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Bramford to Twinstead Reinforcement

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1. Introduction

1.1 Overview

1.1.1 National Grid Electricity Transmission plc (here on referred to as National Grid) is making an application for development consent to reinforce the transmission network between Bramford Substation in Suffolk, and Twinstead Tee in Essex. The Bramford to Twinstead Reinforcement ('the project') would be achieved by the construction and operation of a new electricity transmission line over a distance of approximately 29km (18 miles), the majority of which would follow the general alignment of the existing overhead line network.

1.1.2 This Good Design Report has been produced to support the application for development consent and the accompanying Environmental Statement (ES) under the Planning Act 2008. It sets out the design aspects that have been considered during the development of the project, as submitted within the application for development consent. It should be read alongside both ES Chapter 3: Alternatives Considered (**application document 6.2.3**), which explains the different options that were considered during the project development, and also ES Chapter 4: Project Description (**application document 6.2.4**), which describes the project.

1.1.3 The design considerations have taken place within the context of rigorous health and safety processes that National Grid has in place that govern how it designs and constructs its projects safely, to national policy and to National Grid's various statutory duties, which includes (amongst other things) the requirement to:

- Develop and maintain an efficient, coordinated and economical electricity transmission system (under the Electricity Act 1989); and
- To have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest (under Schedule 9 of the Electricity Act 1989). National Grid's interpretation of this also includes the impact of works on communities, such as but not limited to the effects of noise and disturbance from construction.

1.2 Planning and Policy Context

1.2.1 The project is a Nationally Significant Infrastructure Project (NSIP) under the Planning Act 2008 and the relevant National Policy Statements (NPS) are used by the Secretary of State to determine whether such developments should be consented.

1.2.2 ES Chapter 2: Regulatory and Planning Policy Context (**application document 6.2.2**) sets out the overarching policy relevant to the project, including NPS EN-1 (Department of Energy and Climate Change (DECC), 2011a) and NPS EN-5 (DECC, 2011b). NPS EN-1 describes the need for 'good design' in paragraph 4.5.1 which states:

'The visual appearance of a building is something considered to be the most important factor in good design. But high quality and inclusive design goes far beyond aesthetic considerations. The functionality of an object — be it a building or other type of infrastructure — including fitness for purpose and sustainability, is equally important. Applying 'good design' to energy projects should produce sustainable infrastructure sensitive to place, efficient in the use of natural resources and energy used in their

construction and operation, matched by an appearance that demonstrates good aesthetic as far as possible. It is acknowledged, however, that the nature of much energy infrastructure development will often limit the extent to which it can contribute to the enhancement of the quality of the area.'

1.2.3 In addition, NPS EN-5 references good design in paragraph 2.5.2 which states that '*proposals for electricity networks infrastructure should demonstrate good design in their approach to mitigating the potential adverse impacts which can be associated with overhead lines'*. It goes on to list out biodiversity and geological conservation, landscape and visual; and noise and vibration as examples.

1.3 Good Design

1.3.1 The Design Principles Guide for National Infrastructure (National Infrastructure Commission, 2020) outlines four design principles that should be considered as part of good design:

- Climate: Mitigate greenhouse gas emissions and adapt to climate change;
- People: Reflect what society wants and share benefits widely;
- Places: Provide a sense of identity and improve our environment; and
- Value: Achieve multiple benefits and solve problems well.

1.3.2 The remaining sections of this appendix set out how the project has used these design principles. This is indicated by the design principle being identified like this (CLIMATE).

1.4 Detailed Design

1.4.1 The National Grid options appraisal process promotes good design to be considered at an early conceptual stage by avoiding environmental impacts at the outset, where practicable. This includes using the mitigation hierarchy (i.e. to avoid, then reduce and then compensate) to avoid impacts in the first instance by locating project features away from sensitive receptors where practicable and considering measures that can be embedded into the design where sensitive receptors cannot be avoided. This appendix does not duplicate the text in ES Chapter 3: Alternatives Considered (**application document 6.2.3**) which describes the decisions around the routeing and alignment.

1.4.2 The Order Limits delineate the extent of the project for which development consent is being sought; and encompass the land required temporarily to build the project and permanently to operate the project. The Order Limits include the Limits of Deviation (LoD), which represent the maximum deviation of permanent infrastructure, such as the overhead line, pylons, cable sealing end (CSE) compounds and underground cables. The LoD allow for adjustment to the final positioning of the permanent infrastructure for example to avoid localised constraints or unknown or unforeseeable issues that may arise. Further details can be found in the Guide to the Plans (**application document 2.1**).

