PROFESSIONAL PRACTICE GUIDELINES

BUILDINGS

ENGINEERING SERVICES FOR TEMPORARY STRUCTURES: FORMWORK, FALSEWORK, AND RESHORE

VERSION 1.0
PUBLISHED AUGUST 11, 2021

ENGINEERS &
GEOSCIENTISTS
BRITISH COLUMBIA

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PREFACE

These *Professional Practice Guidelines – Engineering Services for Temporary Structures: Formwork, Falsework, and Reshore* were developed by Engineers and Geoscientists British Columbia to guide professional practice for Engineering Professionals who carry out the practice of structural engineering as it relates to the design and field review of Formwork, Falsework, and Reshore for structures.

These guidelines address the roles and responsibilities of Engineering Professionals in this area of practice, and discuss the level of service required when providing design and field engineering services for these types of Temporary Structures. These guidelines also clarify the services that must be provided for these projects, in order to meet the requirements of the WorkSafeBC *Occupational Health and Safety Regulation,* as well as the professional standards and Bylaws of Engineers and Geoscientists BC, under the *Professional Governance Act*.

These guidelines were first published in 2021, and were developed in consultation with WorkSafeBC to provide clarification for Engineering Professionals who provide design and field services related to Formwork, Falsework, or Reshore structures.

These guidelines describe the expectations and obligations of professional practice to be followed at the time they were prepared. However, this is a living document that is to be revised and updated as required in the future, to reflect the developing state of practice.

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ABBREVIATIONS

ABBREVIATION	TERM
BC	British Columbia
CSA	Canadian Standards Association
OHSR	*Occupational Health and Safety Regulation*
SER	Structural Engineer of Record

DEFINED TERMS

TERM	DEFINITION
Act	*Professional Governance Act* [SBC 2018], Chapter 47.
Application Drawings	Drawings for a project which contain the information necessary for the layout and assembly, and may include erection and dismantling, of the forms, Falsework, and the related components and equipment. (Note: The drawings are also referred to as Erection Drawings or Assembly Drawings)
Approved Drawings	Application Drawings that have been reviewed, sealed, and dated and signed by an Engineering Professional. These drawings are not permitted to be revised without approval of the Engineering Professional.
Assembly Drawings	See Application Drawings.
Authority Having Jurisdiction	The jurisdictional body (usually municipal) with authority to administer and enforce the *British Columbia Building Code* (*BCBC*), the City of Vancouver Building By-law (VBBL), the *National Building Code of Canada* (*NBC*), or a local building bylaw or code, as well as government agencies that regulate a particular function in a building or in a building process.
Bylaws	The Bylaws of Engineers and Geoscientists BC made under the *Act*.
Coordinating Registered Professional	Defined in the *British Columbia Building Code* as a Registered Professional retained to coordinate all design work and Field Reviews of the Registered Professionals who are required for a project.
Design Engineer	The Engineering Professional typically responsible for providing professional services during the design stage of a Formwork, Falsework, and/or Reshore project.
Designer	A person tasked with the preparation of Application Drawings.
Engineering Professional(s)	Professional engineers, professional licensees engineering, and any other individuals registered or licensed by Engineers and Geoscientists BC as a "professional registrant" as defined in Part 1 of the Bylaws.
Engineers and Geoscientists BC	The Association of Professional Engineers and Geoscientists of the Province of British Columbia, also operating as Engineers and Geoscientists BC.
Erection Drawings	See Application Drawings.
Falsework	Any Temporary Structure used to support a permanent structure during construction until the permanent structure is capable of being self-supported.
Field Engineer	The Engineering Professional typically responsible for providing professional services during the field review stage of a Formwork, Falsework, and Reshore project.

TERM	DEFINITION
Flyforms	Large, prefabricated, mechanically handled sections of Formwork designed for multiple reuse; frequently including supporting truss, beam, or shoring assemblies completely unitized. (Note: Also called “fly tables.”)
Formwork	The total system of support for freshly placed concrete, including the mould or sheathing, supporting members, hardware, and necessary bracing, but excluding the Falsework.
General Contractor	The organization, firm, partnership, or corporation who undertakes to construct and manage a construction project based on a contractual relationship with the owner.
Professional of Record	The Engineering Professional who is professionally responsible for professional work, professional activities, and documents related to an engineering discipline for a project.
Registrant	Means the same as defined in Schedule 1, section 5 of the *Act*.
Registered Professional	An Engineering Professional or a person who is registered or licensed to practice as an architect under the *Architects Act* [RSBC 1996], Chapter 17.
Reshore	Shores placed snugly under a stripped concrete slab or other structural member after the original forms and shores have been removed from a large area, requiring the new slab or structural member to deflect and support its own weight and any existing construction loads applied before installation of the Reshore.
Structural Drawings	Drawings containing the information that is necessary to describe the structural design of the permanent structure.
Structural Engineer of Record	The Professional of Record with general responsibility for the structural integrity of the primary structural system under construction.
Subcontractor	The organization, firm, partnership, corporation, or individual obligated under a contract with the General Contractor to carry out the installation of the Formwork, Falsework, Reshore, or a combination.
Temporary Structure	A building or structure that is not intended to remain in place for a period of more than 180 days in any consecutive 12-month period.

VERSION HISTORY

VERSION NUMBER	PUBLISHED DATE	DESCRIPTION OF CHANGES
1.0	August 11, 2021	Initial version.

1.0 INTRODUCTION

Engineers and Geoscientists British Columbia is the regulatory and licensing body for the engineering and geoscience professions in British Columbia (BC). To protect the public, Engineers and Geoscientists BC establishes, monitors, and enforces standards for the qualification and practice of its Registrants.

