

THIRD PARTY DEVELOPMENTS NEAR NATIONAL GRID TUNNEL ASSETS

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PURPOSE AND SCOPE

National Grid is committed to operating electricity cables in a safe and reliable way with the minimum of inconvenience to our customers and local communities – this also includes any infrastructure that supports our cable network like underground cable tunnels.

Underground cable tunnels are a key component of our electricity network, primarily being located deep underneath heavily urbanised areas, they are used to avoid complex interfaces with existing infrastructure in the UK's major cities, as well as challenging geographical constraints.

This National Grid guidance document covers all work by 3rd parties where a proposed development could have an influence on the integrity of National Grid underground tunnel assets, including associated assets like headhouses, access shafts and other relevant infrastructure.

Examples of 3rd party works in proximity to underground tunnel assets might include general construction, excavations, demolition, installation of public utilities and other services including underground and overhead pipes and cables, surveys, ground investigation works and general access.

Further information about National Grid cable tunnel assets can be obtained by contacting National Grid Plant Protection and further contact information can be found in Appendix A.

PART 1 - PROCEDURAL

1 UNDERGROUND TUNNELS IN NATIONAL GRID

1.1 Under ground Tunnel Locations

National Grid has a significant amount of underground tunnels across its transmission network, primarily containing HV cable assets that are owned and operated by National Grid. For accurate locations of the National Grid cable network across the UK – please use the following link to obtain the relevant shape file for underground cables*:

<http://www2.nationalgrid.com/uk/services/land-and-development/planning-authority/shape-files/>

**Please note that a compatible GIS is required to use these files.*

1.2 Typical Under ground Tunnel Construction

The majority of National Grid underground tunnel assets are bored tunnels, which are constructed either by starting from one entrance and constructing the whole tunnel or by starting at both entrances and meeting in the middle. The tunnel sections for the majority of tunnel routes will have been constructed using a Tunnel Boring Machine (TBM).

With regards to more recent underground tunnel projects (for example London Power Tunnels), the tunnels themselves are typically single bored tunnels running from a primary substation to a receiving substation via a series of intermediary access shafts and headhouses – generally located between 20 and 60 metres below ground level, lined with fibre-reinforced precast concrete segments.

Other tunnel assets within National Grid that also contain transmission cables are typically constructed using standard tunnel construction methods (for example cut and cover), although the range of tunnel depths below ground level can vary significantly dependent on location, geology and other physical constraints.

Individual underground tunnel asset drawings and other relevant information (material, design specifications) can be provided by National Grid (where available).

2 UNDERGROUND TUNNEL EXCLUSION AND SAFEGUARD ZONES

2.1 Exclusion Zone

National Grid imposes an Exclusion Zone on all 3rd parties, which represents a pre-defined area around the tunnel structure where National Grid will not permit any encroachment from any private or utility planned development.

The Exclusion Zone, extending outwards from the exterior of the tunnel perimeter, prohibits any works in the close proximity of any tunnel asset that could have a negative impact on the structural integrity and/or operation of the asset and its ancillary systems.

The dimensions of the Exclusion Zone are identified in Figure 1.

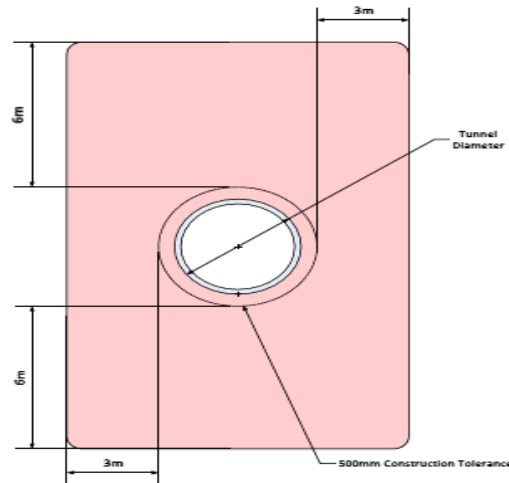


Figure 1 – Exclusion Zone Definition

2.2 Safeguard Zone

National Grid also imposes a Safeguard Zone on all 3rd parties; this aims to promote an interface between the 3rd party and National Grid with regards to any major works that have the potential to have an impact on the structural integrity and/or operation of the asset and its ancillary systems.