1.4.3 Subject to the grant of development consent, the design would continue to evolve and be refined within the parameters set by the LoD. National Grid would employ environmental specialists (including but not limited to ecologists, archaeologists and landscape architects) to advise on the design refinements and the micro-siting of project components within the LoD. The final positioning of the project components would also be informed by the results of pre-construction surveys and consultation with the landowners and would lie within the LoD.

1.5 Structure of This Report

1.5.1 This appendix focuses on the design choices that have been considered during the design evolution. Chapter 1 introduces the concept of good design. Chapter 2 sets out the general good design principles that apply to the project as a whole. Chapters 3, 4, 5 and 6 cover the grid supply point (GSP) substation, the removal of the overhead lines, new 400kV overhead lines and the new 400kV underground cables (including CSE compounds) respectively.

1.5.2 The appendix does not duplicate the text in ES Chapter 3: Alternatives Considered (**application document 6.2.3**) which describes the decisions around the routeing and alignment and also outlines why underground cables were chosen in Section E: Dedham Vale Area of Outstanding Natural Beauty (AONB) and parts of Section G: Stour Valley.

1.5.3 This appendix makes reference to existing commitments made by National Grid during the design process and these include embedded measures (given an EM prefix). These are measures that are intrinsic to and built into the design of the project. The full set of embedded measures are set out in the Register of Environmental Actions and Commitments (REAC), which is Appendix B of the Construction Environmental Management Plan (CEMP) (**application document 7.5.2**). The CEMP is secured by Requirement 4 in the draft Development Consent Order (DCO) (**application document 3.1**).

1.5.4 National Grid has also identified a number of good practice measures, which generally comprise measures imposed through legislative requirements or represent standard sector good practices. These include measures to reduce nuisance from construction activities and are typically listed with a GG prefix. The good practice measures are set out in the Code of Construction Practice (CoCP) (**application document 7.5.1**), which is Appendix A of the CEMP (**application document 7.5.1**).

2. General Routeing and Design

2.1 Introduction

2.1.1 This section describes the good design principles that have been and would be taken regarding the design process including reducing use of raw materials and waste generation. It also sets out how the project has been designed to be resilient to climate change. The options appraisal, as described in ES Chapter 3: Alternatives Considered (**application document 6.2.3**), considered the application of the Holford Rules. Further details on how the rules have been applied can be found in Section 5.8 of the Planning Statement (**application document 7.1**).

2.2 Routeing and Optioneering (CLIMATE/PLACES/VALUE/PEOPLE)

2.2.1 The overarching purpose of the project is around helping deliver the infrastructure needed to help the UK meet its net zero energy targets (CLIMATE).

2.2.2 As outlined in ES Chapter 3: Alternatives Considered (**application document 6.2.3**), the options appraisal has included many good design principles including the following which are aligned with the steps in the Holford Rules. Further details can be found in in Section 5.8 of the Planning Statement (**application document 7.1**):

- Avoiding areas of high environmental value such as conservation areas and scheduled monuments (PLACES);
- Avoiding main settlements and built-up areas with large numbers of people (PEOPLE);
- Proposing underground cables in the areas with the highest landscape sensitivity i.e. the Dedham Vale AONB and parts of the Stour Valley (PLACES/PEOPLE);
- Using Corridor 2 (opportunity corridor) which involves removing the existing 132kV overhead line between Burstall Bridge and the diamond crossing at Twinstead Tee to further reduce the visual impact of the project (PLACES/VALUE/PEOPLE); and
- Removing a stretch of the 400kV overhead line between Twinstead Tee and the Stour Valley West CSE compound, which would benefit the landscape in the Stour Valley (PLACES/PEOPLE).

2.3 General Project Design Considerations (PLACES/VALUE/PEOPLE)

Design Resilience to Climate Change (CLIMATE)

2.3.1 During operation, the project has been designed to be resilient to climate change by locating the above ground elements of the project, including the GSP substation and the CSE compounds, outside of Flood Zones 2 and 3. Further details on the resilience to climate change can be found in ES Chapter 9: Water Environment (**application document 6.2.9**) and in the Flood Risk Assessment (**application document 5.5**).

