

A CODE OF PRACTICE FOR RISK MANAGEMENT OF TUNNEL WORKS

International Tunnelling and Underground
Space Association (ITA-AITES)

International Association of Engineering Insurers (IMIA)

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>> PREFACE OF THE THIRD EDITION

This Code of Practice is the latest edition of a Code prepared jointly by the insurance and tunnelling industries aimed at reducing the frequency and severity of serious incidents (resulting in insurance claims) to within sustainable boundaries.

This 3rd Edition follows an industry-wide survey that canvassed opinions on the application of the Code to date and any necessary updates. The main areas of revision include adding a list of the principal attributes expected in the Code, addressing competence and culture, differentiating between risk management and management of risk, a new section on digital modelling, improved language on both instrumentation and monitoring and emergency response plans, and clarification of the importance of managing high consequence events.

The Code sets out industry best practice for the management of construction risks in underground works which, if followed, should reduce the risk of significant losses (insured and uninsured) across the industry. The Code has been in use since 2003 and its widespread adoption has succeeded in reducing incidents and losses to tolerable levels.

The tunnelling industry is committed to high quality risk management as an enabler of successful project delivery, and the Code represents a robust framework on which projects can be modelled.

The Insurance industry uses the Code as a benchmark against which projects can be assessed. Insurers may require compliance with the Code as a pre-requisite for their provision of insurance cover for damage to the works during construction.

The Code is intended to apply to all project participants insured via a Construction All Risks (or similar) policy and is recommended reading for any other party involved in the planning, design, procurement, and construction of underground works. It assumes that the reader has a working understanding of the terms defined in Appendix A.

Construction All Risks Insurance policies generally provide cover to all the project participants from Client to Sub-contractor, and the Code is written to reflect the responsibilities of each of the participants. Appendix B lists the deliverables that are expected to be produced at each project stage and will therefore assist in benchmarking against and/or demonstrating compliance with the Code.

The words 'shall' and 'should' are used to indicate actions that are either required for compliance, or recommended best practice, respectively. It is recognised, however, that all projects are unique and may have alternative means of achieving the overriding principles expected in the Code. Section 1 lists the principal attributes expected of a project adhering to these best practice principles.

The document is termed as a "Code of Practice", or "Code" and is intended to describe best practice or guidance – it is not, in itself, a legal or legally binding document. It may, however, be contractually binding if referred to as such in, for example, a construction contract or an insurance policy.

The Code is published jointly by the International Tunnelling and Underground Space Association (ITA) and the International Association of Engineering Insurers (IMIA).

Bill Grose and Patrick Bravery
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1 >> OBJECTIVE OF THE CODE

1.1 The objective of the **Code** is to promote and secure best practice for the minimisation and management of **Risks** associated with the design and construction of projects involving **Tunnel Works**.

1.2 The **Code** requires the identification of **Risks**, their allocation between the parties to a contract and **Contract Insurers**, and the **Management of Risks**, through the use of **Risk Assessments**, **Risk Registers** and **Risk Treatment**.

Terms identified in bold italics in the **Code** are defined/described in Appendix A.

1.3 To deliver the **Code's** objective, projects involving **Tunnel Works** should have the following principal attributes:

- a) Technical and management **Competence** and resources suited to the complexity of the project, the contractual mechanisms and the roles and responsibilities required.
- b) A clear commitment to a risk-aware culture through active and integrated **Risk Management** evident in the collaborative behaviours of all the parties, in their communications and sharing of information including the use of **Digital Models**.
- c) Identification and mitigation of **Risks** such that the **Likelihood** of failures from all reasonably foreseeable causes (including high **Consequence**, low **Likelihood Events**) is extremely remote during the **Construction Stage** and throughout the design life of the **Tunnel Works**.
- d) Acknowledgement that insurance is not a **Control** or **Risk Treatment** measure.
- e) Project **Risk Assessments** that are informed by sufficient site and ground investigation to identify and quantify **Risk Sources** and inform design and construction **Risk Assessments** in advance of **Contract Award**.
- f) **Contract Documentation** to include:
 - Project requirements, reference designs and **Risk Assessments**.
 - Explicit, clear and consistent allocation of **Risks**.
 - **Ground Reference Conditions**.
 - **Method Statements** required for tender.
- g) Clear procedures to facilitate changes in scope or requirements.
- g) Tenderers to be given adequate time to assess **Risks** prior to submitting tenders.
- h) **Risk Assessment** in the design process to be evidenced by:
 - assessment of project and alignment options.
 - assessment of health and safety in accordance with **Local National Legislation**.
 - assessment of ground conditions and temporary and permanent conditions including the definition of the limits of the design and the need for and requirements of **Instrumentation and Monitoring and Independent Construction Supervision**.
 - description of the design methods and **Design Assurance** procedures to be adopted.
 - assessment of potential impacts on **Third Parties** and the environment.
- i) The **Contractor's** pre-construction work to include evidence of integrated **Risk Management** including **Risk Management Plans, Risk Registers, Method Statements** (including evidence of adequate resources) and Health & Safety Plans.
- j) **Independent Construction Supervision** and sufficient **Instrumentation and Monitoring** to ensure that the design and other **Risk Assessment** assumptions are verified and validated for the conditions encountered during construction.

2 >> SCOPE OF THE CODE

2.1 The scope of the **Code** applies to the **Project Development, Design, Construction Contract Procurement and Construction** stages of projects involving **Tunnel Works**, the operation of **Tunnel Works** so far as any stipulated defects liability or notification period and the impact of the **Tunnel Works** construction on **Third Parties** including existing buildings, utilities, and other infrastructure.

2.2 The **Code** excludes the operational performance of tunnels and underground structures other than that included within any stipulated defects liability or notification period under a construction contract.

2.3 The **Code** is intended to operate in parallel with and does not derogate from:

- a) statutory duties, responsibilities and requirements of **Local National Legislation** relating to health and safety, the design and subsequent implementation of construction activities in respect of **Tunnel Works**.
- b) **Local National Standards and/or Codes of Practice** applicable to design and construction of **Tunnel Works** including those relating to workmanship and materials.
- c) ISO 31000 – Risk Management.

2.4 Where the provisions of the **Code** are more extensive and/or more onerous than any recommendations, statutory requirements, duties, responsibilities or **Local National Standards/Codes of Practice** set out in Clause 2.3 above, the requirements of the **Code** shall take precedence.

2.5 **The Code** is not intended to address all health and safety **Risks** associated with the design and construction of **Tunnel Works**. Where the **Code** requires the assessment of health and safety **Risks** it is expected that the requirements of applicable **Local National Standards and/or Codes of Practice** equivalent to BS6164:2019 and any subsequent revisions shall be applied.

2.6 Where the **Code** uses the words 'shall', the procedure to which it applies is compulsory. Where the word 'should' is

used, then the procedure is recommended as best practice. All such obligations, requirements and recommendations apply as necessary to the nature, form and extent of **Tunnel Works** proposed.

2.7 In the absence of specific **Local National Legislation** and/or **Local National Standards and/or Codes of Practice** dealing with such matters as set out in Clause 2.3 above, the **Insured** shall notify **Contract Insurers** of the provenance of Standards and/or Codes of Practice that will apply on projects involving **Tunnel Works** which relate to health and safety practices (including those applicable to the provision and operation of plant and machinery), design and construction (including materials and workmanship matters).

2.8 The **Insured** shall provide a schedule of the applicable statutory legislative requirements, Standards and/or Codes of Practice that will apply during the **Tunnel Works**.

3 >> INSURANCE & COMPLIANCE WITH THE CODE

3.1 **Contractors All Risk Insurance** and **Third Party Liability Insurance** are financial products that provide a reactive (post-loss) mechanism to partially alleviate the financial consequences arising from an undesirable **Event**.

3.2 Consequently, insurance cannot and shall not be considered as a **Control** or **Risk Treatment** measure in **Risk Assessments** for **Tunnel Works**.

3.3 Compliance with the **Code** as it applies to projects involving **Tunnel Works**, should minimize the **Risk** of physical loss or damage and associated delays. Hence, Insurance contracts covering **Tunnel Works** would benefit from provisions that enable Insurers to enforce the requirements of the **Code**.

3.4 **Contract Insurers** may include a provision in the Insurance Contract that allows them to enter and inspect any **Tunnel Works** and/or review any related documents within a reasonable time once a request is made. One principal purpose of any such inspection is to assess ongoing compliance with the **Code**.

3.5 **Contract Insurers** may include a provision in the Insurance Contract to ensure that the principles and guidelines given in the **Code** are followed by the issuing of **Insurer's Remedial Measures**.

3.6 Appendix B (Schedule of Deliverables) lists the documentation expected by **Contract Insurers** for their use in assessing compliance with the **Code**.

3.7 The **Insured** should always take advice from their **Insurance Advisers** as to the insurance implication of non-compliance with the **Code**.

4 >> RISK, RISK ASSESSMENT & RISK MANAGEMENT

4.1 RISK

4.1.1 **Risk** shall be an integral consideration in the planning, design, procurement and construction of **Tunnel Works**. **Risks** shall be identified and mitigated such that the **Likelihood** of failures from all reasonably foreseeable causes (including high **Consequence**, low **Likelihood Events**) is extremely remote during the **Construction Stage** and throughout the design life of the **Tunnel Works**.