The Safeguard Zone considers whether any proposed structure falling within a line 45° from the tunnel invert could load the tunnel lining. This ensures that any 3rd party works that is planned to infringe on this zone, seeks appraisal and ultimately acceptance from National Grid, prior to any works taking place.

There is also a notional horizontal boundary for the Safeguard Zone which is set at 35m either side of the tunnel centreline.

The dimensions of the Safeguard Zone are identified below in Figure 2.

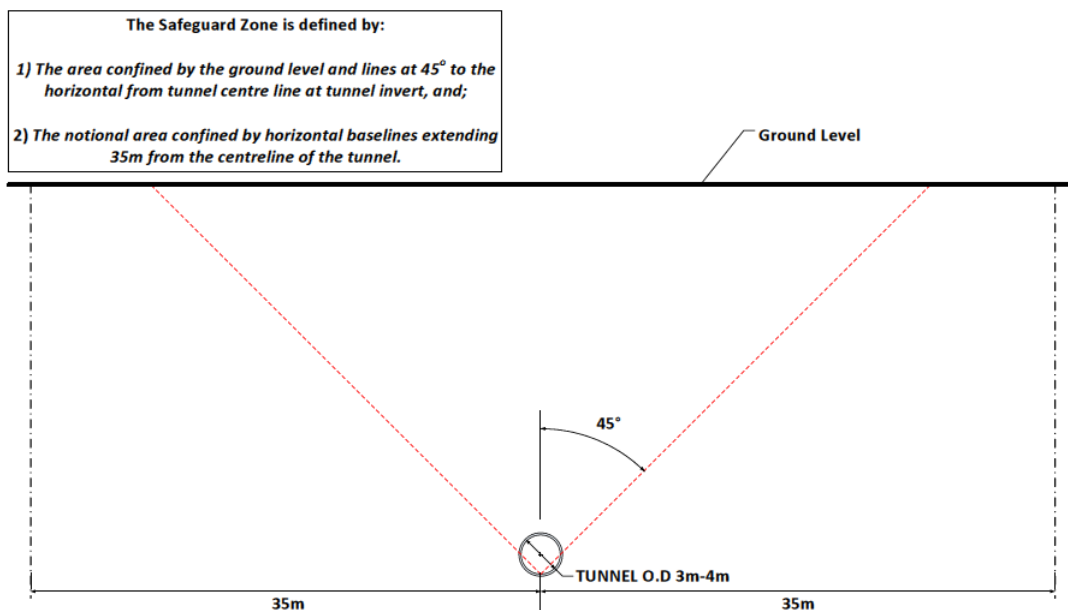


Figure 2 – Safeguard Zone Definition

2.3 Excavation Zone

There is also an Excavation Zone that needs to be considered during any 3rd party works.

The Excavation Zone is a 2.5m strip below ground level constrained by the horizontal baseline of the Safeguard Zone, where any excavation works in this area is unlikely to require any additional engineering assessment but due to the potential effects of heave on clay soils, any excavation that exceeds the 2.5m depth below ground level will require an Engineering Assessment to show that heave will not have an effect on the integrity of the cable tunnel.

2.4 Definition of Works

The definition of 'works' with regards to these zones could include, but are not limited to:

- a) Ground Investigation Works,
- b) Existing Utility Asset Maintenance or Replacement,
- c) 3rd Party Building Developments,
- d) Development and Construction of Underground Public Transport Infrastructure,
- e) Development and Construction of Utility Infrastructure,
- f) Any Development with the potential to impact the integrity and operation of the cable tunnel asset.

The designated zones shall also apply to any decommissioning, demolition or maintenance works that could affect the integrity and operation of any of the cable tunnel assets.

The combined guidance drawing for the zones identified can be found in Figure 3:

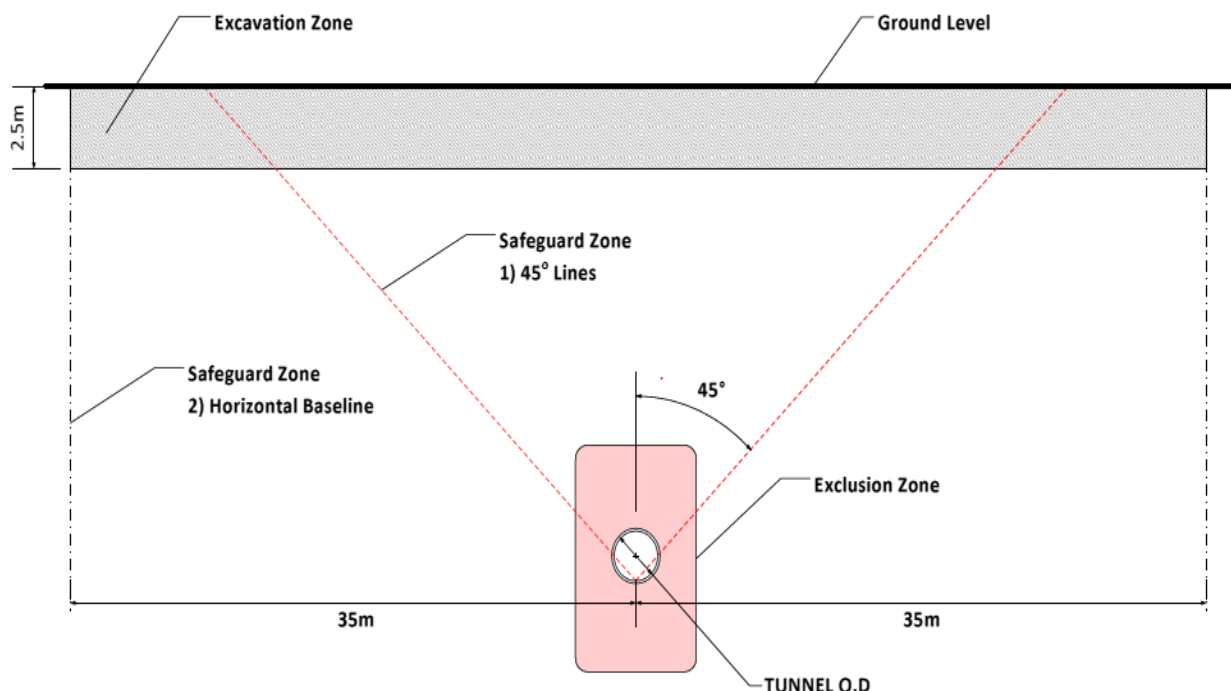


Figure 3 – National Grid Cable Tunnel Exclusion and Safeguard Zones

3 3RD PARTY DEVELOPMENT REVIEW PROCESS

3.1 3rd Party Development Submission Requirements

The basic requirement to be met by the 3rd party nominated design teams, on any structural designs, which could potentially impose loads or other actions on a National Grid underground tunnel asset within 35m horizontally of the centreline of the tunnel is to provide the following:

- a) Information on the design method which the design team intend to use to ascertain the effects of the new structure foundation on the existing tunnel.
- b) An Approval in Principle (AiP) document containing all the relevant information to be submitted to National Grid.
- c) As part of initial discussion between the 3rd Party and NG, an Engineering Assessment of the foundations may be required to ensure that the tunnel can withstand the increased loading, through comparison of the effects of the actual loading with those caused by the design surcharge (see Section 4).
- d) A Category 1, 2 or 3 Design Check Certificate (as appropriate), provided by an independent checker, is to be issued to National Grid to assure the loads on the foundation or pile cut off level.

Note that for 3rd party developments linked to smaller utilities infrastructure (so pipework, cables etc.) an AiP will also be required but may not require an as rigorous assessment when compared to larger developments (high rise buildings, underground tunnels, highways etc.).

3.1.1. Approval in Principal (AiP) Document

The AiP is a document to be produced and submitted by the 3rd party to National Grid to identify and explain the following:

- a) what is proposed with regards to the 3rd party development
- b) where the proposed development is in relation to NG asset(s)
- c) whether there will be any interaction with NG asset(s)
- d) where there is interaction, initial proposals for mitigation measures and design intentions
- e) any available drawings, reports or other important information relating to the proposed development
- f) any Engineering Assessment(s) (if required)
- g) the justification behind not proposing an Engineering Assessment (if required)

There is no pro-forma or template for the AiP so it is expected that the 3rd party will use a sensible format and document structure.

3.1.2 Engineering Assessment

For any potential interaction with a National Grid underground tunnel asset, where it has been determined that it could have an effect on the structural integrity and operation of the cable tunnel – then an Engineering Assessment will be required as part of the AiP

submission from the 3rd party to justify that the engineering effects from the development are not 'significant' on the overall integrity of the tunnel asset.

