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nec4

Guidance on NEC and underground works

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Contents

Introduction

The NEC4 Engineering and Construction Contract (ECC) has been designed for all types of engineering and construction work, including sub-surface work. Risk of ground conditions differing from expected is allocated through compensation event 60.1(12). Under this NEC clause, a compensation event occurs if:

> The *Contractor* encounters physical conditions which:
>
> - are within the Site,
> - are not weather conditions and
> - an experienced contractor would have judged at the Contract Date to have such a small chance of occurring that it would have been unreasonable to have allowed for them.

This is supported by Clause 60.2:

> In judging the physical conditions for the purpose of assessing a compensation event, the *Contractor* is assumed to have taken into account:
>
> - the Site Information,
> - publicly available information referred to in the Site Information,
> - information obtainable from a visual inspection of the Site and
> - other information which an experienced contractor could reasonably be expected to have or to obtain.

The International Tunnelling and Underground Space Association (ITA) has identified a need for an alternative approach of risk allocation for tunnelling work, using a Geotechnical Baseline Report (GBR) to allocate risks between the *Client* and *Contractor* by setting baselines. The approach is specifically suited for application under NEC ECC's options which involve the use of a bill of quantities, namely Options B (Priced contract with bill of quantities) and D (Target contract with bill of quantities).

The ITA's approach requires a mechanism for assessing the changes to the cost of time related charges relating to Critical Tunnelling Operations and for assessing delays to the Completion Date caused by changes in quantities of the Critical Tunnelling Operations. NEC collaborated with ITA to provide a model clause and this guidance on how to implement this approach under ECC contracts.

Alternative approach of risk allocation

Underground projects are different from surface projects in several ways. From a risk perspective, these are mainly related to the uncertainties associated with the subsurface ground conditions, where the excavation will be executed and how the ground will react to excavation (behaviour), along with other characteristics and risks, such as:

- The relatively small percentage of the ground sampled and investigated pre-construction will result in uncertainty in the estimation of the range of potential ground conditions when compared with those encountered during construction.
- The construction method is essential for the success of the project and should be selected to suit the expected physical conditions and anticipated behaviours.
- The time required for critical tunnelling operations and the associated cost are strongly dependent on the actual ground conditions encountered during construction, as well as how well risks are managed and mitigated.
- The access to the location of excavation is in many cases restricted, which makes the logistics for construction a challenge.
- The land above the underground project belongs in many cases to third parties that may restrict access for investigations.
- The upfront cost for construction equipment, such as tunnel boring machines can be significant.
- Tunnel excavation, support and lining works are time intensive.

Underground works involve greater ground related risks than other types of infrastructure work. Hence, projects involving tunnels or other major underground works should have specific and distinct contractual provisions to handle these specific risks effectively.

Project risks which can lead to a positive or negative outcome should be allocated to one of the involved parties. As the project's *Client* has more time and resources to assess the ground related risks and unanticipated ground related risks should be allocated to the *Client*. Conversely, performance related risks for anticipated ground conditions should be allocated to the *Contractor.*

To manage these risks a dedicated risk management system needs to be implemented at an early project stage and maintained throughout the project. Risks must be identified, monitored, mitigated, and responsibility for action allocated to enable cost-efficient solutions.

Geotechnical investigation and reference design

The *Client* will choose the procurement method as either:

1. a design-bid-build, where the *Client* retains the responsibility for the detailed design, or
2. design and build, where detailed design responsibility is transferred to the *Contractor.*

The extent of the *Contractor's* design responsibility must be stated in the Scope.[1]

With a design and build contract, the *Client* will usually develop a 'reference design' demonstrating a feasible solution and the anticipated design and construction methods. This design defines the technical requirements and decision-making process associated with their implementation during construction in accordance with the design, the risk management framework, and any site observational components.