4.1.2 **Risks** shall be identified and evaluated on a project-specific basis and shall be identified and quantified by **Risk Assessments** through all **Project Stages**.

4.1.3 The nature of the **Risks** will be dependent on the **Project Stage** under consideration.

4.1.4 Wherever possible, **Risk** should be eliminated through design and construction procedures.

4.2 RISK ASSESSMENT

4.2.1 The scope, context, and criteria to be used in **Risk Assessment**, particularly in terms of **Likelihood** and **Consequence**, shall be project specific and give due regard to the **Project Stage** under consideration.

4.2.2 The objective of **Risk Assessments** (in situations where **Risks** cannot be eliminated) is to determine and record:

- (a) that potential **Consequences** have been assessed against the costs, effort, or other disadvantages of **Risk Treatment** to test why only the proposed **Risk Treatment** will be undertaken and no more, and
- (b) the **Residual Risk** level that can be achieved, and
- (c) that the **Residual Risk** is acceptable to all those that may be affected by the **Risk**.

4.2.3 **Risk Assessment** should consider, but not be limited to:

- a) health and safety.
- b) the environment.
- c) the design.
- d) the adequacy of (costs of/resources for) the design and **Design Assurance**.
- e) the programme for design.
- f) the methods (including alternatives) for construction of the project.
- g) the cost of and programme for construction.
- h) the costs associated with loss recovery.
- i) the **Competence** and capacity of the parties.
- j) **Third Parties** and existing facilities including buildings, bridges, tunnels, roads, surface and subsurface railways, pavements, waterways, flood protection works, surface and subsurface utilities and all other structures/infrastructure that may be affected by the carrying out of the works.

All of which shall be both project specific and commensurate with the **Project Stage** under consideration.

4.2.4 High **Consequence Risks** shall be considered most carefully during **Risk Assessment** to determine that the **Residual Risk** is acceptable. Such **Risks** should be treated as though they have a high level of **Risk** regardless of **Likelihood**.

4.2.5 **Risk Meetings** should be carried out throughout all **Project Stages** to facilitate **Risk Assessment**. An initial **Risk Meeting** should be held either before or immediately upon commencement of each **Project Stage** and thereafter as required but no less frequently than quarterly.

4.2.6 The output from **Risk Assessment** (as required at each **Project Stage**) shall be summarised in **Risk Registers**. **Risk Registers** shall clearly indicate the **Risk Owner**.

4.3 RISK MANAGEMENT AND MANAGEMENT OF RISK

4.3.1 A formalised **Risk Management** procedure shall be employed as a means of documenting the **Risk Assessment** process and subsequent production and management of **Risk Registers**.

4.3.2 **Management of Risk** shall be assured through the implementation of **Controls**. The effectiveness and efficiency of such **Controls** shall be monitored through all **Project Stages** by the active use of **Risk Registers**.

4.3.3 **Risk Registers** shall be considered as 'live' documents that are continually reviewed and revised as required throughout all **Project Stages**. They shall provide an auditable trail through the life of a project to demonstrate the on-going **Management of Risk** and compliance with the **Code**.

4.3.4 Regular **Risk Meetings** shall be carried out during the **Construction Stage** as the mechanism for reviewing **Risk Registers** and monitoring **Controls**.

4.3.5 Responsibility for **Risk Management** shall be explicitly stated in all contracts related to the design, construction or management of the **Tunnel Works**.

5 >> CULTURE, COMMUNICATION & COMPETENCE

5.1 RISK MANAGEMENT CULTURE AND COMMUNICATION

5.1.1 There should be a clear commitment to generating and maintaining a **Risk-aware** culture through active and integrated **Risk Management** in all aspects of the project and through all **Project Stages**. This commitment should support a holistic approach to the **Management of Risk** and should be evident in the collaborative behaviours of the parties, such as:

- a) relevant contributions to **Risk Assessments**.
- b) active participation in **Risk Meetings**.
- c) comprehensive reviews of **Risk Registers**.
- d) dedication to the implementation of **Controls**.
- e) maintenance of **Digital Models**.

5.1.2 The culture within the project should support and encourage all individuals in learning from incidents, reporting near misses and escalating any areas of concern, particularly regarding health and safety practices, adherence to **Method Statements** and consideration of **Instrumentation and Monitoring** data.

5.1.3 All project parties shall establish and maintain a clear process of communication to assist in the allocation, management and integration of **Risks** and to facilitate the shared understanding of all information necessary for **Risk Management** throughout all **Project Stages**.

5.2 COMPETENCE

5.2.1 All project parties (organisations, group of organisations or individuals) shall have individual and collective technical and management **Competence** and possess the necessary capabilities required to manage their planning, design, procurement and construction obligations.

5.2.2 The **Competence** of organisations should be assessed by reference to features including but not be limited to the following:

- a) recent precedent experience and track record of the delivery of previous projects (including, for designers and **Contractors**, references from previous clients, which should be verified by the **Client**.)
- b) the availability of **Key Personnel**.
- c) the project organisation structure.
- d) the financial stability of each organisation.

5.2.3 The **Competence** of individuals should be assessed by consideration of their experience and skill, development training and academic qualifications and/or certifications to establish that the personnel are suitably qualified and experienced in relation to the nature, form and extent of **Tunnel Works** proposed and the services to be provided. Individuals should be aware of the extent of their responsibilities and limitations of their **Competence** in relation to their professional obligations and codes of conduct.

6 >> DIGITAL MODELS

6.1 All project parties should assist in the development and maintenance of accurate **Digital Models** as an aid to the integration and co-ordination of **Risks**. The management of models should be part of project management and **Risk Management** for the **Tunnel Works**.

6.2 The degree of complexity required to represent and model the **Tunnel Works** should be considered based on the scope, extent and context of the **Tunnel Works**. **Digital Models** may include but not be limited to the following information:

- a) planning, easements and future developments.
- b) three dimensional (3D) spatial design arrangements and constraints.
- c) physical investigations including site investigation, geological data (3D ground and hydrogeological modelling).
- d) existing conditions and infrastructure

including buildings, foundations and utilities.

- e) construction worksites, sequencing and logistics.
- f) **Instrumentation and Monitoring** (including monitoring of **Third Party** property).
- g) as-encountered and as-built conditions.

6.3 Consideration should be given to representing the uncertainty of the ground (and associated ground behaviour) in the **Digital Model**.

6.4 At the commencement of each **Project Stage** and at regular (at least quarterly) intervals thereafter, there should be formal reviews, and updates, as necessary of the **Digital Model**, attended by at least the **Client, Designer** and **Contractor** to verify and ensure that the model remains current and representative of the **Tunnel Works** in relation to the **Risk Management** objectives.

7 >> CLIENT ROLE AND RESPONSABILITY

7.1 The **Client** shall have sufficient technical and management **Competence** available during all **Project Stages**.

7.2 Such **Competence** shall be demonstrable and should be evaluated based on the **Competence** of the **Client** organisation in relation to the proposed **Tunnel Works** and the **Competence** of individual staff within the **Client** organisation including their availability for the project (according to the criteria in 5.2.2).

7.3 In the absence of such **Competence**, the **Client** shall appoint a **Client's Representative**. The criteria for the selection and appointment of a **Client's Representative** should be similar to those with which the **Client** assesses their own **Competence** at the outset (according to the criteria in 5.2.2). The **Client** shall not appoint the **Contractor** as the **Client's Representative**.

7.4 The **Client** shall provide for the **Design Assurance** of the **Tunnel Works** including but not limited to:

- a) Safety in design and health & safety related matters, including those directly related to all persons directly engaged on the **Tunnel Works**, and
- b) all potential impacts on **Third Parties** and the environment arising from the design, and
- c) the preparation of associated design-related **Risk Assessments** and **Risk Registers**.

7.5 The **Client** shall ensure sufficient **Independent Construction Supervision** of the **Tunnel Works** including but not limited to the following assurance and management roles:

- a) quality assurance and quality management.
- b) compliance with the **Contract Documentation** and **Method Statements**.
- c) compliance with the **Instrumentation and Monitoring Plan**.

7.6 In the case of a **Self-Certification** contract, the **Client** shall demonstrate how **Independent Construction Supervision**

and **Design Assurance** will be provided and assured.

7.7 The **Client** shall appoint an identified individual (or individuals) from within their organisation or an **Independent** external organisation (or organisations) who is/are **Competent** in **Risk Management** including the development and use of **Risk Assessments** and **Risk Registers** for each and all **Project Stages**, consistent with the requirements of the **Code**.

7.8 The **Client** shall appoint an organisation (or organisations) who is/are **Competent** in **Instrumentation and Monitoring** of the **Tunnel Works**.

7.9 The **Client** should consider the formation of a **Tunnel Advisory Board** to provide **Independent** oversight of the design and construction process and the associated **Management of Risks**.

7.10 The **Client** should promote and enable the development, maintenance and accuracy of a **Digital Model**. In addition, the **Client** should specify:

- a) the objectives for adopting a **Digital Model**.
- b) how such information is to be shared between the parties during the **Project Stages**.
- c) the degree of complexity of the **Digital Model** required to represent and model the **Tunnel Works**.