Engineers and Geoscientists BC provides various practice resources to its Registrants to assist them in meeting their professional and ethical obligations under the *Professional Governance Act (*the *Act*) and Engineers and Geoscientists BC Bylaws (Bylaws). Those practice resources include professional practice guidelines, which are produced under the authority of Section 7.3.1 of the Bylaws and are aligned with the Code of Ethics Principle 4.

Each professional practice guideline describes the expectations and obligations of professional practice that all Engineering Professionals are expected to have regard for in relation to specific professional activities. Engineers and Geoscientists BC publishes professional practice guidelines on specific professional services or activities where additional guidance is deemed necessary. Professional practice guidelines are written by subject matter experts and reviewed by stakeholders before publication.

Having regard for professional practice guidelines means that Engineering Professionals must follow established and documented procedures to stay informed of, be knowledgeable about, and meet the intent of any professional practice guidelines related to their area of practice. By carefully considering the objectives and intent of a professional practice guideline, an Engineering Professional can then use professional judgment when applying the guidance to a specific situation. Any deviation from the guidelines must be documented and a rationale provided. Where the guidelines refer to professional obligations specified under the *Act*, the Bylaws, and other regulations/legislation, Engineering Professionals must understand that such obligations are mandatory.

Temporary Structures are often required during the construction, renovation, or demolition of buildings and structures. Three specific types of Temporary Structures are used in the construction of concrete buildings and structures: Formwork, Falsework, and Reshore. Sometimes, more than one type of structure is used together.

Formwork, Falsework, and Reshore are used during the construction, alteration, and repair of structures. Formwork is intended to provide temporary containment of freshly placed concrete. Falsework is intended to provide temporary vertical support for structures during their construction, alteration, or repair. Reshore provides for redistribution of live loads in concrete structures during the curing process after Formwork has been removed.

Formwork, Falsework, and Reshore are considered Temporary Structures, but similar care and precision must be applied to their design and construction as is applied to permanent structures. Faulty design or construction of Formwork, Falsework, and Reshore can impact the integrity of the permanent structure and can result in the partial or total collapse of the Temporary Structures, with the potential to greatly compromise the safety of workers and the public. As such, an appropriate level of attention must be given to the engineering design and constructability of Formwork, Falsework, and Reshore.

These *Professional Practice Guidelines –Engineering Services for Temporary Structures: Formwork, Falsework, and Reshore* provide guidance on professional practice for Engineering Professionals who practice in the engineering of Formwork, Falsework, and Reshore for building projects.

1.1 PURPOSE OF THESE GUIDELINES

This document provides guidance on professional practice to Engineering Professionals who provide professional services related to Formwork, Falsework, and Reshore for concrete building projects.

These guidelines outline basic requirements, procedures, and obligations for Engineering Professionals who perform professional services related to Formwork, Falsework, and Reshore structures. Engineering Professionals may perform various roles in these projects; however, the specific professional roles considered for these guidelines are the Design Engineer and the Field Engineer.

The tasks for each role may be completed by the same Engineering Professional, but also may be tasked out to multiple individuals. Other roles related to such projects, such as the General Contractor, Subcontractor, and equipment supplier, are discussed in these guidelines to provide context.

The purpose of these guidelines is to provide a common approach for carrying out a range of professional activities related to this work.

Following are the specific objectives of these guidelines:

1. Describe the expectations and obligations of professional practice that Engineering/Geoscience Professionals are expected to have regard for in relation to the specific professional activity outlined in these guidelines by:
   - specifying tasks and/or services that Engineering Professionals should complete; and
   - referring to professional obligations under the Act, the Bylaws, and other regulations/legislation, including the primary obligation to protect the safety, health, and welfare of the public and the environment; and
   - describing the established norms of practice in this area.
2. Describe the roles and responsibilities of the various participants/stakeholders involved in these professional activities. The document should assist in delineating the roles and responsibilities of the various participants/stakeholders, which may include the Design Engineer, Field Engineer, General Contractor, Subcontractor, equipment supplier, owner, and Structural Engineer of Record.
3. Define the skill sets that are consistent with the training and experience required to carry out these professional activities.
4. Provide guidance on the use of assurance documents, so the appropriate considerations have been addressed (both regulatory and technical) for the specific professional activities that were carried out.
5. Provide guidance on how to meet the quality management requirements under the Act and the Bylaws when carrying out the professional activities identified in these professional practice guidelines.

Appendix A: Legislative Requirement outlines the legislative requirements for overseeing this area of practice.

1.2 ROLE OF ENGINEERS AND GEOSCIENTISTS BC

These guidelines form part of Engineers and Geoscientists BC's ongoing commitment to maintaining the quality of professional services that Engineering Professionals provide to their clients and the public.

Engineers and Geoscientists BC has the statutory duty to serve and protect the public interest as it relates to the practice of professional engineering, including regulating the conduct of Engineering Professionals. Engineers and Geoscientists BC is responsible for establishing, monitoring, and enforcing the standards of practice, conduct, and competence for Engineering Professionals. One way that Engineers and Geoscientists BC exercises these responsibilities is

by publishing and enforcing the use of professional practice guidelines, as per Section 7.3.1 of the Bylaws.

Guidelines are meant to assist Engineering Professionals in meeting their professional obligations. As such, Engineering Professionals are required to be knowledgeable of, competent in, and meet the intent of professional practice guidelines that are relevant to their area of practice.

The writing, review, and publishing process for professional practice guidelines at Engineers and Geoscientists BC is comprehensive. These guidelines were prepared by subject matter experts and reviewed at various stages by a formal review group, and the final draft underwent a thorough consultation process with various advisory groups and divisions of Engineers and Geoscientists BC. These guidelines were then approved by Council and, prior to publication, underwent final editorial and legal reviews.