Extreme climatic events are also assessed within ES Appendix 5.3: Major Accidents and Disasters Scoping (**application document 6.3.5.3**).

2.3.2 Good practice measure W12 in the CoCP (**application document 7.5.1**) states that where new permanent areas of impermeable land cover are created, the drainage design would be in accordance with the requirements of the Essex County Council Sustainable Drainage System (SuDS) Design Guide (2020) and the Suffolk County Council SuDS Palette (2021) and would include allowances for climate change in accordance with current (May 2022) Environment Agency requirements. The drainage infrastructure would provide the storage necessary to achieve discharges at greenfield rates and would not significantly alter groundwater recharge patterns by transferring a significant recharge quantity from one catchment to another. A specialised drainage contractor would review the designs and would provide advice to National Grid and its contractor during relevant construction and reinstatement activities. With these measures in place, the project is considered to be resilient to climate change over the project design life.

Lighting

2.3.3 The GSP substation would require security lighting, which would be used outside of daylight hours. This would be motion-sensor activated and only triggered (i.e. would not be continuous) in exceptional circumstances. Such security lighting would be low lux level light-emitting diode type luminaires with directable light output and passive infrared sensor motion activated lighting at the access gates to facilitate safe entry at night.

2.3.4 Permanent lighting is not required anywhere else on the project. If maintenance works were required at night, for example at the CSE compounds, then portable task lighting would be used.

Fencing

2.3.5 Permanent fencing would be required at the GSP substation and at each of the CSE compounds to secure the sites against trespass. The fencing type would be confirmed during detailed design but it is anticipated to comprise 2.4m high palisade security fencing due to the security requirements for these types of sites in a rural environment. These fencing standards are in line with the National Grid’s Technical Specifications and the Electricity Safety, Quality and Continuity Regulations 2002.

2.4 General Construction Method Considerations (PLACES/VALUE/ PEOPLE)

Temporary Construction Compounds

2.4.1 National Grid has identified potential locations of temporary construction compounds, as shown on Figure 4.1: The Project (**application document 6.4**). A main construction compound has been identified off the A134. This is a large, relatively flat site that is away from residential areas. It was chosen due to its good connections with the local road network and as it is located roughly centrally within the Order Limits, which would reduce the journey distances for site staff to visit the work fronts. A main site compound would make it easier to coordinate car sharing for workers and also pick up/drop offs to local railway stations or other locations.

2.4.2 Other temporary construction compounds have generally been located in close proximity to work sites where there are longer duration works proposed at a specific location i.e. the CSE compounds, GSP substation and the trenchless crossings. These areas would require more deliveries and storage than standard overhead line or underground cable sections and are likely to require a more secure site due to the nature of the works. Outside of these work sites, mobiles units would be typically used to provide welfare facilities to workers during construction, which would have a low impact on the environment.

Temporary Access Points and Temporary Access Routes

2.4.3 Different designs of temporary access routes have been identified for the different project components, which would require different types of machinery (weight and minimum width). In all cases, the lowest form of intervention has been used. These are as follows with the lowest intervention first and the assumptions used within the ES are shown on Figure 4.1: The Project (**application document 6.4**):

- **Using existing access points and tracks where available**: National Grid already has agreed maintenance access points to the existing 400kV overhead line. This would be the case for the minor works to the existing line such as the replacement of the arcing horns in both Section G: Stour Valley and Section H: GSP substation. In these cases, the existing access points and accesses would be used and are unlikely to require any additional works as the works would be undertaken using light goods vehicles such as a 4x4. These are generally indicated by a Y-AP access point reference on the Access, Rights of Way and Public Rights of Navigation Plans (**application document 2.7**);
- **Trackway matting or alternative**: This involves placing protective matting over the soil to avoid the need for soil stripping and reduces compaction of the soil along the temporary access routes. This reduces the risk of damage of the soil and allows for much quicker reinstatement of the site than other measures. This is assumed to be used in the areas of 132kV removal (where required) where the works would generally be undertaken by a tractor or similarly sized vehicle.
- **Stone temporary access route c. 4m wide**: This is likely to involve stripping the topsoil along the width and storing this adjacent to the temporary access route. This is proposed in areas where there is new 400kV overhead line proposed, as shown on Figure 4.1: The Project (**application document 6.4**). A stone temporary access route is assumed, as these works may require cranes to construct/remove the pylons which would be too heavy for trackway matting options; and
- **Stone temporary access route c. 7m wide**: This is likely to involve stripping the topsoil along the width and storing this adjacent to the temporary access route or within the underground cable working area. A 7m wide temporary access route is required in the areas of the 400kV overhead line removal and for the delivery of the cable drums to the underground cable sections. A 7m wide temporary access route is assumed between the A131 and the Stour Valley West CSE compound, to provide access for the cable deliveries to the western end of the cable section in Section G: Stour Valley and also to either end of the underground cable section, as shown on Figure 4.1: The Project (**application document 6.4**).