7.11 The **Client** shall develop and maintain during the course of the **Tunnel Works** (or have developed and maintained on their behalf) an **Overall Management Organisation Chart**. The Chart should be accompanied by curricula vitae of **Key Personnel** from these organisations to support and demonstrate the **Competence** of those persons carrying out the design, construction, **Design Assurance**, **Construction Supervision** and project management of the works.

7.12 The **Client** shall ensure that all requirements set out in the **Code** fall within their own duties or are delegated or contracted to other project parties.

8 >> PROJECT DEVELOPMENT STAGE

8.1 GENERAL

8.1.1 For the purpose of the **Code**, the **Project Development Stage** includes:

- a) feasibility studies.
- b) site and ground investigations.
- c) assessment and evaluation of options and the identification of a preferred option and **Form of Contract** for construction.
- d) any design studies.

8.1.2 The scope of work required under the **Project Development Stage** shall not be constrained by programme considerations and the terms and conditions for the appointment of a **Client's Representative** shall be fully consistent with such scope.

8.1.3 The **Client** shall ensure that sufficient time and budget are available to:

- a) investigate and subsequently demonstrate the technical viability of the **Tunnel Works** prior to proceeding to the **Construction Contract Procurement Stage**.
- b) prepare designs.

8.2 SITE AND GROUND INVESTIGATIONS

8.2.1 The nature, scope and extent of site and ground investigations to be carried out shall be based on the nature, scope and extent of the **Tunnel Works**, its location and its geological/hydrogeological environments. Site and ground investigations shall be designed, planned and procured by personnel who are **Competent** in respect of the nature of the site and ground investigations required for the proposed **Tunnel Works**.

8.2.2 Site and ground investigations shall be designed and executed in accordance with applicable **Local National Standards and/or Codes of Practice**. In the absence of such standards, the rationale and/or use of other internationally recognised Standards upon which the site and ground investigations are designed and executed shall be clearly stated. Site and ground investigations designed and executed by or on behalf of the **Client** should be phased to develop the understanding of uncertainty associated

with the prevailing physical, geological and hydrogeological conditions and therefore be designed and planned to:

- a) enable alignment options to be compared and the feasibility of the options in terms of cost, programme, **Risk** and **Constructability** to be evaluated.
- b) identify, so far as reasonably practicable, artificial (man-made) and natural (geological/hydrogeological) **Risk Sources** (including gases such as methane, radon) and hence enable consequent **Risks** to be assessed (which influence the design and construction of the **Tunnel Works**, including those that affect **Third Parties**).
- c) provide sufficient information on
 - prevailing site conditions.
 - ground (including artificial and natural ground) and groundwater conditions.
 - previous history of the project site, including any constraints of an engineering significance to the works to be carried out (such as mining/mineral extraction, contamination).
- d) enable the financial and technical viability of the **Tunnel Works** to be confirmed from preliminary design studies.

and identify areas of the tunnel alignment which may require supplementary attention and/or additional investigation before and/or during excavation to enable realistic and reliable assessments of different tunnelling methodologies (including temporary and permanent support/lining requirements and health and safety issues) to be made in terms of technical viability, cost, programme and impact to **Third Parties**.

- d) enable the financial and technical viability of the **Tunnel Works** to be confirmed from preliminary design studies.

8.2.3 Site and ground investigations shall be executed by organisations who are **Competent** for such work and supervised by **Competent** personnel by (or on behalf of) the **Client** to ensure that the results of the investigations are reviewed, and the scope of the investigations is amended or revised to suit the conditions being encountered in relation to the proposed nature and scope of the **Tunnel Works**.

8.2.4 The results of site and ground investigations, including laboratory and field testing, shall be recorded factually in accordance with **Local National Standards and/or Codes of Practice** or, in their absence, internationally recognised Standards or Codes of Practice. The method of reporting shall be stated clearly. Any departure whatsoever from any Standards, Codes or other practices referred to or acknowledged in the factual reports shall be identified and clarified to prevent any ambiguity in the reporting of factual data.

8.2.5 As far as reasonably practicable all available records of pre-existing foundations and other structures/artificial obstructions and any other potential future developments which could affect and/or be affected by the **Tunnel Works** shall be collated and made available to the **Designer** and the **Contractor**.

8.3 ASSESSMENT AND EVALUATION OF PROJECT OPTIONS

8.3.1 It should be acknowledged that decisions made early in the project life-cycle regarding the design and alignment may introduce **Risk Sources** that cannot be subsequently eliminated. This raises the significance of the **Client's** role in **Risk Management** and the importance of **Risk Assessment** of a **Tunnel Works** project at the **Project Development Stage**.

8.3.2 Assessments and evaluations of options should be carried out during the **Project Development Stage** by the **Client**. For a selected alignment or alignment options, such assessments and evaluations should consider:

- a) the geology (including the potential for gases of a potentially harmful nature) and the hydrogeology (as characterised by site and ground investigations).
- b) construction methodologies suitable for the expected ground conditions and the environment.
- c) temporary and permanent ground support systems (for example, sprayed concrete linings, rockbolts/dowels, pre-cast concrete segmental linings, cast-iron segmental linings, cast in-situ concrete linings).

8 >> PROJECT DEVELOPMENT STAGE

- d) ground and groundwater treatment measures (for example, the use of compressed air, grouting, dewatering/depressurisation, ground freezing) and their impact on the environment and to **Third Parties** (for example, groundwater abstraction/depressurisation leading to settlements, noise, vibrations).
- e) ground movements and settlements at the ground surface and their impact on a **Third Party** or subsurface ground movements and their impact on buried structures such as utility services, adjacent tunnels and underground structures.
- f) environmental considerations including pollution, dust, noise, vibrations, traffic, plant movements.
- g) associated costs, health (including occupational health considerations), safety and programme implications.
- h) potential **Forms of Contract** under consideration.
- i) hazardous materials including gasses, chemicals, other pollutants or naturally occurring substances that could be injurious to health or affect durability.
- j) all operational, maintenance, and future proofing requirements that introduce a significant construction **Risk**.
- k) any other **Risk Sources** arising from the proposed **Tunnel Works** location, geology and/or environment.

8.3.3 The assessments and evaluations of options shall include the identification and evaluation of associated option-related **Risk Sources** and consequent **Risks**. Option reports shall include formalised **Risk Assessments** for each identified option. The **Risk Assessments** shall be continually reviewed and revised during the **Project Development Stage** to consider the results of site and ground investigation results and further and better information that becomes available during this Stage.

8.3.4 For identified options (in terms of, for example, alignment, tunnelling methodology, environmental, **Third Party** considerations, etc), the **Client** should establish (or have established on their behalf) overall estimates of cost and time for each option with

costs assigned to programme activities. Furthermore, cost and programme sensitivity tests should be undertaken to determine the projected out-turn costs and programme durations in relation to option related **Risks** and associated **Risk Treatment** measures to eliminate or minimise identified **Risks**.

8.3.5 By such means, the **Client** shall determine a technically and commercially viable preferred option.

8.4 PROJECT DEVELOPMENT DESIGN STUDIES

8.4.1 A **Risk Register** shall be prepared for the preferred option (or options) which should include the perceived **Risk Sources** and associated **Risks** and indicate potential **Risk Treatment** measures with comprehensive explanations for their basis, all based on the studies carried out during the **Project Development Stage**. This **Risk Register** shall be included within the information provided to tenderers during the **Construction Contract Procurement Stage**.

8.4.2 The **Client** should prepare (or have prepared on their behalf) a tender or reference design suited to the type of contract (for example 'construct only', 'design and construct', 'design build operate' etc.) and **Form of Contract** to be adopted for the preferred option (or options), all informed by the **Risk Management** activities described in the **Code**.

9 >> CONSTRUCTION CONTRACT PROCUREMENT STAGE

9.1 GENERAL

9.1.1 For the purpose of the **Code**, the **Construction Contract Procurement Stage** includes the:

- a) preparation and issue of **Contract Documentation** for **Tunnel Works** for tendering purposes.
- b) selection or Pre-qualification of **Contractors** for tendering.
- c) tender assessment.

9.2 PREPARATION OF CONTRACT DOCUMENTATION FOR TENDERING PURPOSES

9.2.1 The preparation of **Contract Documentation** for tendering purposes shall take into consideration the type of contract to be awarded (for example 'construct only', 'design and construct', 'design build operate' etc.) and the **Form of Contract**.

9.2.2 The selection of a **Form of Contract** by the **Client** and the drafting of its detailed terms should take into consideration the clear allocation of **Risks** to the parties to the contract (under the proposed contract) and consequently the liabilities of the parties to the contract.

9.2.3 All **Contract Documentation** shall clearly demonstrate how the parties to each contract are to comply with the **Code**. Consequently, such **Contract Documentation** should clearly and explicitly set out the responsibilities and duties of the parties to each contract and the responsibility for meeting the cost of **Insurer's Remedial Measures**, if any.