Engineers and Geoscientists BC supports the principle that appropriate financial, professional, and technical resources should be provided (i.e., by the client and/or the employer) to support Engineering Professionals who are responsible for carrying out professional activities, so they can comply with the professional practice expectations and obligations provided in these guidelines. These guidelines may be used to assist in the level of service and terms of reference of an agreement between an Engineering Professional and a client.

1.3 INTRODUCTION OF TERMS

See the Defined Terms section at the front of the document for a full list of definitions specific to these guidelines.

1.4 SCOPE AND APPLICABILITY OF THESE GUIDELINES

These guidelines provide guidance on professional practice for Engineering Professionals who carry out the practice of structural engineering as it relates to the design and field review of Formwork, Falsework, and Reshore for structures. These guidelines are not intended to provide technical or systematic instructions for how to carry out these activities; rather, these guidelines outline considerations to be aware of when carrying out these activities. Engineering Professionals must exercise professional judgment when providing professional services; as such, application of these guidelines will vary depending on the circumstances.

These guidelines outline the engineering services that should typically be provided by the Design Engineer and the Field Engineer roles that are engaged on Formwork, Falsework, and Reshore projects. These guidelines specify tasks that comprise both the design stage and field stage of such projects.

Although these guidelines may provide thresholds above which professional involvement is specified as being required, Engineering Professionals must always use their professional knowledge, experience, and judgment to apply the appropriate level of service that is commensurate with the risk of their professional activities to public safety and/or the environment.

An Engineering Professional's decision not to follow one or more aspects of these guidelines does not necessarily represent a failure to meet professional obligations. For information on how to appropriately depart from the practice guidance within these guidelines, refer to the *Quality Management Guides -- Guide to the Standard for the Use of Professional Practice Guidelines* (Engineers and Geoscientists BC 2021a), Section 3.4.2.

These guidelines are related only to the engineering services that are provided for Formwork, Falsework, and Reshore structures and do not include:

- engineering services related to the design of the permanent structure, including field review of the constructed permanent structures;
- engineering services for items covered in the *Occupational Health and Safety Regulation* (*OHSR*) Section 13 (Ladders, Scaffolds, and Temporary Work Platforms), and the otherwise unrelated provisions in Section 20;
- details regarding the construction methods and processes employed by contractors; and
- quality control or construction supervision activities that are provided by a qualified supervisor.

These guidelines also address the regulatory concerns that relate to this scope of work, particularly with respect to the requirements of the *OHSR*. In particular, the document describes the professional services that are associated with the generation of Approved Drawings and the issuance of a prior-to-pour inspection certificate.

The approaches outlined and the standard of practice identified in these guidelines recognize industry practices with respect to the use of proprietary Formwork, Falsework, and Reshore equipment, and appropriately reflect the roles of the Design Engineer and Field Engineer when the project delivery involves the use of such equipment. Specific technical approaches that are developed for one particular proprietary system will not necessarily be applicable to other systems. Therefore, these guidelines do not provide a prescriptive step-by-step approach to such projects; rather, they discuss the standard of practice that Engineering Professionals should meet when producing Approved Drawings or conducting field reviews, and which fulfills Engineering Professionals' obligations under the quality management and ethical standards that apply to their practice. These obligations include an Engineering Professional's primary duty to protect the safety, health, and welfare of the public and the environment.

Some of the principles reflected in these guidelines may be relevant to other associated work such as shoring during demolition. However, while the principles contained in these guidelines may inform related activities, these guidelines are not directly applicable to such work.

1.5 ACKNOWLEDGEMENTS

This document was reviewed by a group of technical experts, as well as by various advisory groups and divisions of Engineers and Geoscientists BC. Authorship and review of these guidelines does not necessarily indicate the individuals and/or their employers endorse everything in these guidelines.

Engineers and Geoscientists BC would like to thank WorkSafeBC for their input to these guidelines.

2.0 ROLES AND RESPONSIBILITIES

2.1 COMMON FORMS OF PROJECT ORGANIZATION

Project organization will vary according to the needs of the particular project and the parties involved. Following are examples of different organizational structures for Formwork, Falsework, and Reshore projects:

- The Designer, Design Engineer, and Field Engineer are with the same organization.
- The Designer and Design Engineer are with the same organization, and the Field Engineer is from a separate organization.
- The Designer is from a separate organization, and the Design Engineer and Field Engineer are with the same organization.
- The Designer, Design Engineer, and Field Engineer are all from separate organizations.

See Section 2.2 Responsibilities for discussion of the roles and responsibilities of the various parties involved, and Appendix C: Common Project Organizational Structures for related examples of organizational charts.

2.2 RESPONSIBILITIES

The following sections outline the responsibilities of various potential project team members for Formwork, Falsework, and Reshore projects. Specific roles include the owner, Structural Engineer of Record (SER), General Contractor, Subcontractor, equipment supplier, Design Engineer, Designer, and Field Engineer. Responsibilities for the professional engineering roles may be completed by the same Engineering Professional, but also may be tasked out to multiple individuals.

Depending on the project, the Design Engineer specialized in Formwork, Falsework, and Reshore design may be hired by one of the project team members identified above; for example, the General Contractor, Subcontractor, or equipment supplier.

The responsibilities of the SER, General Contractor, and Subcontractor are discussed here, to provide clarification of what is expected of the individuals carrying out these roles.