The content of the Engineering Assessment section of the AiP will depend on the type of interaction with the tunnel asset and this can be discussed and agreed with a technical specialist from National Grid Asset Policy and/or Asset Integrity, although due to the complex nature of tunnel design and analysis, there is high likelihood that there will be a requirement for significant non-linear dynamic analysis to demonstrate compliance.

The Engineering Assessment should also ensure that a separate 3rd party Category 3 engineering check is carried out and the record of the check is included as part of the overall submission to National Grid.

3.2 3rd Party Development Technical Engagement Process Map

The process that 3rd parties must follow for any development above or in proximity to tunnel assets, as defined in Section 2, is detailed in Appendix A.

Please note that due to the varying complexity of some 3rd party developments, there is no individual time allocations for certain processes, although a general timeline can be discussed between NG and the 3rd party during initial meetings.

4 KEY DESIGN AND CONSTRUCTION CONSIDERATIONS FOR 3RD PARTIES

4.1 Surcharge Loading Constraints

4.1.1 Definition of Acceptable Surcharge Loadings

National Grid will want to discuss loading or unloading from any development that could potentially load or deform the tunnel linings, and have any negative impact on the structural integrity of the asset.

The design of more recently constructed tunnels (post 2000) allows for surcharge loadings from existing buildings or, where there were no existing buildings, assumes a uniformly distributed load of 75kN/m² at ground level, based on the ground level at the time the design was undertaken.

Surcharge loading on the connecting tunnel and shaft forming the head house shall not exceed 75kN/m².

For all other existing tunnel assets, assume a uniformly distributed load of 50kN/m² at ground level, based on the ground level at the time the tunnel as was installed.

It shall be assumed for any 3rd party proposing development above National Grid tunnels, that point loading of a tunnel is not acceptable in any case.

4.1.2 Exceeding Surcharge Loadings

The surcharge allowances in Section 4.1.1 can only be exceeded if an engineering assessment of the tunnel load and deformation is produced and is acceptable to National Grid.

As part of this the 3rd party shall provide the following technical information:

- a) predicted soil movements and therefore tunnel lining movement at stages of construction, loading and consolidation, including unloading for example during demolition or basement construction
- b) tunnel lining hoop stress, joint stress and bending moment changes, allowing for any segment joint lips in that location

- c) combination of hoop stress and bending moment with respect to the M-N interaction diagram
- d) verification where appropriate using semi-empirical methods

The 3rd party shall also consider and respond to the following issues with construction:

- e) stress relief and deformation of National Grid tunnel assets from the boring process
- f) potential for outflow of soil into pile bore, reducing support to tunnel lining
- g) potential for concrete or support fluid flow from pile bore to National Grid tunnel assets

4.2 Foundation and Borehole Constraints

Above National Grid underground tunnels, strip and raft foundations will, subject sufficient clearance to the tunnel soffit, normally be acceptable forms of building foundation and are preferable to piled foundations.

Where piled foundations are required, bored piles are preferred.

The pile should be founded below the tunnel invert so that end bearing loads are transmitted below the tunnel.

The pile should be sleeved throughout to prevent load transfer via skin friction to the ground above the tunnel.

Excessive vibration near to National Grid tunnel assets is unlikely to be acceptable, normally ruling out driven piling, as well as vibro-compaction and stone columns.

The precise location, depth and loading of piled foundations should be carefully specified. As part of the consultation process National Grid may request advance notification of scheduled piling, and that the pile logs and test pile results be made available for review.

If National Grid believes that continuing piling will or is reasonably likely to have an adverse impact on National Grid tunnel assets then we reserve the right to suspend the piling works.

Those proposing boreholes should have regard to the extent of the Safeguard Zone and where necessary liaise with National Grid to establish any constraints and/or monitoring requirements.

As a minimum the drilling method, diameter, proposed depth, inclination and OS coordinates of the foundation/borehole will be required before acceptance is given.

Where drilling support fluid is proposed, the fluid shall be selected to avoid any potential ingress of fluid into the nearby National Grid tunnel assets, for instance from transmission of the fluid through fissures in the ground.

A representative from National Grid may wish to attend site to verify site controls on location and depth – typically, notice of 24 hours will be given prior to a site visit and all effort should be made by the 3rd party to accommodate these types of requests.

4.3 Ground Movements, Vibration, Deflection and Settlement Constraints

Vibration can present a risk to operation through disruption of equipment or through movement of ground or structures (ground displacement, settlement or heave).