To achieve this, the *Client* should conduct a thorough geotechnical investigation and identify key geotechnical risks for the project. Geotechnical site and laboratory testing is typically executed before the project is tendered for construction to allow adequate risk identification and inform appropriate risk allocation. The geotechnical investigation should focus on data and parameters that raise risk awareness for risks that may materialise within the Site.

If the detailed design responsibility is assigned to the *Contractor*, investigations performed later by the *Contractor* may serve to refine its design and construction methods. Should post-tender investigations reveal significantly more adverse conditions than provided for in the baselines, such findings, if materialized during construction, would be compensation events, as the risk allocation will have been set in the contract document. Nonetheless post-tender investigations will help to reduce uncertainty and manage risks.

All results from geological and geotechnical investigations should be compiled in a 'Geotechnical Data Report'[2] (GDR). This report should only contain factual data, avoiding interpretations. All this information should be made available to the bidders. Disclaimers in relation to this information should be avoided. This report should be shared as reference information and be included in the 'Site Information,' a document that is part of the ECC.

Those parts of the *Client's* reference design that are specific requirements or constraints on the *Contractor* must be included in the Scope. However, parts of the reference design that are indicative and not mandatory should not be included in the Scope. The *Client* should share details and options evaluated with Bidders for information only not as part of the Contract.[3]

[1] In the NEC Engineering and Construction Contract the 'Scope' sets out the requirements of the *works* and any constraints on how the Contractor 'Provides the Works.' It will include what some other standard forms of contract call 'Specification' and 'Drawings.'

[2] Also known as the "Factual Report" or "the factual data included in the Ground Investigation Report required under Eurocode 7, Geotechnical design".

[3] These might be included by the Client as an appendix to the Instructions to Bidders/Tenderers

Risk management

Since underground works require decision-making under uncertainty, and are generally considered to be high risk, risk management is considered an essential part of the project delivery, having an important impact on the definition and management of the risk allocation mechanisms. Active and integrated risk management must be implemented throughout all phases of the project to continuously identify, assess, and manage risks in accordance with the Code of Practice for Risk Management of Tunnel Works (ITA, 2023).

The ECC provides for risk management through its programming, early warning, compensation event mechanisms and quality management procedures, underpinned by the cooperative approach between the ECC Project Manager and the Contractor in accordance with clause 10.2.

The *Contractor* should be required to develop and implement during construction an integrated risk management procedure, including risk management plans, risk registers, method statements, and health & safety plans in conjunction with the ECC procedures.

It will normally be appropriate for the *Client* to provide an initial risk management plan to bidders for information only, to serve as a basis for the development of the Construction Risk Management Plan (RMP) by the *Contractor.*

Additionally, the plan prepared by the *Client* should identify:

- risks which were identified during the project development and design phase, but adequately managed and controlled by the technical measures included in the Scope,
- residual risks not eliminated but presenting an acceptable risk level to the Parties.

Technical measures and risk management procedures required to be followed by the *Contractor* should be stated in the Scope and.

Risk Registers included in the RMP should list the risks identified and treated during the tendering phase. They describe events which are sources of potential risks. In case of occurrence, they describe the foreseeable consequences on the reference design and/or the worksite organization and then the planned technical measures to mitigate these consequences (corrective measures).

Risks identified in the *Client's* risk register should be listed by the *Client* in Contract Data part one as matters that will be included in the Early Warning Register. The Early Warning Register acts as the agenda and minutes for early warning meetings and, importantly, does not affect risk allocation. The *Client* should also specify the frequency of early warning meetings. At these meetings, all issues identified by the *Client* or *Contractor* at tender stage, and any further risks identified during construction are reviewed to determine actions to mitigate or avoid the risk.

Under NEC, the risk allocation for individual events is defined by whether or not the event is a compensation event. Each compensation event is a *Client's* risk. The costs arising from anything that is not a compensation event or included in the measurement of quantities of work is a *Contractor's* risk (or, in a target contract – Option D – a risk shared between *Client* and *Contractor*).