The responsibilities of the roles noted in the following sections are typical but may be modified for a particular project. Nevertheless, it is essential for each Formwork, Falsework, and/or Reshore project that the professional tasks, as outlined in these roles and responsibilities and further described in Section 3.3 Basic Engineering Services, are assigned explicitly to the Engineering Professional(s) involved on the project. This should be done formally in the contracts that define the scope of work for each Engineering Professional engaged on the project.

See also Appendix C: Common Project Organizational Structures for examples of common project execution models.

2.2.1 OWNER

The owner could be a registered owner, trustee, receiver, mortgagee in possession, tenant, lessee, or occupier of a project site, and/or a person who acts for or on behalf of an owner as an agent or delegate.

The responsibilities of the owner include:

- hiring the project team, including the Coordinating Registered Professional, the SER for the permanent structure, and the General Contractor;
- ensuring that appropriate scopes of work and contracts are developed and finalized that describe the work to be performed by the hired parties;

- ensuring that the project has adequate financing, including reasonable contingency funds; and
- recognizing that reasonable changes to project specifics may occur during the design and construction phases of the project, and working with the project professionals and Authorities Having Jurisdiction to approve such changes.

2.2.2 STRUCTURAL ENGINEER OF RECORD

The SER is hired to complete the structural design and drawings of the permanent structure in preparation for construction. It is recommended that the SER prepares a written contract for services with the client, and that the contract provides the SER's role and responsibilities along with those of the client.

The SER is responsible for completing the Structural Drawings and providing any updates to the General Contractor in a timely manner and consistent with any relevant provisions specified in the contract for services. The Structural Drawings must have all pertinent information included such that the Designer and Design Engineer can design the Formwork, Falsework, and/or Reshore with minimal further clarification. The SER's responsibilities are described in detail in the *Professional Practice Guidelines – Structural Engineering Services for Part 3 Building Projects* (Engineers and Geoscientists BC 2019).

It is recommended that the Design Engineer and Field Engineer for the Formwork, Falsework, and/or Reshore be able to consult with the SER and discuss the SER's design throughout all stages of the project.

2.2.3 GENERAL CONTRACTOR

The General Contractor is the organization, firm, partnership, or corporation who undertakes to construct and manage a construction project based on a contractual relationship with the owner. This contract typically states that the General Contractor is responsible for the labour, materials, and equipment for the building project, as well as the construction methods, techniques, sequences, procedures, coordination of workplace health and safety, and programs associated with the construction, as set out in the contract documents.

The General Contractor is responsible for providing the latest information from the SER and architect to the Subcontractor in a timely manner. The continuity between design and construction, and the associated teams and organizations, is the responsibility of the General Contractor.

The General Contractor, in collaboration with the Coordinating Registered Professional, is responsible for ensuring continuity of design, construction, inspection, and field review, in the event of a change of Engineering Professional or if multiple Engineering Professionals are involved.

2.2.4 SUBCONTRACTOR

The Subcontractor is the organization, firm, partnership, corporation, or individual obligated under a contract with the General Contractor to carry out the installation of the Formwork, Falsework, and/or Reshore.

The Subcontractor is responsible for providing the Designer and Design Engineer with the necessary information to create the Application Drawings, as determined in coordination with the Design Engineer in the execution of the activities listed in Section 3.3.2 Design Stage.

The Subcontractor is responsible for informing the Designer, Design Engineer, and/or Field Engineer, as appropriate, of any portion of the Formwork, Falsework, and/or Reshore that cannot be erected as designed due to site conditions or other reasons, and for requesting that the appropriate Engineering Professional provide a redesign for that portion of the Formwork, Falsework, and/or Reshore. Approved Drawings documenting the design must be available on site for use by the General Contractor and Engineering Professional(s) before and during placement of concrete, and must be updated as soon as is practicable in consultation with an Engineering Professional when any changes are made.

The Subcontractor must ensure that the concrete Formwork, Falsework, and/or Reshore is inspected, and that an engineering document confirming compliance of the Formwork to the Approved Drawings is issued by an Engineering Professional and is available on site, prior to the concrete pour.

2.2.5 EQUIPMENT SUPPLIER

The equipment supplier is the organization contracted to supply the equipment to be used to withstand the loads imposed by freshly placed concrete. Note that in some cases an Engineering Professional employed by an equipment supplier may act as the Design Engineer and/or Field Engineer on a Formwork, Falsework, and/or Reshore project.

The equipment supplier must supply all relevant information relating to the equipment being furnished to the Contractor, Designer, and Design Engineer, including such items as erection instructions, procedures, safety rules, and load capacities.

2.2.6 DESIGN ENGINEER

The Design Engineer is responsible for the development of the Application Drawings in accordance with Section 3.0 Guidelines for Professional Practice of these guidelines, or for reviewing the Application Drawings prepared by the Designer in a manner that allows the Design Engineer to seal and take full responsibility for the Approved Drawings.

The level of review required to take responsibility for the Application Drawings is identified in Clause 3.5.1 of the *Quality Management Guides – Guide to the Standard for the Authentication of Documents* (Engineers and Geoscientists BC 2021b). The design must also be in accordance with the standard CSA S269.1-16, Falsework and Formwork, and with the WorkSafeBC *Occupational Health and Safety Regulation* (*OHSR*).