9.2.4 **Contract Documentation** shall include full disclosure of those **Risk Sources** and associated **Risks** identified at the **Project Development Stage** for the preferred option (or options) in the form of a **Risk Register** or **Risk Assessment** report.

9.2.5 **Contract Documentation** shall include **Ground Reference Conditions** prepared by the **Client** (or prepared on their behalf) and/or shall require tenderers to submit an assessment of **Ground**

Reference Conditions to suit their proposed methods of construction. The process of incorporation of **Ground Reference Conditions** (modified to suit the tenderer's proposed methods of construction where required) and their function within the contract shall be defined and fully described in the **Contract Documentation**.

9.2.6 When prepared by (or on behalf of) the **Client**, the **Ground Reference Conditions** shall be issued to tenderers as integral and formative information upon which tenders shall be based and for which the **Client** shall take responsibility.

9.2.7 When prepared by a tenderer, the **Ground Reference Conditions** shall be used by the **Client** in the tender assessment process.

9.2.8 **Ground Reference Conditions** prepared either by the **Client** or jointly prepared with a tenderer shall form part of the **Contract Documentation** and shall provide the basis of foreseeability against which encountered conditions can be assessed and compared and thereby provide the basis for comparison to those assumed and allowed for at the tender stage by the **Contractor**. The **Ground Reference Conditions** shall also identify **Risk Sources** from the site and ground conditions established from the investigations and other available sources (such as similar local tunnel projects) to enable **Risks** to be assessed and accounted for at the time of tender, consistent with the **Contract Documentation** requirements.

9.2.9 **Contract Documentation** shall specify the requirements for the **Instrumentation and Monitoring Plan** and identify key **Method Statements** (that the **Client** considers critical for the construction of the works) to be submitted with a tender.

9.2.10 Notwithstanding the issue of a project **Risk Register** in the **Contract Documentation**, tenderers shall be required to prepare and submit their own **Tender Stage Risk Register** based on **Risk Assessments** specific to the proposed means and methods of working

(as described in **Method Statements**). For **Risks** with critical **Consequences**, including but not limited to collapse, flood, inundation and loss of life, tenderers shall be required to prepare and submit **Emergency Response Plans**. The **Client** shall specify the requirements for the **Emergency Response Plan**.

9.2.11 **Contract Documentation** should clearly set out the information required for assessment of tenders together with the criteria and their weighting on which the evaluation of the tenders will be based.

9.2.12 Sufficient time and resources should be allocated for the preparation of **Contract Documentation** to limit the need for subsequent supplementary documentation (including addenda, corrigenda) during the tendering period.

9.3 SELECTION OR PRE-QUALIFICATION OF CONTRACTORS FOR TENDERING PURPOSES

9.3.1 The selection or **Pre-qualification of Contractors** for tendering purposes is a key activity and the **Client** shall allocate dedicated time and resources to such. This process shall require **Contractors** to demonstrate **Competence**.

9.3.2 The requirements for selection or **Pre-qualification** shall be prescribed and information to be sought during this process should include but not be limited to:

- a) relevant recent experience with a list of projects and **Clients**. Previous **Clients** should be contacted for references (for example on matters relating to the **Contractor's** performance, working relationships).
- b) performance details on previous projects.
- c) financial status.
- d) any proposed 'joint venture' arrangements.
- e) key staff available with the required qualifications.
- f) current workload and available resources.
- g) proposed use of subcontractors and supply chain with details of previous working relationships.

9 >> CONSTRUCTION CONTRACT PROCUREMENT STAGE

h) a focused technical submission on the proposed **Tunnel Works** which demonstrates technical understanding of the requirements for the **Tunnel Works**.

9.4 TIME FOR TENDERING

9.4.1 Provision shall be made by the **Client** for reasonable time for tendering to reflect the type of contract, the complexity of the **Tunnel Works** and the requirements of the **Contract Documentation** in terms of a tender submission.

9.5 TENDER STAGE RISK REGISTER

9.5.1 Tenderers shall submit a **Tender Stage Risk Register** for review during the tender assessment. The **Tender Stage Risk Register** should demonstrate how the tender submission accounts for **Risks** identified by the tenderer, the **Client** or the **Designer**. The tenderer shall demonstrate that they have made sufficient allowance for the cost and programme implications of all **Controls**.

9.5.2 The **Tender Stage Risk Register** should identify those **Risks** with critical **Consequences** and demonstrate, through the production of an **Emergency Response Plan**, how these **Consequences** will be managed.

10.1 GENERAL

10.1.1 For the purpose of the **Code, Design Stages** include conceptual, preliminary and detailed designs for both the permanent **Tunnel Works** and the temporary works required during the **Construction Stage**.

10.1.2 The principles to be adopted during the **Design Stages** shall apply equally to the designs for permanent works and the designs for temporary works, howsoever defined in the **Code**.

10.1.3 The design processes for safety-critical temporary works, particularly those that support the ground during construction, shall be the same as for permanent works.

10.1.4 Prospective **Designers** should be provided with a brief, either from the **Client** or **Contractor**. The prospective **Designers** should review this brief and identify any deficiencies or omissions that could lead to a **Risk** to the **Tunnel Works**. The **Client** or **Contractor** shall be required to address these issues and adjust the terms and scope of engagement prior to awarding the design commission.

10.2 TRANSFER OF INFORMATION BETWEEN DESIGNERS

10.2.1 Where a design is transferred between **Designers** for different **Design Stages**, the employing party (**Client** or **Contractor**) shall ensure that all information developed and collated during the previous **Design Stage** is made available to the **Designer** of the following stage, including **Risk Assessments** and **Risk Registers**.

10.2.2 The **Designer** appointed and responsible for the subsequent **Design Stage** shall be required to evaluate this information and make recommendations to the employing party (**Client** or **Contractor**) for further investigations and/or studies for the subsequent **Design Stage** to fulfil the brief for appointment.

10.3 DESIGN PROCESS

10.3.1 In the context of the **Code**, the

fundamental objective of the design process is that of achieving a design whereby the **Likelihood** of failure of or damage to the **Tunnel Works** or to a **Third Party** from all reasonably foreseeable causes (including health and safety considerations) is extremely remote during the construction and the design life of the **Tunnel Works**.

10.3.2 **Risks** from high **Consequence**, low **Likelihood Events** that could affect the **Tunnel Works** or a **Third Party** shall be explicitly considered in the design process. Wherever possible such **Risks** should be eliminated by design. Where this is not possible such **Risks** should be clearly identified on the **Risk Register** and mitigated by **Controls**.

10.3.3 The **Designer** shall prepare documentation which shall include but not necessarily be limited to:

- a) a description of the element to be designed.
- b) the design requirements and criteria to be adopted.
- c) a geotechnical assessment that shall evaluate the geological, hydrogeological and geotechnical information available (including the presence or generation of harmful gases, ground and groundwater contamination) and assign design values for the assessed ground and groundwater conditions for the purpose of design with their justification for adopting such values.
- d) a description of the method of design (including reference to any applicable **Local National Standards and/or Codes of Practice**).
- e) a description of the method(s) of analysis to be used for the design and justification thereof.
- f) a **Design Stage Risk Register** as a formal record of the design **Risk Assessments**.
- g) the in-house design checking procedure to be implemented.
- h) development of the design requirements for the **Instrumentation and Monitoring Plan**.

10.3.4 Design **Risk Assessments** shall consider the impact on the design, and its **Constructability**, of any credible variations

in the material properties and/or loading conditions assumed, taking account of the anticipated and/or proposed method(s) of construction. The design **Risk Assessments** shall also consider the potential failure mechanisms and the potential impact on both the **Tunnel Works** and **Third Parties**.

10.3.5 The **Risk Register** shall include **Controls** for the anticipated and/or proposed method(s) of construction and the description of **Controls** should include the **Instrumentation and Monitoring** requirements for assessing the performance of the **Tunnel Works** during construction.

10.3.6 Calculations, analyses, and assessments shall consider intermediate stages of construction.

10.3.7 To achieve the objective stated in 10.3.1, the design process shall assess the uncertainty and variability associated with:

- a) physical constraints, including existing and future developments.
- b) methods of construction and construction tolerances.
- c) variation in geotechnical design values.
- d) variation in materials characteristics.
- e) variation in loading conditions.
- f) variation in workmanship and geometry.
- g) time dependency or sensitivity in the implementation of **Controls**.
- h) exposure to natural perils in the region of the **Tunnel Works** such as rainfall, inundation, flood, storm, seismic or tidal effects.

10.3.8 The design process shall include an assessment of the predicted ground movement and subsequent infrastructure damage assessment to establish the potential impact of construction on **Third Party** infrastructure.

10 >> DESIGN STAGE

10.3.9 The design process shall include an assessment of the **Instrumentation and Monitoring** systems that will be required to demonstrate that the **Tunnel Works** and their environs are behaving as expected during construction. Trigger levels shall be specified in all cases where a breach of the trigger levels may result in a compromise to the design, physical safety or stability.

10.4 DESIGN ASSURANCE

10.4.1 All designs shall be subject to **Design Assurance** to ensure that the fundamental objective of 10.3.1 has been achieved.