2.4.4 When identifying locations for positioning access points, a combination of aerial surveys, site surveys and discussions with landowners were used to identify the most suitable locations. Existing accesses have been identified where suitable and available. Where these were not available, the access points were generally sited as close as practicable to the working area, taking into account known site constraints.

2.4.5 The ES has assumed the access point locations shown on Figure 4.1: The Project (**application document 6.4**) for the assessment. However, as noted in Section 1.4, the specific location of temporary access points or temporary access routes could be located anywhere within the Order Limits, unless a commitment has been made otherwise.

2.4.6 In terms of locations where the temporary access routes are required to cross watercourses, good practice measure W17 in the CoCP (**application document 7.5.1**) states that temporary clear span bridge crossings (e.g. bailey bridge) would used for the crossing at the River Stour, River Box and the River Brett. A typical design is shown on Design and Layout Plans Temporary Bridge for Access (**application document 2.11.13**). The remaining watercourses within the Order Limits are generally small ditches / land drains, where it would be disproportionate in terms of cost, duration and the impact on the channel associated with open span bridges, when considering the size and weight of the construction machinery proposed. Instead, culvert crossings are proposed and a typical design is shown on the Design and Layout Plans Temporary Culvert for Access (**application document 2.11.14**).

2.5 Materials and Waste Management (CLIMATE/VALUE)

2.5.1 National Grid has developed a Material and Waste Management Plan (**application document 7.7**). This sets out the good practice principles around materials and waste.

2.5.2 National Grid sources its materials from global supply chains, and carefully considers the most carbon neutral procurement routes whilst committing to the highest quality of its components. National Grid also works closely with its contractors to encourage sourcing materials from sustainable sources and reducing waste being sent to landfill. These include measures to recycle the 132kV and 400kV overhead line pylons and conductors that are being removed. Good practice measure AS09 in the CoCP (**application document 7.5.1**) states that soil excavated from the project would be reused on site through the backfilling of trenches and for landscaping where practicable and where soil is suitable for reuse.

2.6 Design Considerations in Relation to SF_6 (CLIMATE)

2.6.1 Sulphur hexafluoride (SF_6) is required for use in the switchgear at the GSP substation and in the proposed circuit breakers at Bramford Substation. The consultation draft of NPS EN-5 (Department for Business, Energy and Industrial Strategy, 2021b) states in Section 2.14 that '*The climate-warming potential of SF_6 is such that applicants should, as a rule, avoid the use of SF_6 in new developments. Where no proven SF_6-free alternative is commercially available, and where the cost of procuring a bespoke alternative is grossly disproportionate, the continued use of SF_6 is acceptable, provided that emissions monitoring and control measures compliant with the F-gas Regulation and/or its successors are in place.*'

2.6.2 EN-5 goes on to say that applicants should carefully consider at the design phase of the process whether the project could be reconceived to avoid the use of SF_6-reliant assets. It also says that where it cannot be so conceived, the applicant must provide evidence of their reasoning on this point including an explanation of the alternatives considered, and a case why these alternatives are technically infeasible or grossly disproportionate in terms of cost. In particular, an accounting of the cost differential between the SF_6-reliant asset and the appropriate SF_6-free alternative should be provided.

2.6.3 The consultation draft of EN-5 also states that where Applicants propose to put new SF_6-reliant assets onto the electricity system, they should design a plan for the monitoring and control of fugitive SF_6 emissions consistent with the F-gas Regulation and its successors. Applicants must provide evidence of this plan, and its compliance with the aforementioned regulatory prescriptions, to the Examining Authority.