There is an ultimate vibration limit of 30mm/sec peak particle velocity for all aspects of work in proximity to National Grid underground assets (tunnels and shafts).

If the piling methods, identified earlier in this section, are specified and the developer cannot demonstrate that the vibration does not exceed a peak particle velocity of 5mm/s at any structure then a settlement and vibration monitoring regime will be required.

Minor settlement will have occurred during the tunnelling operations associated with the installation of the majority of National Grid tunnel assets but this will have been calculated with a high level of accuracy and is typically anticipated to plateau after a few years.

Deflection of the shaft shall not exceed 0.15% of the theoretical diameter.

The absolute deflection of any point of head house from its as built position in any direction shall not exceed 10mm

As per Figure 3, for any large scale excavations (car parks, basement areas etc.) that remove a depth of soil greater than 2.5m, the 3rd party must liaise with National Grid to establish whether there is a requirement to provide calculations for review and acceptance by National Grid.

The calculations should quantify any ground movements that may occur across the excavated area - as well as satisfying National Grid that the integrity of the tunnel asset is maintained. National Grid would mainly be concerned about the potential for heave, certainly in the various clay strata in South East England but will also require information regarding settlement during and post construction works.

National Grid will not accept any claim with regard to settlement.

National Grid does not offer the right of support nor does it accept liability for any settlement, damage, noise or vibration emanating from the normal operation or maintenance of any tunnel asset.

5 MONITORING REGIME FOR 3RD PARTY WORKS

It may be necessary for a 3rd party to provide monitoring equipment within a National Grid underground tunnel asset during certain works.

For developments above, below or near to tunnels the developer will agree with National Grid whether tunnel monitoring is required and, if so, to agree a monitoring regime.

Measures will depend upon the predicted load and deformation at the tunnel extrados and may include:

- a) pre-works and post-works tunnel condition survey
- b) a review of cable support structures including vertical and horizontal alignment
- c) pre-works and post-works three dimensional survey using laser or fixed targets (also during the works if for an extended period) to identify the radial and longitudinal deformation profile changes of the National Grid tunnels during the works
- d) monitoring equipment recording movement of tunnel lining in real time. This will need to be in place well before loading (to allow a stable set of readings to be taken) and continue until soil movement is largely complete or until it is clear that the settlement has matched the predictions
- e) monitoring of adjacent structures such as retaining walls forming basements close to the National Grid tunnels so that displacements of the wall are monitored at source and may be able to be correlated with displacements of the nearby National Grid tunnels

Where a 3rd party may require access to a National Grid underground tunnel asset for monitoring-related activities prior to the start of any significant works in proximity to the asset - requests for access should be directed through National Grid Plant Protection in the first instance, with ongoing involvement from National Grid technical and operational staff as required.

Access to National Grid cable tunnels may require considerable input and support from Operations staff to ensure safety from the system is maintained for all parties involved therefore the timeline for access for monitoring activities cannot be advised in general – and will be discussed on a case-by-case basis.

The 3rd party will also have to provide a safe system of work for review and acceptance by National Grid Operations before access to the underground tunnel can be granted – as well as detailed information about any equipment that will be used for monitoring activities.

6 NATIONAL GRID ASSET PROTECTION AGREEMENT AND RECOVERING ‘REASONABLE COSTS’

There may be a requirement for the 3rd party to enter in a legal undertaking with NG that covers the protection of the NG asset(s) and also the reimbursement of reasonable costs incurred by NG in relation to the 3rd party’s proposed works – this is in the format of an Asset Protection Agreement (APA) and/or a Supply of Consultancy Services (SCS) contract.

NG is likely to require at least ‘in principle’ agreement on the undertaking of the APA before engagement with the 3rd party in consideration of their proposed works and the agreement to reimburse ‘reasonable costs’ associated with providing technical services to the 3rd party.

NG use a standard template for Asset Protection Agreements (including staff rates) which can be reviewed and discussed once an ‘in principle’ agreement has been reached between the 3rd party and NG.

NG Commercial Engineering Services will manage the commercial interface between NG and the 3rd party via the SCS contract.

7 FORMS AND RECORDS

Not applicable.

PART 2 - DEFINITIONS AND DOCUMENT HISTORY

8 DEFINITIONS

Not applicable.