Significant geotechnical risks should be allocated through the baselines in the GBR and so clearly allocated between the parties noting that exceeding any of the baselines will trigger a compensation event.

Preparation of the GBR

The *Client* and its designer should prepare a GBR.

The key contractual role of the GBR is to set 'baselines' for the anticipated subsurface conditions, which include ground physical conditions and behaviours. Ground physical conditions consist of the inherent composition and properties of the ground that are relevant for construction, as well as other natural or man-made geohazards that could influence the construction process. Behavioural conditions correspond to the ground's response or reaction to specific construction methods used for excavation and support, under given physical subsurface conditions.

Subsurface conditions within the baselines in the GBR are considered foreseeable and payment for work is included in the prices as bid and the remeasurement of the BOQ. Subsurface conditions more adverse than the baselines in the GBR are considered 'unforeseeable' and so, in the ECC are compensation events. The GBR is the single source of baseline subsurface conditions for contractual purposes.

The GBR should provide information on the geotechnical parameters and conditions that could affect the design and construction of the excavation, support and lining works.

Although the data contained in the GDR serves as a basis for the preparation of the GBR, the GBR is an interpretative report based on engineering judgement, experience in other projects, and includes in the baselines the Client's decisions on risk allocation.

The GDR is included in the ECC's 'Site Information' and should be referenced from the GBR.

The baselines must be set out clearly and be measurable during construction. If there is a need to set out how a parameter included in a baseline is to be measured, the measurement rules must be included in the GBR.

'Baseline' is a defined term in the modifications to the ECC and for clarity the term should be capitalized in the GBR.

Note that, as stated in the modifications to the ECC, the GBR is included in the contract by identifying it in the Contract Data.

More information on the preparation of the GBR is provided in the document "ITA Guidelines for the Preparation of the NEC4 GBR".

Bill of Quantities and production rates

The BoQ prepared by the *Client* should include measured quantities for "Critical Tunnelling Operations" – those that affect the progress of the tunnelling work (i.e. excavation, support, and lining works). These should provide for the activities that affect the progress of the tunnelling work. The BoQ may include estimated quantities for Critical Tunnelling Operations items for which the quantities or frequency of occurrence cannot realistically be forecast.

Within its tender, the *Contractor* should be required to state its planned production rates for the Critical Tunnelling Operations items included in the BoQ. In the modifications to the ECC, these production rates will be included in the Contract Data part two, either as a list of items or by reference to a separate schedule. The *Contractor* should normally be required to submit a first programme with the tender, to demonstrate that the production rates proposed have been used in programming the work and showing how the Critical Tunnelling Operations fit with the overall programme.

The BoQ should include a lump sum item for time-based method related charges relating to the Critical Tunnelling Operations. This will be adjusted depending on the actual quantities of Critical Tunnelling Operations carried out.

If the *Contractor* is appointed on a design and build basis, other items in the BoQ should normally be included as lump sums.

Payment and time for carrying out the excavation, support and lining works

Time and cost for carrying out the excavation, support and lining works are strongly dependent on the actual subsurface conditions encountered during the excavations. The cost consequences of variability in the subsurface conditions (within the baselines of the GBR) will be dealt with by simple arithmetic, multiplying the actual executed works in each Critical Tunnelling Operation by the rates in the BoQ.

However, if the ground conditions are more adverse than a baseline in the GBR the compensation event procedure in ECC applies.

Compensating the *Contractor* for the real encountered subsurface conditions beyond the baselines is a fair approach for the *Contractor* as well as the *Client*. The ECC's 'Prices' are increased to cover the work needed because of physical conditions in excess of the baselines, and the Completion Date may be delayed. The *Client* does not pay for risks that have not occurred.

The risk allocation through the GBR is illustrated in Figure 1.

If excavation work is carried out in areas not covered by Baselines, the risk of ground conditions is dealt with under clause 60.1(12). Guidance on the application of this clause is provided on the NEC website neccontract.com and in the NEC guidance manuals.