2.6.4 SF_6 is currently proposed for use in switchgear at the GSP substation and in the proposed circuit breakers at Bramford Substation, as there is currently no alternative available. SF_6-free transmission switchgear is being developed by all major switchgear manufacturers globally and National Grid is working closely with these manufacturers to expedite the elimination of SF_6 from new equipment, as defined in National Grid Policy (PS(T)005). The two emerging technologies for SF_6-free switchgear at transmission voltages are:

- A technology based on a fluorinated compound in combination with natural origin gases (CO_2, N_2, O_2). This is able to closely match the performance of SF_6 within a similar physical footprint; and
- A technology that uses synthetic air for insulation and vacuum for interruption. This technology combination is common at medium voltage but is still proving challenging to develop to the transmission level.

2.6.5 SF_6-free equipment using these technologies is already commercially available for the 132kV voltage class and is being deployed by National Grid. Higher voltage technology may be available for use on the project by the time it is constructed, although a commitment cannot be made to do this at application. The use of relatively small amounts of SF_6 is therefore included within the assessment presented in ES Appendix 4.3: Greenhouse Gas Assessment (**application document 6.3.4.3**).

2.6.6 If the project still requires the use of SF_6 at the point of construction, due to no SF_6-free alternative being commercially available, then National Grid would undertake emissions monitoring and implement control measures that are compliant with the F-gas Regulation and/or its successors are in place until the point that SF_6 can be phased out of use on the project.

3. GSP Substation

3.1 Options Appraisal (CLIMATE/PLACES/VALUE/ PEOPLE)

3.1.1 ES Chapter 3: Alternatives Considered (**application document 6.2.3**) outlines that a GSP substation has been assessed as the best solution for providing an alternative connection to the local electricity network owned and operated by UK Power Networks (UKPN). The GSP substation would need to be located where the 400kV overhead line and the 132kV overhead lines are close together.

3.1.2 ES Chapter 3: Alternatives Considered (**application document 6.2.3**) also outlines why the GSP substation has been sited between Butler's and Waldegrave Woods. Considerations included the existing screening provided by the adjacent woodland (PEOPLE/PLACES/VALUE), that the site benefits from direct access off a main road (VALUE) and the site is generally located away from residential areas or sensitive environmental receptors (PLACES). The GSP substation is also located in Flood Zone 1 (lowest risk of flooding) (CLIMATE).

3.2 Design and Layout (PLACES/VALUE/ PEOPLE/CLIMATE)

3.2.1 The GSP substation has been designed to fit between the two existing woodland blocks without encroaching into the root protection areas (PLACES). The permanent access point where it would join the local road network has been designed to highway standards. The permanent access route has a bend to avoid the ancient woodland and adjacent ditch which would reduce the visual impact of the GSP substation.

3.2.2 The design includes low mounds to the east and west of the GSP substation, which it is assumed would be created from soil excavated from the site as part of the enabling works to level the site (EM-H04). These would be planted to help filter and soften views of the GSP substation from the road (A131) and other visual receptors to the east and west.

3.2.3 Higher banks were considered but were dismissed as a high steep sided bank would be out of character in the local landscape and would also require a greater land take for the footprint. The greater land take would also extend the GSP substation further to the west, which would have greater landscape and visual effects, as the GSP substation would then protrude from the existing woodland and be more visible to receptors, including users of public rights of way to the west.

3.2.4 A single circuit sealing end compound is proposed to connect to the existing 400kV overhead line to the new GSP substation. A replacement 132kV overhead line pylon with sealing end gantries (CSE platform pylon) would also be built instead of a full CSE compound, which would require a larger footprint. The CSE platform tower would replace an existing pylon and would limit the visual intrusion associated with reconnecting the GSP substation into the distribution electricity network.

3.2.5 A noise enclosure (EM-H01) has been built into the designs of the GSP substation. This would reduce noise at source avoiding significant noise effects at nearby residential properties.

3.2.6 The GSP substation would require a power connection. The routeing of this started with discussions with UKPN to identify the nearest suitable connection on the low voltage network that had capacity. The design then sought to take the shortest route from the connection to the GSP substation (VALUE) taking into account existing land boundaries and avoiding unnecessary cutting through vegetation or other features (PLACES).

3.3 Construction (PLACES/CLIMATE)

3.3.1 There are existing ditches at the edge of the field which provide a natural protection for the root zone of the ancient woodland during construction. National Grid has an embedded measure to not undertake works beyond the ditches to protect the woodland (EM-H03).

4. Removal of Overhead Lines

4.1 Options Appraisal (PEOPLE/PLACES/VALUE)

4.1.1 The options appraisal process is documented in ES Chapter 3: Alternatives Considered (**application document 6.2.3**). In summary, this started at a strategic level which considered an overhead line taking the most direct route from Bramford Substation to Twinstead Tee (VALUE).