9 AMENDMENTS RECORD

Issue	Date	Summary of Changes / Reasons	Author (s)	Approved By (Inc. Job Title)
1	April 2018	New Document	Lee Warren Asset Policy	EEPIG

10 IMPLEMENTATION

10.1 Audience Awareness

Audience	Purpose Compliance (C) / Awareness (A)	Notification Method Memo / letter / fax / email / team brief / other (specify)
External 3 rd Parties - Developers - Design Consultants	Compliance	N/A – sent out via NG Plant Protection Team
Asset Integrity	Compliance	Email
Asset Policy	Compliance	Email
ETO Operations	Compliance	Email

10.2 Training Requirements

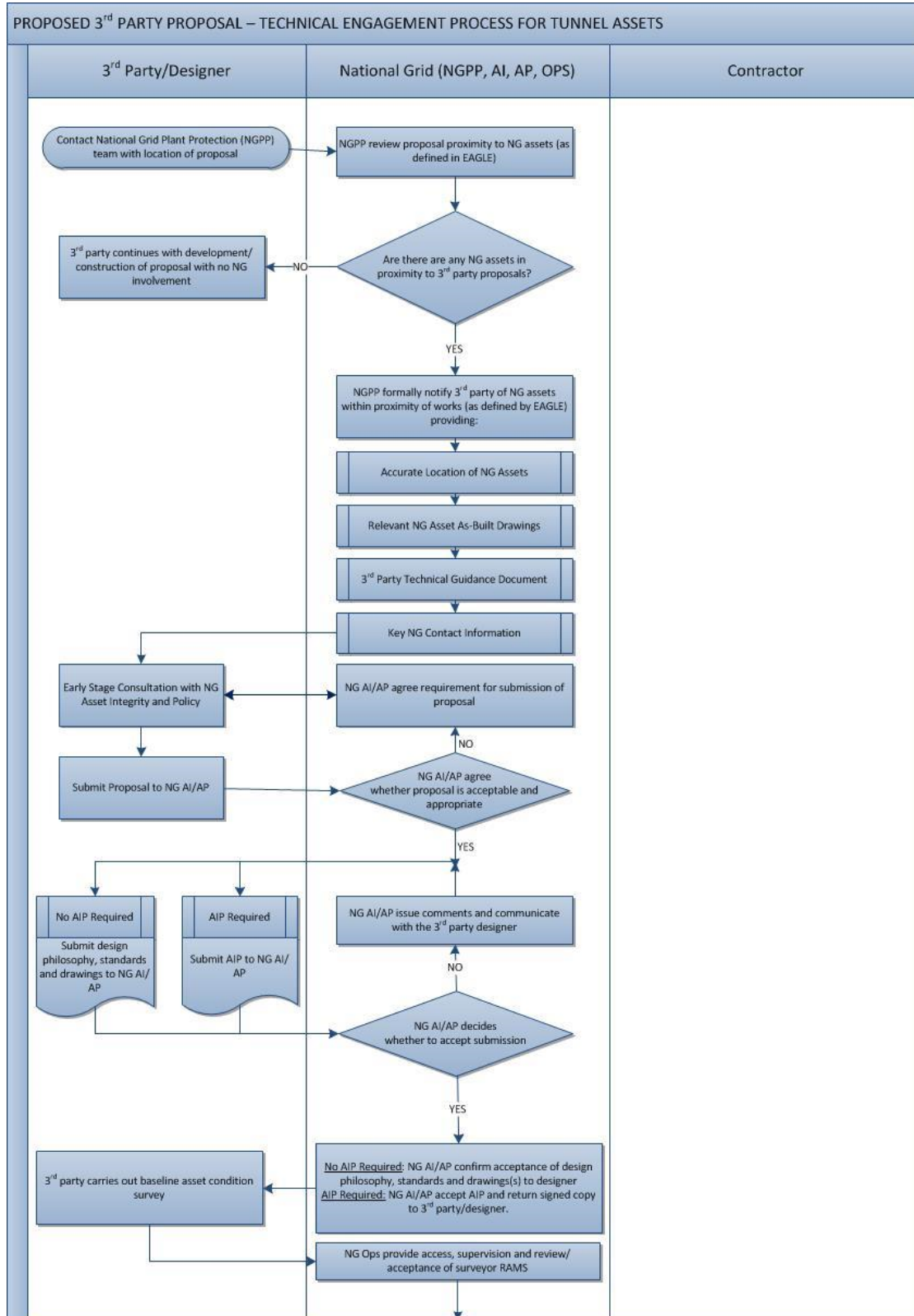
Training Needs N/A / Informal / Workshop / Formal Course	Training Target Date	Implementation Manager
NG Plant Protection	March 2018	Damien Culley
ETO Operations	March 2018	TBC