10.4.2 **Design Assurance** should integrate the following elements:

- a) **Independent** check of the permanent works design, including the design methods, parameters and tolerances, the material assumptions, and safety and constructability.
- b) **Independent** checks of methods of erection and design of temporary works that may represent significant **Risk**.
- c) Clear allocation of responsibility for validation of the design and **Instrumentation and Monitoring**, including the management of any design changes, either resulting from the as encountered conditions or as a result of other design changes.
- d) Provision of representatives of the **Designer** on site to validate the implementation of the design.

10.4.3 The extent and scope of **Design Assurance** shall be adjusted to suit:

- a) the complexity, degree of difficulty and type of construction of the **Tunnel Works** (including excavation/support sequencing for intermediate construction stages if applicable).
- b) the level of **Risk** (to the **Tunnel Works** and/or **Third Parties**) determined from **Risk Assessments**.
- c) any statutory or other requirements by a **Client** or **Third Parties**.

10.4.4 Design programmes shall allow sufficient time for the **Design Assurance** required at each **Project Stage** to be completed.

10.5 CONSTRUCTABILITY

10.5.1 The **Designer** shall ensure that the design can be safely constructed by undertaking formal **Constructability Reviews** of the design.

10.5.2 Within these **Constructability Reviews**, the **Designer** shall take account of the impact of staged or sequential excavations to ensure the feasibility of construction stages, to allow the assessment of the potential impacts on **Third Parties** and to assess the suitability of the design. Provision shall be made by the **Client** to ensure that the **Designers'** intent and their requirements are achieved during construction.

10.5.3 The **Designer** shall obtain sufficient ground and groundwater information and geotechnical properties to enable assessment of the construction of the **Tunnel Works** and development of a suitable method(s) of tunnelling/excavation. The limitations and uncertainty associated with the available information shall be quantified as far as reasonably practicable.

10.5.4 The design of support measures shall detail excavation/support sequences and identify the **Instrumentation and Monitoring** requirements and associated **Controls** as required during the works for the range of anticipated ground and groundwater conditions. The **Designer** shall ensure the design is consistent with the fundamental objective of 10.3.1 and the requirements in 10.3.7 in terms of geotechnical variability, workmanship and construction tolerances.

10.5.5 Where an 'observational method' is proposed or required, there shall be compliance with a recognised standard such as CIRIA Report R185 or any successor. In particular, where the design is based on or includes any element of an 'observational' approach for its implementation during the **Construction Stage**, the **Insured** shall ensure that the **Designer** has in place, prior to the commencement of the **Construction Stage**, pre-planned and pre-designed **Controls**. Such **Controls** shall allow for all resources (including but not limited to personnel, equipment, plant and materials) to cater for **Events** which have not been

predicted but observed based on monitoring which reveal at any time during the works that ground conditions and/or ground and/or underground structure behaviour is more adverse than that predicted. Such **Controls** may include (but shall not necessarily be limited to) increased monitoring frequency, ground treatment, additional support measures and modifications to the excavation/support sequencing, and should be co-ordinated with an **Emergency Response Plan** as required.

10.5.6 Design programmes shall allow for sufficient time to incorporate the output from **Constructability Reviews** including ensuring the necessary co-ordination and compatibility between the design and the proposed tunnel construction means and methods.

10.6 VALIDATION OF DESIGN DURING CONSTRUCTION

10.6.1 Provision shall be made in a contract for sufficient **Instrumentation and Monitoring** of **Tunnel Works** during the **Construction Stage**. The overall performance of the construction works relative to the design shall be reviewed by the **Designer** as required by the **Instrumentation and Monitoring Plan** and **Design Assurance** requirements to ensure that the assumptions of the design will be verified and validated during construction.

10.6.2 **Instrumentation and Monitoring** results shall be clearly and directly compared with the trigger levels set out in the **Instrumentation and Monitoring Plan**. There shall be a system of alerting the **Risk Owners** and other **Key Personnel** if trigger levels are exceeded to prompt the implementation of the pre-defined responses.

10.6.3 Where the design is based on or includes any element of an 'observational' approach for its implementation during the **Construction Stage**, the **Insured** shall ensure that the **Designer** provides sufficient **Competent** persons during the construction of the **Tunnel Works** so that the works are communicated, co-ordinated and implemented at the **Construction Stage** to the satisfaction of both the **Designer** and **Contractor** including the implementation of any pre-planned **Controls**.

11 >> CONSTRUCTION STAGE

11.1 GENERAL

11.1.1 This section of the **Code** identifies the elements of best practice that a **Contractor** is required to adopt as a minimum - in addition to any statutory, contract or other code requirements both prior to and during construction. This section should be read in conjunction with all other sections of the **Code**.

11.1.2 The **Construction Stage Risk Registers** should be used as an active and dynamic project management tool to facilitate **Management of Risk**.

11.2 PRE-CONSTRUCTION ACTIVITIES

11.2.1 Following **Contract Award** and prior to commencing the construction of **Tunnel Works**, pre-construction activities shall include, but depending on the **Form of Contract**, not necessarily be limited to:

- a) the preparation and submission of a **Risk Management Plan** incorporating a **Construction Stage Risk Register**.
- b) the preparation and submission of Health and Safety, Quality, and Environmental Plans.
- c) the preparation of a **Management Plan**.
- d) the identification, design (as necessary under the contract) and procurement of items which involve long lead items (such as tunnel boring machines, for example).
- e) the preparation of pre-construction Planning and **Method Statements** and **Emergency Response Plans**.
- f) development of the **Instrumentation & Monitoring Plan**.
- g) obtaining all necessary statutory consents and/or approvals.
- h) **Constructability Reviews**.

11.3 RISK MANAGEMENT PROCEDURES

11.3.1 The **Risk Management Plan** shall include the **Construction Stage Risk Register** which records all project-related **Risks** identified for the **Construction Stage** of the **Tunnel Works** and includes **Risks** brought forward from the **Client's** pre-contract **Risk Register** and/or the **Design Stage Risk Register**.

11.3.2 The **Construction Stage Risk Register** shall identify the **Risk Owners**, **Controls** and measures required to mitigate the impact of the identified **Risks** of or to the **Tunnel Works**. The **Construction Stage Risk Register** may include the health and safety **Risk Assessments** related to the construction works/activities (in respect of any prevailing statutory or legislation requirements).

11.3.3 The **Risk Management Plan** shall define the scope, context and criteria, and consequent process that will be adopted, to understand **Risks** to the **Tunnel Works**. In addition, it shall identify the means and methods for:

- a) regular monitoring and review of the **Construction Stage Risk Register** by **Risk Owners** and other **Key Personnel**.
- b) the means of identifying and formally recording **Risk Sources** and associated **Risks** which arise during the **Construction Stage**.
- c) identifying progress in the reduction/mitigation of the overall impact of **Risks**.
- d) updating of the **Construction Stage Risk Register** and subsequent identification of any changes to the **Risk Profile** during the **Construction Stage** of the **Tunnel Works**.

11.3.4 All **Risks** from high **Consequence**, low **Likelihood Events** that could affect the **Tunnel Works** or a **Third Party** during the **Construction Stage** shall be subject to specific **Risk Assessments** and shall be included within the **Construction Stage Risk Register**. Where the **Likelihood** has been reduced to an acceptable level by **Controls** in the **Contractor's** construction methods such **Controls** shall be identified as critical and shall be managed as such.

11.3.5 For all **Risks** with critical **Consequences** (including but not limited to collapse, flood, inundation and loss of life) irrespective of proposed or applied **Controls**, the **Contractor** shall provide the **Client** with an **Emergency Response Plan** that details how the **Consequences** will be managed if the **Control** measures fail and the **Event** occurs.

11.4 CONTRACTORS' STAFF AND ORGANISATION

11.4.1 Prior to commencing work on site and thereafter whenever there is a material change, the **Contractor** shall submit an **Overall Site Organisation Chart** for the approval of the **Client**.

11.4.2 The **Overall Site Organisation Chart** shall be in sufficient detail to enable the **Client** to identify how and with whom the **Contractor** intends to manage the works. The chart shall be submitted together with the names and curriculum vitae of all **Key Personnel** to demonstrate the **Competence** of those persons who will be employed in the management of the **Tunnel Works**.

11.4.3 In addition, the **Contractor** shall provide details of the roles and responsibilities of those **Key Personnel** to link the **Overall Site Organisation Chart** with reporting lines.

11.4.4 The **Contractor** shall, through policies on employment and training, ensure that all staff are and will remain **Competent** for the positions and responsibilities that they are to hold and that all operatives have the necessary **Competence** to carry out the processes required for the construction of the works.

11.4.5 As part of the organisation structure, the **Contractor** shall develop and implement a procedure for the dissemination of information including the methods they shall employ to ensure that feedback from sections of the works are communicated to all parts of the project.

11.5 CONSTRUCTABILITY

11.5.1 Throughout the duration of any **Tunnel Works** contract, the **Contractor** shall carry out **Constructability Reviews** jointly with the **Designer** and others as required. The frequency of such reviews shall be consistent with the requirement of ensuring that the construction methods being employed and to be employed are suitable and that the design and performance can be validated through the **Instrumentation and Monitoring** and assured by the Independent **Construction Supervision** of the works.