CONDITIONS COVERED BY THE GBR	CONDITIONS NOT COVERED BY THE GBR
More adverse than Baseline • *Client* risk	*Contractor* entitled to compensation under clause 60.1 (12) only if the conditions meet the specified criteria.
Within Baseline • Option B contract – priced contract with bill of quantities - *Contractor* risk except quantity changes • Option D contract – target contract with bill of quantities – shared, 'project' risk	

Figure 1 Summary of risk allocation and the GBR

The quantities in the Bill of Quantities for the Critical Tunnelling Operations are set by the *Client* at the Contract Date (the time of award of contract) and priced by the *Contractor*. The final quantities are measured and paid for at the rates tendered by the *Contractor*. Unlike a standard ECC Option B/D, in the modified contract there is no compensation event for significant changes in quantities of work within the baselines.

The Bill of Quantities should include an item for a time-related method related charge for the Critical Tunnelling Operations. This is adjusted in the following way.

The time required at the Contract Date for the tunnelling work is calculated using the production rates applied to the Critical Tunnelling Operation quantities in the BoQ at the Contract Date. The calculation is repeated using the production rates applied to the final quantities for Critical Tunnelling Operations. The price for the time-related method related charge is increased or decreased in proportion to the difference in time.

There may be a delay to the Completion Date if the calculation using actual quantities encountered results in additional time being required to carry out the tunnelling work. A delay to the Completion Date is the length of time that the change in quantities of the Critical Tunnelling Operations causes planned Completion to be later than shown on the Accepted Programme.

Once it becomes evident that extra time would be required, the effect of that extra time on planned Completion shown on the current Accepted programme is assessed. This may need to be repeated as tunnelling continues until the full extent of the change was known. Note the Completion Date can only be delayed and not advanced even if less time is required to carry out the tunnelling work.

If the effect of the extra time caused a delay to planned Completion, the required Completion Date is delayed by the same period.

Additional condition of contract (Z clause)

Additional conditions of contract are required to amend and add to the published ECC to implement this approach to risk allocation. A model clause is included in Appendix 1 and guidance on the clause is provided in Appendix 2.

Appendix 3 sets out where documents referred to in this guidance are used in the ECC.

APPENDIX 1 Model Z clause

Z2 Critical Tunnelling Operations

Defined terms	Z2.1	A Baseline is a statement setting out the allocation of physical condition risk included in the Geotechnical Baseline Report. The Critical Tunnelling Operations are the items identified in the Bill of Quantities which are critical to the progress of the tunnelling work and for which *production rates* are provided. The Geotechnical Baseline Report is the *geotechnical baseline report*.
Compensation events	Z2.2	(1) Delete 60.1(12) and replace with: (12A) The *Contractor* encounters physical conditions other than those which are the subject of a Baseline which • are within the Site, • are not weather conditions and • an experienced contractor would have judged at the Contract Date to have such a small chance of occurring that it would have been unreasonable to have allowed for them. Only the difference between the physical conditions encountered and those for which it would have been reasonable to have allowed is taken into account in assessing a compensation event. (12B) The *Contractor* encounters conditions that are more adverse than a Baseline. Only the difference between the conditions encountered and the Baseline is taken into account in assessing a compensation event. (2) Delete 60.2 and replace with: In judging the physical conditions for the purpose of assessing a compensation event other than those which are the subject of a Baseline the *Contractor* is assumed to have taken into account: • the Site Information, • publicly available information referred to in the Site Information, • information obtainable from a visual inspection of the Site and • other information which an experienced contractor could reasonably be expected to have or to obtain.
Bill of Quantities	Z2.3	(1) Clauses 60.4 and 60.5 do not apply to items in the Bill of Quantities for Critical Tunnelling Operations.
Measurement	Z2.4	(1) The forecast of the time expected to be taken on Critical Tunnelling Operations is calculated using the *production rates* applied to the relevant quantities of work in the *bill of quantities* for the Critical Tunnelling Operations. (2) The assessed time taken for Critical Tunnelling Operations is calculated using the *production rates* applied to the quantities of work which the *Contractor* has completed for the relevant items in the Bill of Quantities for the Critical Tunnelling Operations. (3) If the assessed time is different from the forecast time, the amount for the item for time-related charges in the Bill of Quantities is multiplied by the measured time and divided by the forecast time.