The Design Engineer must:

- review the structural and architectural drawings to assess the necessary professional services;
- be aware of any and all expected site conditions, including limitations that may affect the professional services being provided;
- note the design criteria and assumptions applicable on the Approved Drawings, and either list such items in general notes attached to the Approved Drawings or on the drawings themselves;
- design in a manner that is consistent with the standard of practice identified in Section 3.0 of these guidelines;
- consider any identified loading patterns, particularly those noted by the SER, that place unusual effects on the Temporary Structure during construction (for example, irregular loading with extended cantilevers, unusual construction loads, or walls above that are not self-supporting);
- ensure that the Application Drawings are clear, concise, and easy to understand such that they convey all necessary design requirements and installation details to permit the safe, accurate, and correct erection of the Temporary Structures as noted on the drawings;
- liaise with the Designer who prepared the Application Drawings on an as-needed basis (see Section 2.2.6.1 Designer Role); and
- apply the necessary changes to the Approved Drawings as field changes, in coordination with the Field Engineer.

The Design Engineer is ultimately responsible for all aspects of the Application Drawings. As such, the Design Engineer must fully understand the Application Drawings and how they relate to the structural and architectural drawings, prior to sealing those drawings.

The Application Drawings must include a confirmation that the Temporary Structure design is:

- in accordance with CSA S269.1-16 and the *OHSR*; and
- coordinated with the issued for construction architectural and Structural Drawings; and
- notes the specific version of drawings used as the basis of design.

The Design Engineer must ensure that there is a complete load path for all loads expected to be placed on the system, as noted on the Application Drawings, and must also ensure that the design criteria are clearly noted on the Application Drawings.

The Design Engineer is responsible for ensuring that loads imparted by Temporary Structures during construction do not exceed the capacity of other structures that they are bearing upon to accommodate such loading. This assessment can be provided by the Design Engineer, by a specialist engaged by the Design Engineer, or by coordinating with other professionals such as the SER for the permanent structure.

Once all of the above are complete, the Design Engineer must seal, date, and sign the Application Drawings, which then become Approved Drawings.

The Design Engineer, if not further engaged to act as the Field Engineer, may provide recommendations to their client regarding persons who could be engaged as the Field Engineer to review the construction of the designs in the Approved Drawings. The Design Engineer should also inform the client of the potential consequences if a professional who is not competent in this practice area is engaged as the Field Engineer.

2.2.6.1 Designer Role

In some project delivery models, the preparation of the Application Drawings containing the information necessary for the layout and assembly of the Formwork, Falsework, and/or Reshore may be assigned to a Designer who is relatively independent of the Design Engineer. In such cases, the Designer prepares the Application Drawings for review and authentication by the Design Engineer. The drawings subsequently issued by the Design Engineer are considered the Approved Drawings.

The Designer is not necessarily under the direct supervision of the Design Engineer. Where the Design Engineer does not directly supervise the Designer, the Design Engineer must still meet the requirements described in the *Quality Management Guides – Guide to the Standard for the Authentication of Documents* (Engineers and Geoscientists BC 2021b). Specifically, per Section 3.5 of that guide, the Design Engineer must undertake a review of documents produced by the Designer at a level comparable to that required to prepare the Application Drawings.

2.2.7 FIELD ENGINEER

The Field Engineer is an Engineering Professional who provides field review services related to the Formwork, Falsework, and Reshore, as per the Approved Drawings. The Field Engineer may or may not be the same person as the Design Engineer.

The Field Engineer is responsible for determining that the installed Temporary Structures are in conformance with the layout, specifications, and instructions in the Approved Drawings. In the case of nonconformances, the Field Engineer is responsible for ensuring the resolution of those nonconformances prior to issuing a pre-pour certificate.

The Field Engineer is responsible for issuing a field review report in accordance with Section 3.3.3 Field Review Stage. The Field Engineer should:

- be familiar with the Approved Drawings and their intent;
- be aware of any and all site conditions that may affect the Approved Drawings, and which can result in the issue of revised Approved Drawings (see Section 3.3.3.1 Field Conditions and Status of the Approved Drawings);
- have comprehensive knowledge of the equipment being used, including its limitations;
- ensure that the erection of the equipment on site substantially conforms to that noted on the Approved Drawings, through the execution Field Review services (see Section 3.3.3 Field Review Stage);
- provide a field review report outlining the findings of the field review, including any equipment or equipment layout modifications completed on site (see Section 3.3.3.10 Field Review Reports); and
- sign, seal, and date the prior-to-pour field review report and inspection certificate.

3.0 GUIDELINES FOR PROFESSIONAL PRACTICE

3.1 OVERVIEW

This section outlines the professional services that Design Engineers and Field Engineers usually provide when engaged on Formwork, Falsework, and/or Reshore projects. These outlines may also assist Design Engineers and Field Engineers in explaining their services to clients.

These outlines are not intended to be exhaustive, and professional services for Formwork, Falsework, and/or Reshore projects may include, but are not limited to, the services and activities described here.

3.1.1 CONSIDERATION OF RISK

Design Engineers and Field Engineers have a professional responsibility to uphold the principles outlined in the Engineers and Geoscientists BC Code of Ethics, including protection of public safety and the environment. As such, the Professional of Record must use a documented approach to identify, assess, and mitigate risks that may impact public safety or the environment when providing professional services.

Areas of risk encountered in professional practice are quality, technical, financial, and commercial risks, and risks associated with climate change. Engineering Professionals should consider risks in such areas using techniques that are appropriate to their area of practice.

3.2 SCOPE OF SERVICES

Typically, the Design Engineer provides services in the design stage, as outlined in Section 3.3.2,while the Field Engineer provides services in the field review stage, as noted in Section 3.3.3.

However, the specific responsibilities of an Engineering Professional involved in a particular Formwork, Falsework, and/or Reshore project may be modified according to project needs. Any modification of the allocation of responsibility between the Design Engineer and the Field Engineer must be clearly defined in the associated contracts and project engineering plans, so all parties clearly understand the boundaries of responsibility for each stage.