11 >> CONSTRUCTION STAGE

11.6 METHODS AND EQUIPMENT

11.6.1 Prior to commencement of any operation or process in connection with construction of the **Tunnel Works**, the **Contractor** shall provide the **Client** with fully detailed **Method Statements, Inspection and Test Plans, Instrumentation and Monitoring Plans, Emergency Response Plans** and **Risk Assessments** as required or defined under the contract.

11.6.2 **Method Statements** shall clearly detail the methods and resources with which the **Contractor** intends to construct the works and should cover all aspects of the works including specification, design, environment, health and safety and quality. **Method Statements** shall reflect and demonstrate compliance with accepted current best practice and standards for the operations intended to be carried out.

11.6.3 **Inspection and Test Plans** shall clearly detail how the **Contractor** intends to inspect, check and certify the works throughout the construction process and should detail 'hold' points requiring approval by others such as the **Designer** or **Client** in accordance with the contract requirements. **Inspection and Test Plans** should identify those sections of the specification which are being referred to and the tolerances permitted.

11.6.4 The **Contractor** shall provide input to the **Instrumentation and Monitoring Plan** to detail how they intend to observe and monitor the physical performance of the **Tunnel Works**, facilitate sufficient engagement with the **Designer** to review and respond to such information and otherwise comply with the provisions of section 10.6. There shall be regular reviews of the **Tunnel Works'** response to excavation and/or loading/unloading including reviews of **Instrumentation and Monitoring** to ensure that the physical performance is within design limits, **Risks** are communicated effectively and that **Controls** are implemented in a timely manner.

11.6.5 **Emergency Response Plans** shall clearly detail how the **Contractor** intends to interact with emergency services, safely and efficiently evacuate the construction site and minimise the potential for damage (or further damage) to the **Tunnel Works** and **Third Parties**.

11.6.6 **Risk Assessments** shall deal with specific **Risks** associated with the construction methods, plant, equipment and materials to be employed including fire related **Risks** associated with the working environment, construction methods, specific plant, material and equipment to be used in the construction of the works, having due regard to any **Local National Legislation** and/or **Local National Standards and/or Codes of Practice** relating to health and safety. **Risk Assessments** shall demonstrate that the **Risk Sources** and associated **Risks** involved in the construction process have been fully identified and assessed. The **Construction Stage Risk Register** shall demonstrate that **Method Statements** incorporate all **Controls** necessary to reduce the **Consequences** of identified **Risks** to acceptable levels.

11.6.7 The **Method Statements** and **Inspection and Test Plans** shall be integrated with both the **Design Assurance** and the **Instrumentation and Monitoring Plan** to ensure that the critical **Risks** and **Controls** are clearly identified and monitored.

11.6.8 The **Method Statements** and **Inspection and Test Plans** shall define the checking that will be carried out by the **Contractor**, the individuals responsible for the checking and at what intervals. Quality records shall be produced to demonstrate compliance with the contract requirements. Procedures for dealing with non-compliances shall be included.

11.6.9 The **Method Statements** shall identify what equipment and/or methods are intended to be used for the works and the criteria for selection of that method or equipment, particularly with regard to the **Risks** identified in the **Construction Stage**

Risk Register.

11.6.10 Where critical equipment or methods such as tunnel boring machines or ground freezing are to be used, a statement shall be prepared setting out the basis of the selection of the equipment or method with regard to operation, ground conditions, safety systems, maintenance, environmental monitoring, access, settlement, emergency procedures.

11.6.11 A register of approved signatories shall be maintained together with authority levels for all staff employed in the checking and certifying of **Inspection and Test Plans** and quality records.

11.7 MANAGEMENT SYSTEMS

11.7.1 Prior to commencement of construction, the **Contractor** shall provide the **Client** with a copy of their Health and Safety Plan, Quality Plan and Environmental Plan together with an overall **Management Plan** for the **Tunnel Works**. The **Management Plan** shall cross-reference the foregoing plans (and other project-specific plans as required by the contract) to avoid duplication but demonstrate that an integrated management approach is being adopted.

11.7.2 The **Management Plan** shall identify and demonstrate the systems the **Contractor** intends to use to manage and control the construction process with regard to the requirements of the contract. The **Management Plan** shall also demonstrate that the **Contractor** is working to current accepted best practice.

11.7.3 The **Contractor** shall provide the **Client** with an Audit Plan that demonstrates how they intend to audit the construction process with both internal and external audits.

11.7.4 The **Contractor** shall implement a regular management review of all systems and procedures to ensure continuing compliance with the requirements of the contract and shall update all procedures as necessary.

11 >> CONSTRUCTION STAGE

11.8 INDEPENDENT CONSTRUCTION SUPERVISION

11.8.1 The construction of the **Tunnel Works** shall be subject to **Construction Supervision** carried out by **Independent** individuals or organisations who are **Competent** in the nature, form and extent of the works being executed. **Construction Supervision** shall include oversight of the control and assurance processes employed by the **Contractor**.

11.8.2 **Construction Supervision** shall provide assurance that:

- a) the **Risks** identified in the **Construction Stage Risk Register** are addressed in the **Method Statements, Inspection and Test Plans and Instrumentation and Monitoring Plan**, and
- b) the **Controls** are managed and monitored during the **Construction Stage** to achieve the objective of 10.3.1.

11.8.3 The provision of adequate **Construction Supervision** should support the assessment of compliance with the requirements of the **Code**, the contract and/or **Third Party** requirements.

11.9 MANAGEMENT OF CHANGE

11.9.1 Any changes to the design and/or method of working which result in material change in **Risk** to the **Tunnel Works** or a **Third Party** shall be notified to the **Contract Insurers** as soon as possible.

11.9.2 All **Value Engineering** proposals submitted for approval to the **Client** shall include a statement setting out in full, the benefits of the proposals together with any disadvantages requiring adjustments to **Risk Assessments** and the **Risk Register**. Full specifications and drawings shall be prepared and approved by the **Client** before implementing any such changes.

11.9.3 All design changes or material changes to construction means and methods, whether instructed by the **Client** or introduced by the **Contractor**, shall be implemented only after reviewing and

revising as required the **Risk Assessments** to assess the effects and consequences of those changes.

11.9.4 Any modifications to safety critical equipment and/or procedures shall be undertaken only by **Competent** persons and shall be subject to a specific **Risk Assessment**.

11.9.5 Regular monitoring of ground conditions shall be undertaken and any significant changes from those envisaged by the design shall be reviewed with the **Designer**, the **Contractor** and the **Client**. The significance and potential impact of such changes in ground conditions shall be evaluated in relation to **Method Statements, Inspection and Test Plans, Instrumentation and Monitoring Plans, Emergency Response Plans and Risk Assessments**. The overall **Management Plan** and **Construction Stage Risk Register** shall be revised as necessary.

11.9.6 All changes in the construction process or design from that envisaged at commencement of the contract shall be identified, reviewed and the **Construction Stage Risk Register** revised as necessary.

>> APPENDIX A - DEFINITIONS AND TERMS USED IN THE CODE

Client

The final owner of the **Tunnel Works**. In the case of concession contracts the **Client** is the authority granting the concession.

Client's Representative

An individual, or company, that has been appointed by the **Client** to represent the interests of the **Client**. Where a **Client's Representative** has been appointed, all references to **Client** in the **Code** can be replaced by **Client's Representative**, as relevant.

Code

The Code of Practice for Risk Management of Tunnel Works, 3rd Edition.

Competence/Competent

The ability of individuals or organisations to effectively and efficiently carry out a task required by the project.

Consequence

Outcome of an **Event** affecting the **Tunnel Works, Third Parties**, the environment and/or the health and safety of associated personnel.

Constructability Review

A review of the design by **Competent** individuals to assess the practicality of constructing the design for the **Tunnel Works** including health and safety issues and impacts on **Third Parties**.

Construction Contract Procurement Stage

The stage of a project which involves the preparation and issue of **Contract Documentation** for tendering purposes following the selection or pre-qualification of **Contractors** for tendering and tender assessment.

Construction Stage Risk Register

A register that records all construction-related **Risks** identified for the **Construction Stage** and includes and identifies the construction-related **Risks** brought forward from the **Risk Registers** from previous **Project Stages**, the **Risk Owner** and **Controls** required to mitigate the impact of the identified

construction-related **Risks** on the **Tunnel Works**.

Construction Stage

The stage of a project that involves all aspects relating to the implementation of designs for completion of the works to the requirements of the **Client**.

Construction Supervision

The management process for checking construction compliance in accordance with the **Contract Documentation, Method Statements** and **Risk Management processes**.

Contract Award

The award of a construction contract to a principal **Contractor** by the **Client**.

Contract Documentation

Documentation that defines the scope of works, the nature, the **Form of Contract** (including drawings and specifications for the works), and the apportionment of **Risk** and payment mechanisms. This term shall extend to include subcontract documentation for all **Tunnel Works**.

Contract Insurers

The collective term for the providers of the **Contractors All Risk Insurance** and/or **Third Party Liability Insurance** for a **Tunnel Works** project. The **Contract Insurers** may be a single company, or a number of insurers operating in a co-insurance arrangement. In the instance of co-insurance there is likely to be a nominated Lead Insurer who will be the main point of contact for the **Insured**.