Delay to the Completion Date Z2.5

(1) If the assessed time is greater than the forecast time, the *Contractor* assesses any delay to the Completion Date and Key Dates. The *Contractor* notifies the *Project Manager* within eight weeks of the date when the *Contractor* believes that additional time will be required for Critical Tunnelling Operations and this will delay planned Completion or a Key Date. The *Contractor* includes in the notification its assessment.

If the additional time for Critical Tunnelling Operations increases after an assessment, the *Contractor* submits an assessment of any further delay within 3 weeks of the date when it becomes aware of the increase in time.

The *Contractor* provides details of the assessment with each submission.

If the *Contractor* does not notify a difference between the measured time and the forecast time within the time required by the contract, the Completion Date or a Key Date are not changed.

(2) A delay to the Completion Date is assessed as the length of time that, due to the difference between the assessed time and the forecast time for Critical Tunnelling Operations, planned Completion is later than planned Completion as shown on the Accepted Programme current at the date of the notification.

A delay to a Key Date is assessed as the length of time that, due to the difference between the measured time and the forecast time for Critical Tunnelling Operations, the planned date when the Condition stated for a Key Date will be met is later than the date shown on the Accepted Programme current at the date of the notification.

The assessment takes into account

- any delay caused by the difference between the assessed time and the forecast time already in the Accepted Programme and
- events which have happened between the date of the Accepted Programme and the date of the notification.

(3) The *Project Manager* replies to the notification within three weeks of the notification.

The reply is a notification

- that the additional time for Critical Tunnelling Operations has no effect on Completion or meeting a Key Date,
- that the *Contractor's* notification has not been notified within the timescales set out in these *conditions of contract*,
- of acceptance of the *Contractor's* assessment or
- that the *Project Manager* will be making an assessment of the delay.

(4) The *Project Manager* notifies the *Contractor* of its assessment of the delay and gives details of the assessment within 3 weeks of the reply to the *Contractor's* submission.

(5) If the submission is accepted or the *Project Manager* assesses the delay, the Completion Date and the Key Dates are changed accordingly.

Contract Data entries

CONTRACT DATA PART ONE

The *geotechnical baseline report* is in

CONTRACT DATA PART TWO

The *production rates* are in

or (the following table could be included in Contract Data)