Furthermore, care must be taken to ensure that all required engineering services are being provided by the Engineering Professionals involved on the project, and there are no gaps in responsibilities. Where an Engineering Professional is engaged to provide services for only a portion of an overall project, the Engineering Professional should inform the client of their obligation to procure engineering services to support the entire project, and to ensure engineering activities are coordinated, including the involvement of a Coordinating Registered Professional (CRP), where required.

In addition, it is important to determine which Engineering Professional will be responsible for providing design services for any changes that occur on site during the field review stage of the project, particularly if supplementary field design services are required, as described in Section 3.4.2.

Before commencement of services, each Engineering Professional, or their firm, must coordinate with the client to:

- determine the terms of reference and the scope of work for the basic engineering services (Section 3.3) and the additional engineering services (Section 3.4) being provided, including
  - the specific area(s) of Formwork, Falsework, and/or Reshore for which the Engineering Professional is providing engineering services,
  - the necessary inputs from the client, General Contractor, Subcontractor, or Structural Engineer of Record (SER), or any third parties required to execute the engineering services, and
  - the deliverables resulting from the engineering services provided;
- reach agreement on fees, payment schedule, and professional liability insurance coverage; and
- reach agreement on a contract.

3.3 BASIC ENGINEERING SERVICES

3.3.1 GENERAL CONSIDERATIONS

The design of Formwork, Falsework, and Reshore must be undertaken such that the temporary works will not have an adverse effect on the permanent structure or any impacts on neighbouring properties.

To avoid any misunderstanding, the specifications for permanent works should be reviewed prior to Formwork, Falsework, and/or Reshore design. A discussion around the requirements for installation, use, and removal of temporary works with the SER and the Subcontractor may be appropriate, to ensure that each party understands their responsibilities and the requirements related to maintaining the structural integrity of the permanent structure.

Specifications for permanent structures should clearly state all standards and codes, special design requirements, monitoring techniques, and methods of reporting for temporary works that the SER requires.

Engineering Professionals on Formwork, Falsework, and Reshore projects should also communicate with the Subcontractor and, where appropriate, the SER, to clearly establish the purpose, intended use, method of construction, and staging of Formwork, Falsework, and Reshore. All Formwork, Falsework, and Reshore design must be supported by an appropriate level of analysis of the loadings during all stages of construction.

All engineering analyses and engineering recommendations related to temporary works must have the appropriate level of documented analysis and checking to support them. See Section 4.1.4 Retention of Project Documentation and Section 4.1.5 Documented Checks of Engineering Work for further details.

The Design Engineer must have awareness of special conditions or issues in a project that would require care and consideration in excess of the typical level of service. Examples include, but are not limited to:

- unequal loading;
- cantilever loading;
- stability of sloped forms;
- equipment bearing on sloped floors;
- delay strips, pour break locations; and
- special requirements from the SER.

In such cases, the Design Engineer must adapt the service offerings to provide the required level of service, as per Section 3.4.1 Special Design Applications.

3.3.2 DESIGN STAGE

Typically, the Design Engineer is responsible for design stage activities and services.

The design of Formwork, Falsework, and/or Reshore must be conveyed in the Approved Drawings for use in the field. The Design Engineer should become familiar with the design documents for the permanent structure and the applicable expected or existing site conditions, before taking professional responsibility for the Approved Drawings for the Formwork, Falsework, and/or Reshore.

The Design Engineer should also be aware of the following codes and standards that may apply to the designs:

- CSA S269.1-16, Falsework and Formwork
- *Occupational Health and Safety Regulation* (*OHSR*) and other related WorkSafeBC guidelines
- *BC Building Code* (as applicable; see Division B, Part 4, Structural Design)
- Vancouver Building By-law (as applicable; see Division B, Part 4, Structural Design)

Following are the main items to be addressed during the design of Formwork, Falsework, and Reshore, and in the preparation of the Approved Drawings.

3.3.2.1 Structural and Architectural Drawings

The most recent version of the structural and architectural drawings showing the permanent structure must be used at all times; Design Engineers should make reasonable efforts to ensure that they are provided with the most recent versions of these documents.

The date and revision number of the structural and architectural drawings must be recorded on all sealed and signed Approved Drawings.

3.3.2.2 Approved Drawings

The Approved Drawings must reflect the physical geometry of the permanent structure including, but not limited to, grid lines, elevations, dimensions, and a sufficient number of cross sections. Information must be included regarding the size, shape, and thickness of all members of the concrete structure, including elevations, steps, and slopes.

It is recommended that sections should be used to convey installation details, where required.

3.3.2.3 Loads

The Design Engineer must consider the following loads on the Formwork, Falsework, and Reshore:

- **Dead loads**: the mass of Falsework, structural elements to be supported, Formwork, concrete reinforcement, and other embedded material.
- **Live loads**: the mass of workers, the plant, the equipment and runways, the material, and an impact allowance, in addition to the imposed weight of mechanically operated equipment acting on the Formwork, Falsework, and Reshore and the weight of wet concrete including reinforcement. This is also dependent on the delivery method for the concrete, whether pump or skip.
- **Environmental loads**: wind acting on the exposed area of Formwork and Falsework, and on any attached to or supported objects like signs. Consideration must be given to the length of time the equipment is erected on site.
- **Other loads**: special conditions likely to occur during construction, such as the redistribution of the load due to the effects of pre-stressing or post-tensioning, construction stages and staged removal of Falsework, and lateral loads.
- **Concrete pressure**: the allowable concrete pressure and corresponding vertical pour rates for walls, columns, and other vertical concrete elements.

The Approved Drawings must identify all loads referenced in the design.