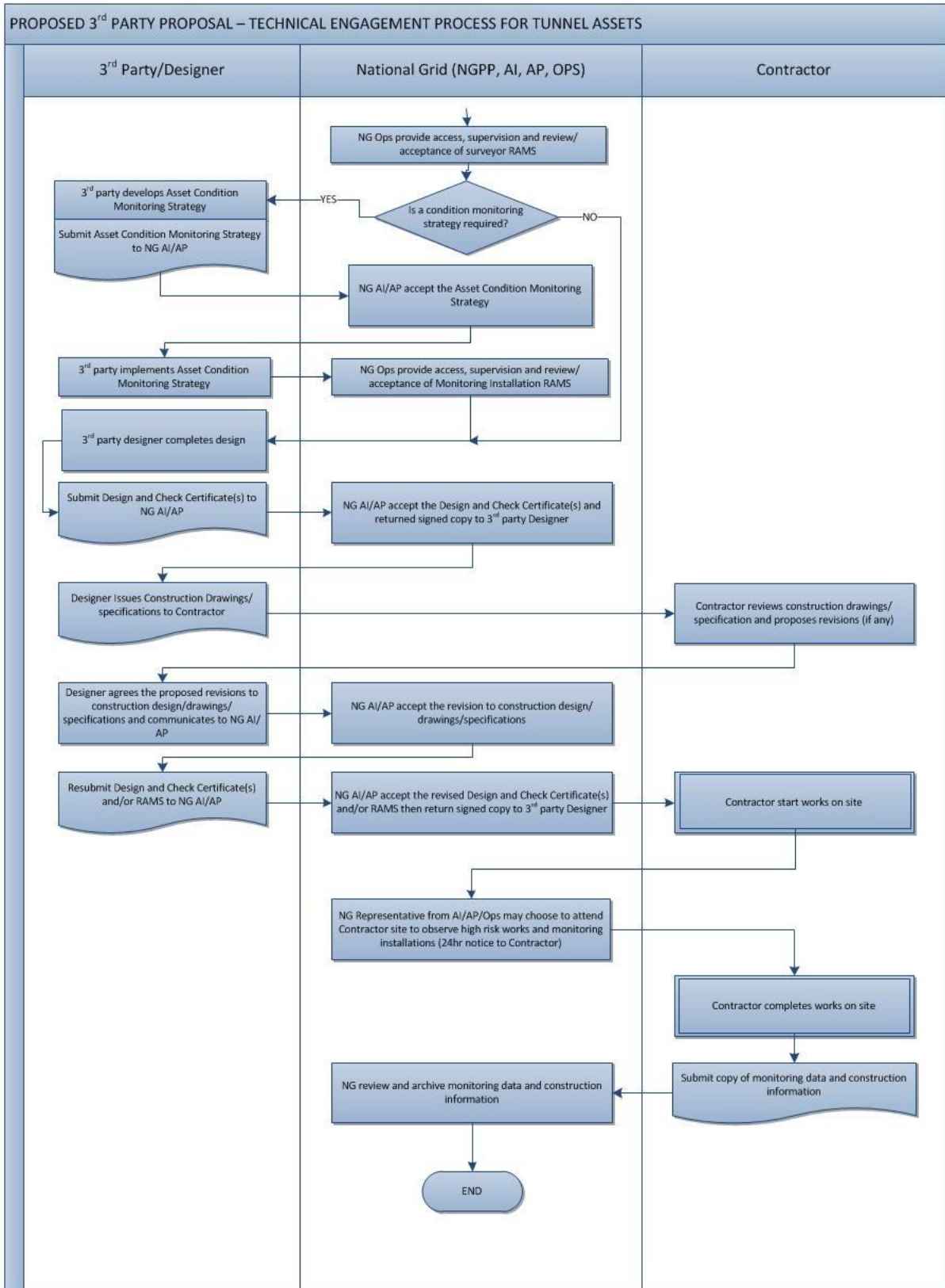
10.3 Procedure Review Date

4 years from publication date.

PART 3 – GUIDANCE NOTES AND APPENDICES

APPENDIX A – TECHNICAL ENGAGEMENT PROCESS MAP





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