The *production rates* are

BOQ ITEM	UNIT	UNITS/ 24 HOUR PERIOD

APPENDIX 2

Guidance notes

Defined Terms	Z2.1	The Critical Tunnelling Operations are activities which could delay the tunnel excavation and lining works. Separate BoQ items should be included for all required items of work, with Client assessment of the likely quantities. The operations will include the necessary excavation, support and lining works, but also can include uncertain work items which are likely to occur but for which the extent is unknown. The BoQ should include measurement rules for these items.
Compensation events	Z2.2	Clause Z2.2(1) deletes compensation event 60.1(12), and replaces it with two events, 12A and 12B, providing a different approach according to whether or not the physical conditions encountered are the subject of a Baseline. 12A restates 60.1(12) but excludes from the physical conditions any which are the subject of a Baseline. 12B provides that if a physical condition is encountered which is the subject of a Baseline and which is more adverse than the Baseline, that is a compensation event with no further foreseeability test. It relies solely on the definition of the Baseline in the GBR. Clause Z2.2(2) replaces clause 60.2 so that the assumptions only apply to physical conditions encountered which are not the subject of a Baseline.
Bill of Quantities	Z2.3	Clause 60.4 and 60.5 in ECC provide for a compensation event in certain circumstances for increases in measurement of quantities. Since payment for the measured quantities of tunnelling work is intended to cover all costs, this clause removes this compensation event for any change in quantities of Critical Tunnelling Operations.
Measurement	Z2.4	This clause deals with the change to the time related charge for tunnelling work. The BoQ should include a lump sum time related method related charge for tunnelling work. The change to the time related charge is not based on the time taken, but on a calculation made in accordance with this clause. The calculation uses the initial and final quantities of work for the Critical Tunnelling Operations to establish the anticipated time and the assessed time by applying the *production rates* to the initial and the final quantities. This calculation will normally result in an increase or decrease in the time taken for tunnelling work. The amount for the time-related charge is increased or reduced in proportion to the increase or decrease in time. This adjustment is made whether or not any additional time is allowed for completing the works.
Delay to the Completion Date	Z2.5	Whilst the change in quantities will not be a compensation event, and therefore would not be assessed for whether or not they delay planned Completion or the date for meeting a Key Date, an assessment is still required to establish whether an increase in quantities does result in a delay. Clause Z2.5(1) provides for an assessment and notification by the *Contractor* of any delay. The clause applies a similar approach to that for a compensation event, but uses the assessed time for Critical Tunnelling Operations using the calculation described above using tendered *production rates*. The onus is placed on the *Contractor* to assess whether there is a delay and notify the *Project Manager* including details of its assessment. This must be done within eight weeks of when the *Contractor* believes that additional time is required which would delay planned Completion or the date for meeting a Key Date. As the assessment may change as works continue, the *Contractor* is required to provide fresh notification if further changes to the quantities of Critical Tunnelling Operations show that additional delays affect planned Completion or a Key Date.

Clause Z2.5(2) sets out how a delay to the Completion Date or to a Key Date is assessed. It uses the difference between the assessed time and forecast time calculated as above using the intended *production rates* to identify the delay to tunnelling works. This delay is applied to the Accepted Programme at the time the assessment is required to be made, to establish whether the delay to Critical Tunnelling Operations does have an effect on planned Completion or meeting a Key Date.

Clauses Z2.5(3) to (5) deal with the responses to the *Contractor*'s notification and assessment. The *Project Manager* should normally discuss the assessment with the *Contractor*, to assist in deciding whether to accept the assessment or not. If not, and it is accepted that there was an effect on Completion or meeting a Key Date, the *Project Manager* must make the assessment and notify the *Contractor*. This would normally have been explained to the *Contractor* during the discussions, but in any event details of the *Project Manager*'s assessment are required to be provided.

APPENDIX 3

Location of items in ECC documents

Contract document	Includes
conditions of contract	-
Contract Data part one	*Geotechnical Baseline Report* – the GBR The *method of measurement* of the *bill of quantities* The item 'The following matters will be included in the Early Warning Register' to include the risks from the Risk Registers of the Risk Management Plan *additional conditions of contract* to include the clause in Appendix 1
Contract Data part two	*production rates* The entry in Contract Data part two: 'The programme identified in the Contract Data is' should identify the *Contractor's* tender programme
Scope	*Client's* Reference design (if applicable), including those parts that are specific requirements or constraints to the *Contractor.* Statement of the parts of the works which the *Contractor* is to design, including the *Client's* technical requirements. Risk Management Plan requirements
Site Information	Include all site data, public information. Geotechnical Data Report
bill of quantities	Critical Tunnelling Operations (identified in the *bill of quantities*) The items of work of the *bill of quantity* set out in the *method of measurement* Quantities for each of the Critical Tunnelling Operations Prices
For information at tender	Risk Management Plan