3.3.2.4 Special Considerations

Design considerations during construction should account for sequencing of loading and the variability of loads. Many elements of the completed structure that provide strength, stiffness, stability, or continuity may not be present during construction.

Examples include the following:

- When designing Formwork and/or Falsework for cantilevered slab sections, instructions must be provided to ensure that the Formwork supporting the structure is stripped at the appropriate time.
- Formwork supported on permanent structural elements that is not yet self-supported may require additional Falsework, as specified by the Design Engineer.
- Consideration of Reshore for construction loads applied on the structure, such as pump on slab, heavy equipment, or placing boom.
- Design and Falsework instructions should be provided for Formwork when supporting structural elements suspended from the permanent structure above.

The Approved Drawings must reflect any special considerations addressed in the design.

3.3.2.5 Concrete Placement

Concrete placement must be considered in the design, as it may affect the load distribution to the Formwork and Falsework structures.

Considerations that must be addressed in the design include:

- the sequence and rate of concrete placement; and
- areas that require special attention when placing concrete, such as
  - placement of concrete into beams prior to slabs,
  - inboard sections prior to placement of concrete onto cantilevers,
  - unbalanced loads on slabs and other sections, and
  - pour break locations.

The design assumptions used with respect to concrete placement must be noted on the Approved Drawings.

3.3.2.6 Site Conditions

Site conditions that must be considered in the design include:

- backfill;
- bearing capacity;
- frozen ground; and
- uneven surface.

The design assumptions used with respect to site conditions must be noted on the Approved Drawings.

3.3.2.7 Formwork and Falsework Requirements

The Design Engineer must ensure that:

- the design of the Formwork and Falsework is performed in accordance with
  - section 6 of CSA S269.1-16, Falsework and Formwork; and
- the Approved Drawings for the Formwork and Falsework are completed in accordance with
  - section 7 of CSA S269.1-16,
  - sections 20.20 and 20.21 of the *OHSR*, and
  - Division B, Part 4, Structural Designs of the *BC Building Code* and the Vancouver Building By-law.

3.3.2.8 Equipment and Materials

The Design Engineer must specify the equipment and materials used in the design.

All materials identified in the design must comply with specified standards (i.e., CSA S269.1-16, Table 1).

Unrated or ungraded material or equipment must not be used, unless it is verified by load-testing performed under the supervision of an Engineering Professional. Proprietary products must be labelled for the purpose of field identification and for compliance with the design requirements and specified standards (i.e., CSA S269.1-16, Table 1). It is the responsibility of the Design Engineer to be aware of the rated capacity of all

equipment items, per the manufacturer's specifications, that are being used in the design.

The Design Engineer must retain all Formwork and Falsework design documentation that shows the specifications and properties of the materials or equipment used, and their compliance to their specified standards or their tested properties. The Design Engineer must also ensure that the design capacity of components and systems is determined by:

- structural analysis in accordance with design codes and standards (i.e., CSA S269.1-16, Table 1);
- testing, including test results, that is documented and in compliance to section 9 of CSA S269.1-16; and
- tests to be approved and witnessed by an Engineering Professional.

The Approved Drawings should address the layout of the material and equipment and other appropriate details of the Formwork or Falsework. In addition, the Approved Drawings should clearly and concisely present the following minimum information:

- Specifications of the equipment and/or materials to be used
- Size, location, and connections of all relevant components and assemblies in relation to each other and the permanent structure

If the equipment material provided is changed prior to construction, the Approved Drawings must be revised and sealed by the Design Engineer.

3.3.2.9 Equipment Layout

The Approved Drawings must clearly convey all design requirements and installation details, to permit the correct erection of the Formwork and/or Falsework equipment.

Details of Approved Drawings must not be left up to others, particularly the Subcontractor, to determine on site. Approved Drawings and specifications must be complete, and the Formwork and/or Falsework structure should be buildable with minimal further clarifications.

It is appropriate for an Engineering Professional to seal a set of equipment layout drawings, in order to communicate design information needed for the next stage in the design process. However, such drawings are not considered Approved Drawings if there are outstanding details to be provided by others; this should be noted explicitly next to the application of seal.

When terms such as "design details to be provided by others" or similar words are included on Application Drawings, these design details must be completed and provided with the Design Engineer's seal, including signature and date, for the set of documents to be considered Approved Drawings.

If the equipment type or layout is changed prior to construction, the Approved Drawings must be revised and sealed by the Design Engineer.

3.3.2.10 Erection and Stripping Requirements

The Design Engineer must provide information on procedures that have special requirements or require special attention during erection and dismantling. This may include the weight of workers on cantilevers prior to placement of counterweight or tie downs, or partially loaded portions of a structure during the erection and dismantling phases of work.

This information should be included on the Approved Drawings.

3.3.2.11 Reshore Requirements

The Design Engineer must ensure that:

- the Reshore design is performed in accordance with section 6 of CSA S269.1-16, Falsework and Formwork;
- the Approved Drawings for the Reshore are completed in accordance with section 7 of CSA S269.1-16, and with Sections 20.20 and 20.21 of the *OHSR*;
- design assumptions are listed;
- the required number of floors to be used in the Reshore system is included on the drawings;

- shore capacity and spacing are identified, including the maximum extension;
- where separation strips or closure (delay) strips are included, accumulation of loads are accounted for; and
- where unstripped shoring is used as Reshore, accumulation of loads are accounted for.

3.3.2.12 Design Assumptions

Any assumptions that will impact the design intent or performance of the Formwork, Falsework, and/or Reshore must be clearly identified on the Approved Drawings.