Contractor

The organisation appointed by the **Client** for the implementation for the **Tunnel Works**.

Contractors All Risks Insurance

Insurance purchased to cover the financial **Consequences** of physical loss or damage to the contract works (commonly referred to as 'CAR Insurance') and may include/allow for physical loss or damage to construction plant and equipment or machinery. In addition, it may also include cover for removal

of debris; architects, engineers or surveyors' fees; and expediting expenses. A 'CAR' policy may be effected by the **Client** or by the **Contractor** engaged for the work and can include all subcontractors. The cover typically begins at the start of the work except for items of construction plant and the like which are generally only covered after they have been unloaded at the site. The cover terminates when the completed project is handed over or any completed part is taken over or put into service. In respect of construction plant and the like, cover terminates when such equipment is removed from the site. A maintenance period, typically 12 months, can be incorporated in addition to the period of construction. The maintenance cover is for physical loss or damage to the works occurring during the defects liability or notification period stipulated in the provisions of the clauses in the contract relating to the works.

Control

An action or step taken that maintains and/or modifies **Risk**; a mitigation measure.

Design Assurance

The process of checking and certifying the design and verifying its implementation (during the **Construction Stage**), including compliance with all applicable codes, standards and project requirements.

Design Stage(s)

The stage or stages of a project which involve the preparation of preliminary and/or detailed designs for permanent and temporary works.

Design Statement

A document that details the method(s) of design, the parameters to be used in the design, the standards to be adhered to when undertaking the design.

Designer

The organisation appointed to carry-out the design of the works. Different **Designers** may be appointed for different elements of the works and stages of the design process. The **Designer** is typically a firm of consulting engineers but may be part of the **Contractor's** organisation.

>> APPENDIX A - DEFINITIONS AND TERMS USED IN THE CODE

Digital Model(s)

The virtual representation of the proposed and actual physical assets, places, and future developments that can be used to support the planning, design, procurement, construction, operation and maintenance of the **Tunnel Works**.

Event

An occurrence or change of circumstances. Something expected to happen that does not, or something unexpected that does. An **Event** can be a **Risk Source**.

Emergency Response Plan

A document outlining the roles and responsibilities required for rapid response to an **Event** with critical **Consequences** in order to mitigate the impact to personnel, the **Tunnel Works** or **Third Parties**. This should be drafted during the **Project Development Stage** (in conjunction with the emergency services where necessary) but shall be finalized and accepted by the **Client** (and emergency services) before construction commences. The plan should include, but not be limited to, an emergency escalation process for all contracting parties, the emergency services and other **Third Parties** as required.

Form of Contract

The contractual arrangement between the purchaser of services/goods and the provider of the services/goods.

Ground Reference Conditions

Definitive statements about the nature, form, composition and structure of the ground (both artificial and natural) and groundwater together with geotechnical properties of the ground which serve as a basis of foreseeability for construction contract tendering purposes and for the subsequent application of the contract with respect to a 'differing site conditions' clause and the conditions actually encountered during construction of the **Tunnel Works**. The **Ground Reference Conditions** represent a contractual definition of 'what is assumed will be encountered'. However, the provision of such Conditions in the contract is not

a warranty that the Conditions will be encountered. A Geotechnical Baseline Report is a typical example of **Ground Reference Conditions**.

Independent

Free from undue commercial constraints, influences or conflicts of interest and therefore able to provide entirely objective advice, guidance or support. To be **Independent** a party should be employed directly by and report to the **Client** and not by/to the **Designer** or **Contractor**.

Inspection and Test Plan

A description and definition of the methods and procedures to be used to maintain and check quality within the construction process

Instrumentation and Monitoring

Instruments, devices and systems used to monitor the response of the **Tunnel Works** and potentially impacted utilities, infrastructure and structures or other **Third Parties**.

Instrumentation and Monitoring Plan

A description and definition of the **Instrumentation and Monitoring** to be used, including their location, typology and the frequency, accuracy, reliability and reporting requirements, to monitor the physical performance of the design and its potential impact on the **Tunnel Works** and **Third Parties** relative to the limits set by the **Designer(s)**. The **Instrumentation and Monitoring Plan** shall be developed specifically for the selected method(s) of working and should include pre-defined trigger levels with actions and response plans to achieve the objective of Clause 10.3.1. Trigger levels should be developed specific to failure mechanisms, previous experience, operational response times and monitoring capability and in consideration of **Consequences** to **Tunnel Works, Third Parties**, personnel, equipment and the environment. The **Instrumentation and Monitoring Plan** shall be finalised and agreed by the **Designers, Contractors** and the **Client** before works commence.

Insurance Advisor

An organisation or individual appointed to procure and provide professional advice on insurance products on behalf of the **Client** or **Contractor**, typically an Insurance Broker.

Insured

The **Insured** is the collective nomenclature for the insured parties named in the Insurance Policy. This is likely to include the **Client** and the Principal **Contractor** and may include subcontractors and design professionals (for their on-site activities).

Insurer's Remedial Measures

Those measures required by **Contract Insurers** following identification of a breach of the **Code** to ensure subsequent compliance with the **Code**.

Key Personnel

Named staff identified by an organisation that are nominated to undertake important roles within the work scope required.

Local National Legislation

The legal and legislative framework applicable in the country, region or area in which **Tunnel Works** are to be carried out which give rise to statutory duties, responsibilities and requirements to **Clients** and/or **Contractors**.

Local National Standards and/or Codes of Practice

Standards and/or codes of practice for the design and implementation through construction of **Tunnel Works** which represent good practice, and which are applicable in the country, region or area in which the **Tunnel Works** are to be carried out.

Likelihood

In general terms, the chance of something happening, or in mathematical terms the probability of an **Event**.

Management of Risk

The demonstrable and auditable implementation of **Controls** identified on the **Risk Register** to deliver the required level of **Risk**.

>> APPENDIX A - DEFINITIONS AND TERMS USED IN THE CODE

Management Plan

A plan (or series of plans) that identifies and demonstrates the systems and procedures the **Contractor** will use to manage and control the construction process. The **Management Plan** should include, as a minimum, procedures for the management and control of Documents, Design (including design changes and variations), **Self-Certification** (where required), Procurement, Planning, Training, Emergency Response Procedures, Survey and Control and Calibration of Test and Inspection Equipment.

Method Statement

A document prepared in advance of undertaking design or construction work that details the methods to be utilised, the people required to undertake the work, the equipment required to undertake the work, and any supporting documentation necessary to undertake the work. In addition, the **Method Statement** will contain an assessment of the **Risks** that may be encountered when undertaking the work

Operational Stage

The stage of a project after completion of the works to the requirements of the **Client**.

Overall Management Organisation Chart

A project specific organisation chart that identifies reporting structures and lines of communication between the **Client**, the **Client's Representative**, the **Designer(s)** and the **Contractor(s)** and illustrates the arrangements for **Design Assurance**, **Independent Construction Supervision** and **Instrumentation and Monitoring** of the **Tunnel Works**.

Overall Site Organisation Chart

A site-specific organisation chart that identifies the reporting structure and lines of communication of **Key Personnel** and those persons nominated for safety critical work and **Self-Certification** (where required under the contract).

Pre-qualification

A process used by employers to assess prospective suppliers against pre-determined criteria.

Project Stages

All stages of a project being the **Project Development**, **Construction Contract Procurement**, **Design**, **Construction** and **Operational Stages**.

Project Development Stage

The stage of a project which includes project feasibility studies, initial site and ground investigations, and the assessment and evaluation of options including identification of a preferred option and **Form of Contract** for construction.

Residual Risk

Risk remaining after **Risk Treatment**.

Risk (s)

The effect of uncertainty upon the construction of the **Tunnel Works**, **Third Parties**, the environment and the health and safety of associated personnel. **Risk** should be expressed in terms of **Risk Sources**, potential **Events**, and their **Consequences** and **Likelihood**.

Risk Analysis

The process to understand the nature, sources and causes of **Risk** and to estimate the level of **Risk**.

Risk Assessment

The process of **Risk Identification**, **Risk Analysis** and **Risk Evaluation**.

Risk Evaluation

The process, following **Risk Analysis**, to determine whether the level of **Risk** is acceptable.

Risk Identification

Process of finding, recognizing and describing **Risks**.

Risk Management

The coordinated activities required to direct the scope, provide the context and define the criteria that will control the planning, design and construction of **Tunnel Works** in relation to **Risk**.

Risk Management Plan

A document that defines the scope,

context and criteria, and consequent process, that will be adopted in order to understand **Risks** to the **Tunnel Works** including the frequency of reviewing and updating the **Construction Stage Risk Register** and thereby identify, evaluate and control changes to the **Risk Profile** during the **Construction Stage** of the **Tunnel Works**. It should include a clear definition of the roles and responsibilities of **Risk Owners** and reporting structure should a **Risk Source** lead to an **Event**.