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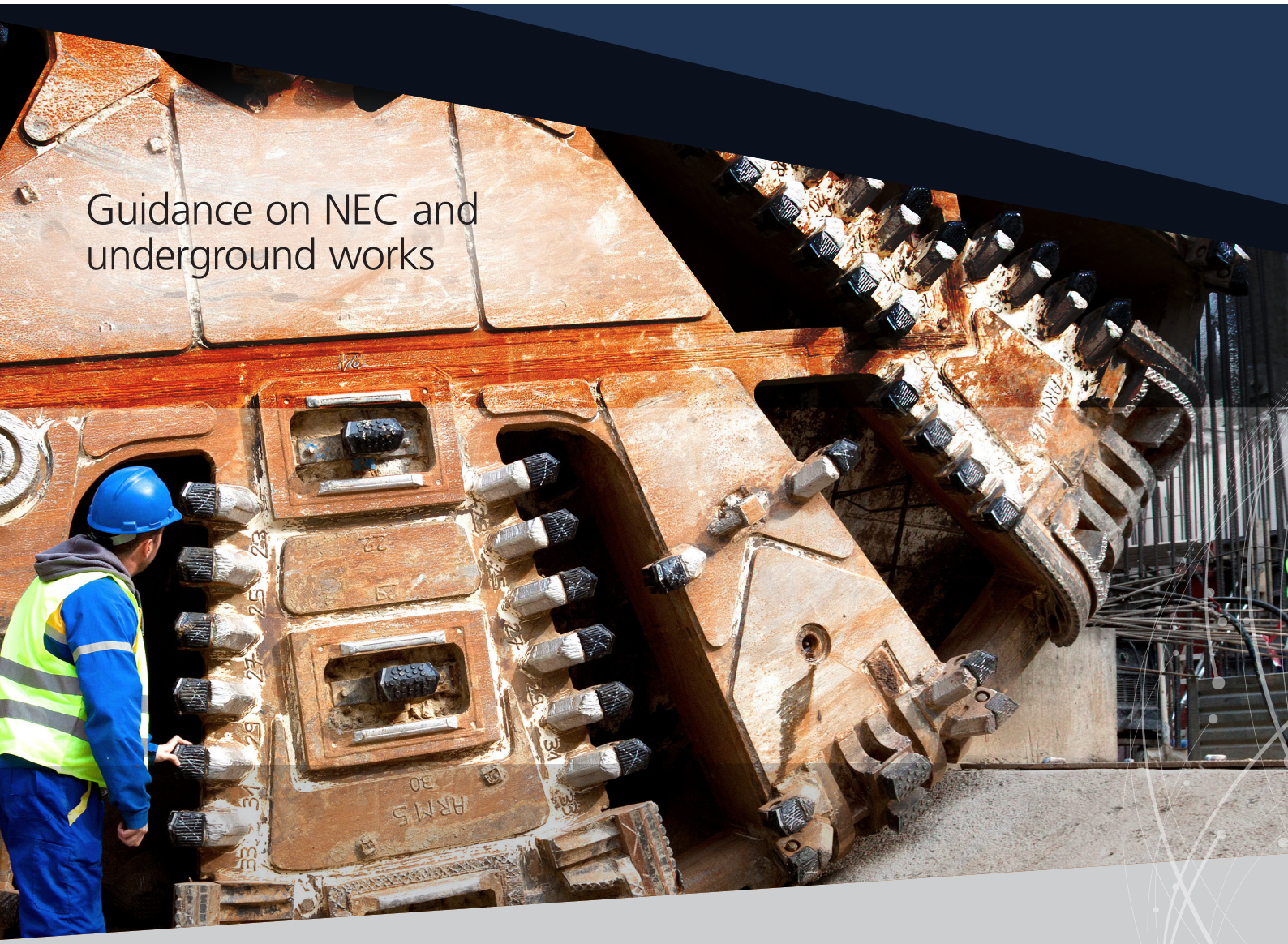

The Government Construction Board, Cabinet Office UK

The Government Construction Board (formerly Construction Clients' Board) recommends that public sector organisations use the NEC contracts and in particular the NEC4 contracts where appropriate, when procuring construction. Standardising use of this comprehensive suite of contracts should help to deliver efficiencies across the public sector and promote behaviours in line with the principles of the Government Construction Strategy.

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