4.1.2 As part of the options appraisal National Grid has considered to rationalise electricity lines within the area and this highlighted Corridor 2 as an opportunity corridor, as the new 400kV overhead line would use the route of the 132kV overhead line. This would avoid the need for an additional overhead line within the landscape and would reduce the magnitude of impact of a new overhead line on the environment (PLACES). Embedded measure EM-P02 commits to removing the 132kV overhead line between Burstall Bridge and Twinstead Tee.

4.1.3 National Grid has not identified a need for removing sections of the 132kV overhead line between Twinstead Tee and the GSP substation, as these works are not required for the project, they would increase the disturbance associated with the temporary works and would cost more to UK electricity customers. The 132kV overhead line is owned and operated by UKPN and they would be responsible for any works to this line in the future.

4.2 Design (PEOPLE/PLACES/VALUE)

4.2.1 The design assumes that where pylons are to be removed, that the foundations would be removed to a depth of 1.5m. This is considered to be a suitable depth that balances excavating the foundations to a sufficient depth for example for ploughing, without incurring excessive costs for customers associated with deeper excavations. In addition, deeper excavations would disturb a greater area of land due to the need to safely batter back the trenches.

5. New Overhead Lines

5.1 Options Appraisal (PEOPLE/PLACES/VALUE)

5.1.1 The options appraisal process is documented in ES Chapter 3: Alternatives Considered (**application document 6.2.3**). In summary, this started at a strategic level which considered an overhead line taking the most direct route from Bramford Substation to Twinstead Tee (VALUE). Corridor 2 was identified as an opportunity corridor as it would allow for the removal of the 132kV overhead line to reduce the magnitude of impact of a new overhead line (PLACES). It would also allow paralleling of the existing 400kV overhead line, to further reduce the landscape impact of two lines.

5.1.2 The routeing studies identified key constraints to avoid such as larger settlements and villages and scheduled monuments. The designs also sought to maintain a straight alignment to reduce the number of tension (angle) pylons. National Grid has continued to refine the alignment of the overhead lines based on engineering and environmental assessments, through discussions with landowners and statutory consultees and through responses received during consultation events.

5.1.3 ES Chapter 3: Alternatives Considered (**application document 6.2.3**) also compares overhead lines and underground cables and the justification for their use on the project.

5.2 Design and Layout

Pylon Type (PLACES)

5.2.1 Assessment of pylon design was undertaken in 2013, which considered different designs of pylons that could be used on the project and the potential effects of each. Three types of pylon were considered and the dimensions of each are set out in Table 5.1.

Table 5.1 – Comparison of Pylon Design

Suspension Pylon Type	Typical Height	Base at Widest Point	Number of Cross Arms	Width of Widest Cross Arm	Number of Earth Wires
Standard steel lattice pylon	49.95m	9.3m	3	20.8m	1
Low-height steel lattice pylon	35.3m	7m	2	29.2m	1
T-pylon	34.5m	2m	1	22.4m (31m including insulators)	2

5.2.2 The assessment considered the potential environmental effects of each pylon type, including landscape and visual, ecology and historic environment. It considered the effects in terms of visibility alongside the existing 400kV overhead line, which comprises steel lattice pylons.

5.2.3 The assessment concluded that although the low-height steel lattice pylon and the T-pylon would be lower in height (with potential benefits on distant views), introducing a notably different pylon design parallel to the existing 400kV standard steel lattice pylons would have greater adverse effects on close views. The standard steel lattice pylons also benefits from having a greater span which would allow the design to pass over sensitive features more easily, resulting in less habitat loss than low-height steel lattice pylons or

T-pylons. The assessment concluded that the standard steel lattice pylon would be the preferred pylon design.

5.2.4 National Grid has also started to construct T-pylons on other projects, including on the Hinckley Connection Project in Somerset. The results from these projects have shown that T-pylons take longer to construct, require additional abnormal indivisible loads and require more concrete for the foundations than standard lattice pylons. T-pylons also require permanent maintenance access to each pylon for maintenance activities, whereas steel lattice pylons can be climbed by linesmen to perform any necessary maintenance for the duration of the asset lifecycle of the lattice pylons. This reinforces the assessment that standard steel lattice pylons would be the preferred pylon design.