Risk Meeting

A meeting of **Competent** personnel to conduct **Risk Assessment** and/or review **Risk Registers** and/or monitor **Controls** or any other **Risk Management** activities. Attendees should be selected to provide a sufficient level and diversity of knowledge and experience as is required for the **Project Stage** and nature of the **Tunnel Works**.

Risk Owner

The named individual identified on the **Risk Register** as responsible for the **Controls** associated with any specific **Risk**.

Risk Profile

An assessment of the **Residual Risks** at any point in time during **Tunnel Works** which potentially impact on the outcome of the project.

Risk Register

A formalised record of **Risks** identified from the **Risk Assessment** process including full descriptive details of **Risk Sources** and Controls, identification of the **Risk Owner**, and the critical dates for completion of actions, and a record when required actions have been completed. A **Risk Register** is the means of recording and monitoring the **Risk Management** process. A **Risk Register** shall be developed for each **Project Stage** (e.g. **Construction Contract Procurement** (Tender) **Stage Risk Register**, **Design Stage Risk Register**, **Construction Stage Risk Register**). For the sake of brevity, the **Construction Contract Procurement Stage Risk Register** is referred to as the **Tender Stage Risk Register**.

>> APPENDIX A - DEFINITIONS AND TERMS USED IN THE CODE

Risk Source(s)

Element which alone or in combination has the potential to give rise to **Risk**, in relation to downside **Risk** (negative **Consequences**), a **Risk Source** is a hazard.

Risk Treatment

Process to modify **Risk**.

Self-Certification

A Quality Assurance process whereby the **Contractor** self-inspects and certifies that the Works are compliant with the design and contract requirements.

Third Party /Parties

A party that is affected by the actions of two other parties that are in a contractual relationship.

Third Party Liability Insurance

Insurance purchased to cover the financial **Consequences** of damage to third party property or bodily injury to third parties arising from the performance of the contract.

Tunnel Advisory Board

A multi-disciplinary panel of **Competent** expert practitioners that provides **Independent** oversight on the planning, design and construction of the **Tunnel Works**.

Tunnel Works

Tunnels, caverns, shafts and associated underground structures howsoever constructed and including the renovation of existing underground structures.

Value Engineering

The process of adding value to a project (by for example reducing cost and/or time) during the design and construction process.

>> APPENDIX B - SCHEDULE OF DELIVERABLES

SCOPE OF THE CODE

CLAUSE	DELIVERABLE	PRIMARY RESPONSIBILITY	SCOPE AND INTENT
6.8	Schedule of applicable statutory legislative requirements, Standards and/or Codes of Practice.	Client	To confirm the legislative requirements, Standards and Codes that will apply during the Tunnel Works .

RISK, RISK ASSESSMENT AND RISK MANAGEMENT

CLAUSE	DELIVERABLE	PRIMARY RESPONSIBILITY	SCOPE AND INTENT
4.2.5	Risk Meeting agenda and minutes (accompanied by new or revised Risk Registers).	According to Project Stage	To confirm that sufficient resources have been employed in the identification and assessment of Risk Sources and associated Risks during each Project Stage .

DIGITAL MODELS

CLAUSE	DELIVERABLE	PRIMARY RESPONSIBILITY	SCOPE AND INTENT
6.1	Digital Model (strategy and integration)	Client	To confirm the scope of the Digital Model(s) and that they will be an inherent part of the project and Risk Management of the Tunnel Works .

CLIENT ROLE AND RESPONSIBILITIES

CLAUSE	DELIVERABLE	PRIMARY RESPONSIBILITY	SCOPE AND INTENT
7.4	Design Assurance Plan	Client/Designer	To confirm the integration of Independent design verification, Instrumentation and Monitoring requirements and Construction Supervision .
7.5	Construction Supervision Plan	Client	To assess how the Client will ensure sufficient Independent Construction Supervision of the construction process.
7.11	Overall Management Organisation Chart (with associated Curricula vitae of Key Personnel)	Client	To assess the reporting structures and lines of communication between the project parties and confirm the Competence of Key Personnel .

PROJECT DEVELOPMENT STAGE

CLAUSE	DELIVERABLE	PRIMARY RESPONSIBILITY	SCOPE AND INTENT
8.2.4	Site Investigation - Factual Reports	Client	To assess the range of ground conditions and obtain an understanding of the scope and extent of investigations and testing carried out.
8.3.3	Risk Assessments of Project Options	Client	To confirm that Risks associated with project options have been assessed and that the design is capable of safe and efficient construction.
8.4.1	Risk Register for preferred project option.	Client	To verify that Risk Assessments associated with the preferred project option have been formalised in a Risk Register that can be shared with other stakeholders in subsequent Project Stages .

>> APPENDIX B - SCHEDULE OF DELIVERABLES

CONSTRUCTION CONTRACT PROCUREMENT STAGE			
CLAUSE	DELIVERABLE	PRIMARY RESPONSIBILITY	SCOPE AND INTENT
9.2.3 to 9.2.5	Contract Documentation	Client	To assess extent of information supplied to tenderers including disclosure of Risk Sources and associated Risks identified during the Project Development Stage .
9.2.5 to 9.2.8	Ground Reference Conditions	Client and/or Tenderers	To assess the contractual allocation of geotechnical Risks arising from the identified site and ground conditions.
9.2.9	Key Method Statements	Tenderers	To assess construction methods, materials and plant identified by tenderers.
9.2.10	Risk Assessments	Tenderers	To assess tenderers' awareness and preparedness for Risks and to confirm that Risk Sources and associated Risks involved in the construction works have been fully identified and assessed for inclusion in the Tender Stage Risk Register .
9.5.1	Tender Stage Risk Register	Tenderers	To understand how the tender submission assesses the Risks of the Tunnel Works and how these will be managed during the Construction Stage .
9.5.2	Emergency Response Plans	Tenderers	To assess tenderers' preparedness to implement a timely systematic response to critical Consequence Events .

DESIGN STAGES			
CLAUSE	DELIVERABLE	PRIMARY RESPONSIBILITY	SCOPE AND INTENT
10.1.4	Design Brief	Client / Contractor	To confirm that the scope of works is clearly defined.
10.3.3 f)	Design Stage Risk Register(s)	Designer	To verify that Risk Assessments associated with the design have been formalised in Risk Registers that can be shared with other stakeholders in subsequent Project Stages .
10.3.3 h)	Instrumentation and Monitoring Plan	Client/Designer	To understand how the physical performance of the works will be monitored to verify and validate assumptions in the design.
10.3.8	Schedule of Third Party Infrastructure	Designer	To confirm that all Third Party assets at risk from the Tunnel Works have been identified.
10.5	Constructability Reviews	Designer	To confirm that assessments of the safety and constructability of the design have been carried out taking account of Risk Sources such as ground conditions and Third Party infrastructure.

>> APPENDIX B - SCHEDULE OF DELIVERABLES

CONSTRUCTION STAGE			
CLAUSE	DELIVERABLE	PRIMARY RESPONSIBILITY	SCOPE AND INTENT
11.2.1 a)	Risk Management Plan	Contractor	To confirm that the scope, context and criteria, and consequent process, that will be used to control Risks during construction have been defined and documented.
11.2.1 f)	Instrumentation and Monitoring Plan	Contractor	To understand how the physical performance of the works will be monitored to verify and validate assumptions in the design.
11.3.1	Construction Stage Risk Register	Contractor	To confirm how the Contractor intends to manage the Risks of the Tunnel Works during the Construction Stage including risks identified by the Contractor as well as construction-related risks brought forward from the Tender and Design Stage Risk Registers .
11.3.5	Emergency Response Plans	Contractor	To confirm the Contractor's preparedness to implement a timely systematic response to critical Consequence Events .
11.4.1	Overall Site Organisation Chart	Contractor	To understand the organisational Competence , availability and reporting structure of Key Personnel including persons nominated for safety critical work.
11.4.4	Training Plan	Contractor	To confirm how the Contractor intends to ensure all staff are and will remain Competent for the positions and responsibilities that they are to hold.
11.6.2	Method Statements	Contractor	To confirm safe and efficient working methods and plant, materials and level of labour are planned to be used taking account of the project and design requirements and Risk Sources .
11.6.3	Inspection and Test Plans	Contractor	To confirm the integration of quality, Design Assurance and Construction Supervision during construction (see section 10.6.7).
11.6.6	Risk Assessments	Contractor	To confirm that Risk Sources and associated Risks involved in the construction works have been fully identified and assessed for inclusion in the Construction Stage Risk Register .
11.6.10	Plant Selection Criteria	Contractor	To understand the key plant and its maintenance regime e.g. level of spares, frequency of inspection, Maintenance staff (to be included in Method Statements).
11.7.1	Management Plan	Contractor	To understand the systems the Contractor intends to use to manage and control the construction process, to confirm that an integrated management approach will be adopted and to verify that the Contractor is working to current accepted best practice.
11.7.3	Audit Plan	Contractor	To assess the Contractor's approach to internal and external auditing of the construction process and the Risk Management process.
11.9.2	Value Engineering Proposals	Designer and Contractor	To understand and assess options to optimise the Tunnel Works in accordance with the Risk Management objectives for the project, including assessment against the project risk criteria and amendments to the design, including any alternative construction methods and associated Risk Assessments .

