines (plus sketch of the view with these elements marked if appropriate) • Grid reference

Source: Kay Hawkins, E4environment Ltd

For compass bearings, it is more accurate to use a sighting compass, as bearings to within 0.5 degrees can be measured. However, sighting compasses do not have the deviation adjustment (to compensate for the difference between grid and magnetic north). There is less risk of mistakes if the bearings are recorded in the photo log and recalculated back in the office to allow for the appropriate number of degrees deviation. Significant deviations in the compass bearings will be caused by nearby metal objects (including passing vehicles) and, if this is a possibility, it should be noted.

Annex E: Summary of visualisations to be provided at each viewpoint. NB, <u>not</u> presented to scale here, do not use to compare images.

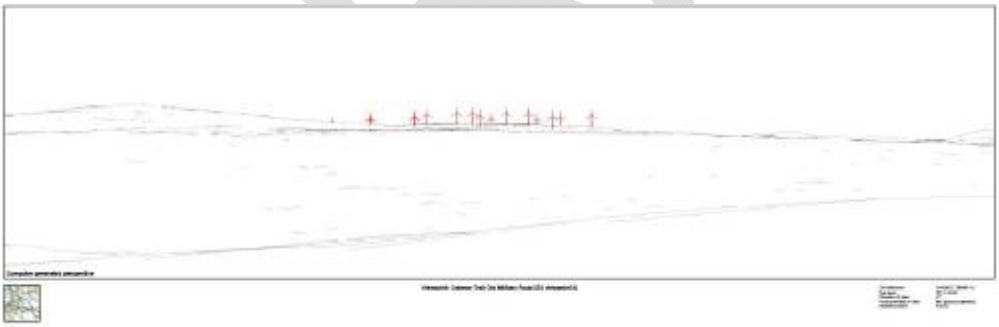
Images required as standard

50mm single frame

75mm single frame

Baseline panorama and wireline

Wireline



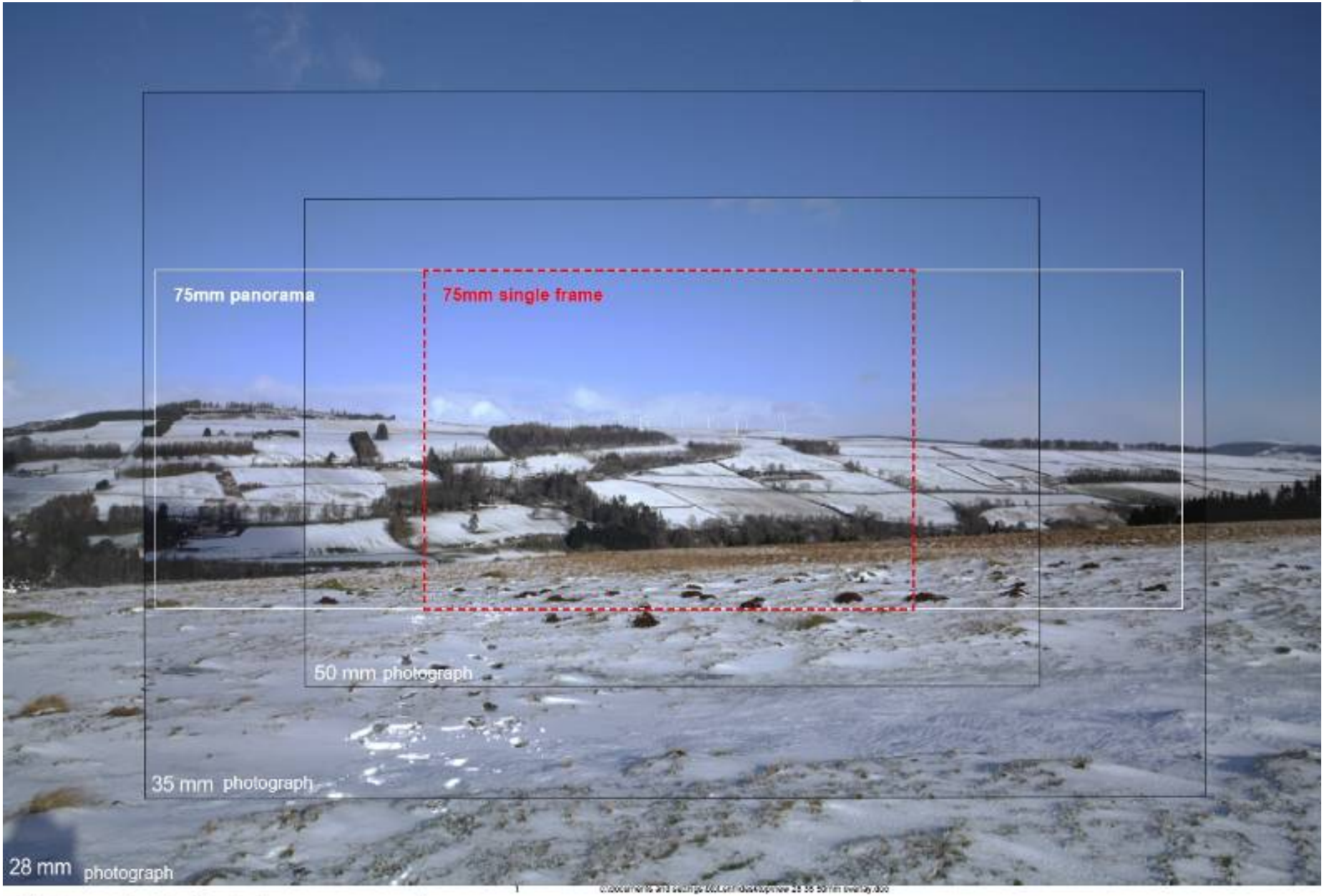
75mm panorama

Optional extra images

A3 50mm transparency

A3 version of panorama

Annex F: Diagram showing the relationship between 75mm single frame, 75mm panorama and 28mm / 50mm / 35mm photography



Not to scale – for illustrative purposes only