Conductor Design (PLACES/VALUE)

5.2.5 The assessment presented in the ES assumes the use of aluminium triple ‘araucaria’ conductors, which is an ‘all aluminium alloy conductor’ (AAAC). An alternative design considered was an ‘aluminium conductor or steel reinforced’ (ACSR). These are both examples of bare conductors used in overhead transmission lines. The project chose the AAAC conductor type based on the better electrical ratings compared to the ACSR and it can also carry the current for the electrical charge required (capacity).

5.2.6 Due to its geometrical configuration the triple Araucaria design is the least electrically stressed conductor system that National Grid uses. It is currently the best available technology for reducing the effects of line crackle (corona discharge) from the proposed overhead lines during operation. The embedded measure (EM-P03) includes the use of triple araucaria conductors or alternative technology that performs to the same or better standard in relation to noise , to allow the use of emerging technologies that may provide even better electrical ratings and no increase in noise.

6. Underground Cables

6.1 Options Appraisal (PEOPLE/PLACES/VALUE)

6.1.1 The options appraisal process is documented in ES Chapter 3: Alternatives Considered (**application document 6.2.3**) and outlines the reasons why underground cables are proposed in the high value landscapes, namely Section E: Dedham Vale AONB and parts of Section G: Stour Valley. There has been general support through the consultation responses regarding these areas reflecting the right balance between the effects of underground cables (which are more disruptive and expensive to construct than overhead lines) compared to the landscape and visual effects of an overhead line. Further details on the consultation responses can be found in the Consultation Report (**application document 5.1**) and the planning balance is discussed in the Planning Statement (**application document 7.1**).

6.2 Design and Layout

Order Limits (PLACES/VALUE)

6.2.1 The Order Limits are typically 100m wide for the underground cable sections, outside of the trenchless crossings. The permanent cable width would be c. 60m wide, which is based on six cable trenches with three cables in each, as shown on the Design and Layout Plans Cable Working Cross Section (**application document 2.11.9**). An extra 20m is required to provide space for the temporary access route and soil storage providing an 80m standard construction working width. The Order Limits typically include an additional 20m to provide flexibility for site constraints during detailed design and construction, for example avoiding an archaeological site or a badger sett.

6.2.2 The temporary access route is generally assumed to be located within the centre of the cable working area to provide access to both sides of the cable working area.

6.2.3 As described in ES Chapter 4: Project Description (**application document 6.2.4**) the assumption is that the standard 80m working width would be narrowed to 60m at hedgerows where they are crossed at a right angle by the working width and at other very short crossings. This reduces the length of hedgerow affected by locating the stockpiles of soil away from the hedgerow. It can only be done for short sections such as hedgerow crossings, as the alternative would require soil to be transported to other areas within the Order Limits increasing the number of vehicle movements and increasing risks to soil becoming damaged and biosecurity issues with transferring soil between land plots. This assumption is shown on the Trees and Hedgerows to be Removed or Managed Plans (**application document 2.9**) and also on the Vegetation Retention and Removal Plan in Appendix A of the Landscape and Ecological Management Plan (**application document 7.8.1**).

General Design (PLACES/VALUE)

6.2.4 There would be a minimum of 0.9m between the top of the protective tiles and the top of the finished ground level for opencut trenches. This is a technical standard used by National Grid to provide the right balance between maintaining a suitable plough depth for landowners or other land uses and the cost and time associated with digging deeper trenches. In addition, deeper excavations would disturb a greater area of land due to the need to safely batter back the trenches.

Ducting Solution (PLACES/VALUE)

6.2.5 National Grid is proposing to use a ducted solution for the cable installation, compared to the alternative of opencut laying of cables within the trenches. A ducted solution means that a trench is dug, then a duct is placed into the trench, the cable can then be pulled through the ducts at a later date. The ducted solution has engineering and environmental advantages over the standard opencut method, as the trenches can be back filled with the subsoil quicker compared to standard opencut techniques. This avoids having an open trench for a longer duration than necessary. A ducted solution also has advantages during operation and maintenance, as in some cases, cables can be pulled between ducts instead of excavating a trench and disturbing the soil.

6.2.6 The review confirmed that a ducted solution would have technical and environmental benefits during construction, compared to a standard opencut methodology. There would be some locations where ground conditions or other site constraints may mean that ducted solutions cannot be used. However, National Grid has decided to use the ducted solution as the main form of cable installation on the project.

Trenchless Crossings (PEOPLE/PLACES/VALUE)

6.2.7 Trenchless crossings are proposed at the River Box (EM-E05), River Stour and Sudbury Branch Railway Line (EM-G04), and to the south of Ansell's Grove (EM-G08). These are locations that have been identified as particularly sensitive to opencut methods and therefore warrant the extra cost and duration associated with trenchless crossing methods. Further details on why the trenchless crossings are proposed at these locations and the impacts of the trenchless techniques compared to standard cable installation are described in ES Chapter 3: Alternatives Considered (**application document 6.2.3**).

6.2.8 The ES assumes that horizontal directional drilling (HDD) is used for the trenchless crossings, which is the preferred method for this type of work and the anticipated ground conditions at the point of application. Other trenchless construction techniques could include auger bore, pipe jacking or micro-tunnelling, depending on the results of ground investigations, soil analyses and third party authorisations (i.e. Network Rail).

6.2.9 The above methods would likely require excavations on either side of the crossing to aid the installation of the ducting and cables. De-watering, sheet piling, safety barriers and other provisions may be required to enable excavations and construction techniques to be carried out in accordance with Health and Safety Regulations. Trenchless crossings vary in construction duration, depending on the size and type of the crossing. All the techniques require additional land to be taken, during the construction period only, on both sides of the crossing to accommodate the additional excavated material from the pits and necessary plant and equipment.

6.2.10 The ES generally references trenchless crossings (to show the difference from opencut methods) and does not specify a technique. This is to allow the consideration of ground conditions, alternative and / or new emerging technologies during detailed design where appropriate and where these would not result in new or different significant effects compared to the HDD assumed within the ES.

Cable Sealing End Compounds

General Approach (PEOPLE/PLACES/VALUE)

6.2.11 The options appraisal process is documented in ES Chapter 3: Alternatives Considered (**application document 6.2.3**) and outlines the reasons why each CSE compound was chosen and the alternatives that were considered as part of that process, which are not duplicated here. These were generally positioned in locations where there was natural screening for example existing vegetation and/or making use of natural topography. The locations were also dictated by the length of underground cable required i.e. the balance between cost and length noted in paragraph 6.1.1. Further details on the planning balance can be found in the Planning Statement (**application document 7.1**).

Landscape Planting (PEOPLE/PLACES)

6.2.12 The assessment presented in the ES, assumes that the CSE compounds have landscape planting embedded into the design as described in ES Chapter 4: Project Description (**application document 6.2.4**) and as shown on Figure 4.1: The Project (**application document 6.4**). This would help screen the compound area within the landscape and soften views. The embedded planting is included in the following embedded measures: EM-D01; EM-F01; EM-G03; and EM-G06.

Terminal Pylons and Gantries (PEOPLE/PLACES)

6.2.13 The original designs assumed terminal pylons at each CSE compound to transition between overhead line and underground cables. During the design development, gantries have been identified as an alternative design solution. Gantries are lower structures (up to 16m high) compared to a c.50m high terminal pylon see the Table of Parameters in the Works Plans (**application document 2.5**) and as shown on Design and Layout Plans Pylon Designs (**application document 2.11.10**). The shorter gantry would have landscape and visual benefits compared to a terminal pylon and therefore have been taken forward as the preferred design at all CSE compounds.

Permanent Access Routes (PEOPLE/PLACES/VALUE)

6.2.14 Each CSE compounds would have a permanent access route from the local road network to the compound. The most appropriate route has been taken for these, subject to topography, following existing field/landowner boundaries and other site constraints. The permanent access route would be designed to relevant highways standards. The design of the permanent access routes (e.g. width and surfacing) would be the lowest impact design that could be chosen given the size and weight of vehicles that would need to use the track during operation and maintenance.

7. Conclusion

7.1.1 This document has demonstrated that there have been a number of factors that have influenced the options appraisal, design, and construction methods that are considered to be part of ‘good design’. At each stage, there has been a consideration of the most suitable option, design, and method based on technical (including constructability, economic and programme) factors and also environmental acceptability.

7.1.2 As noted in Section 1.4, work would be undertaken during detailed design of the project to further inform and refine designs and methods. This would include continuing to identify good design principles through the detailed specification of the design, such as lighting, fencing and surfacing. The final positioning of the project components would also be informed by the results of pre-construction surveys and consultation with the landowners and would lie within the LoD.

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