3.3.2.13 Drawing Reference to Field Review Requirements

The Approved Drawings must state what the field review requirements are. Field review must be completed prior to concrete placement. The number, frequency, and scope of the required field reviews may vary depending on project specifics.

In special instances of complex or innovative design or construction, the Design Engineer may require the Field Engineer to complete preliminary field reviews. The goal of these preliminary field reviews would be to ascertain that all of the Formwork and Falsework are appropriately installed in accordance with the Approved Drawings prior to the final prior-to-pour inspection, notwithstanding the complexity or extent of the temporary works construction activities. Preferably, such special instances should be anticipated when defining the scope of services (see Section 3.2 Scope of Services).

3.3.2.14 General Notes in Approved Drawings

The general notes in Approved Drawing must include notes regarding all of the matters discussed in Sections 3.3.2.1 to 3.3.2.13 above.

3.3.3 FIELD REVIEW STAGE

According to section 8 of CSA S269.1-16, Falsework and Formwork, a field review must be provided immediately prior to concrete placement.

Field reviews consist of multiple actions undertaken by the Field Engineer. The following is a minimum list of elements of addressed by the field review stage:

- Field Conditions and Status of the Approved Drawings
- Initial checks
- Formed structure
- Site conditions
- Formwork and Falsework equipment
- Reshore equipment
- Deficiencies
- Field design
- Noncompliant situations
- Field review reports

The following subsections describe each element above, and assume that in their scope of work the Field Engineer is to take professional responsibility for on-site design changes. If the Design Engineer is to take such responsibility, the Field Engineer must coordinate with the Design Engineer to implement any necessary changes to the Approved Drawings.

3.3.3.1 Field Conditions and Status of the Approved Drawings

Following are a number of possible scenarios according to the status of the Approved Drawings and the Field Engineer's judgment regarding the condition of the constructed Temporary Structures. The status of these items will dictate the required actions to be taken by the Field Engineer before proceeding with a complete field review.

Scenario 1: Approved Drawings on Site – Approved Drawings Acceptable

- When the Approved Drawings are adequate and complete, the Field Engineer may proceed with the field review, per the considerations outlined in Sections 3.3.3.2 to 3.3.3.7 below.

Scenario 2: Approved Drawings on Site – Approved Drawings Not Acceptable

- When the Approved Drawings do not have adequate information or are deficient, according to the considerations outlined in Section 3.3.2 Design Stage above, the Field Engineer must not proceed with a field review and should either:
  - provide field design services, identify and resolve the design deficiencies, and issue revised Approved Drawings (see Section 3.3.3.8 Field Design); or
  - return the Approved Drawings to the Design Engineer for revision.

Scenario 3: Approved Drawings on Site – As-Built Condition Acceptable

- To comply with *OHSR*, section 20.17(4), the Subcontractor must consult with an Engineering Professional to make changes to the Approved Drawings. However, in some cases minor changes are made to the temporary works during the construction process, due to site conditions, material or equipment availability, or other concerns.
- After providing a check of the on-site design changes, if the Field Engineer finds the modifications on site to be acceptable, the Field Engineer may complete the field review.
- Field Engineers must exercise caution and not incorporate changes into Approved Drawings without adequate analysis or technical justification. The changes must be documented on a field review report and marked-up drawings, in order to identify any modifications from the Approved Drawings, as follows:
  - The Field Engineer provides a sealed field review report reflecting the modifications and/or supplementary instructions.
  - If the site drawings have been marked up to reflect the as-built condition, the Field Engineer obtains a copy of the marked up approved as-built drawing (photocopy or original) for their records. This may be sent to the Design Engineer as required. The Field Engineer is required to seal these record drawings, and an appropriate disclaimer or qualification of the scope of responsibility being implied by the application of seal should be included.

Scenario 4: Approved Drawings on Site – As-Built Condition Not Acceptable

- To comply with *OHSR*, section 20.17(4), the Subcontractor must consult with an Engineering Professional to approve changes to the Approved Drawings.
- However, when the Field Engineer encounters constructed Formwork, Falsework, and Reshore that is not in substantial compliance with the Approved Drawings, the Field Engineer must fail the field review. The Approved Drawings must be revised and re-issued and/or the construction deficiencies resolved, with the prior-to-pour inspection completed at a later time.
- If it is decided that the design should be changed, and depending on the agreed scope between the Field Engineer and the Design Engineer, one of the following two solutions may be used:
  - The Field Engineer provides field design services, per Section 3.3.3.8. In this case, the Field Engineer reviews the existing Approved Drawings and, in consideration of the site conditions or changes, revises the drawings accordingly to resolve the issues encountered.
  - The Design Engineer addresses the design issues. In this case, the Field Engineer communicates the problems encountered to the Design Engineer. The field review by the Field Engineer may only be completed once the revised Approved Drawings are signed, sealed, and issued to the site by the Design Engineer.

Scenario 5: No Approved Drawings on Site – As-Built Condition Acceptable

- In this case, the Field Engineer can immediately assess and document the as-built design to the extent necessary to produce Approved Drawings, as described in Section 3.3.2 Design Stage. If the Field Engineer is so equipped, capable, and contractually engaged, then they may provide the required supplementary field design services, per Section 3.4.2 Supplementary Design Applications. Upon completion of such services, the field review activities noted in Sections 3.3.3.2 to 3.3.3.7 above may proceed, despite the fact that the project was initially noncompliant with respect to the *OHSR*, section 20.17. Field Engineers must retain copies of the Approved Drawings generated during supplementary field design for their records.
- The Field Engineer must include in the field review report that there were no Approved Drawings on site, and that a site-prepared drawing has been left at the site documenting the approved as-built Formwork, Falsework, and Reshore and/or supplementary instructions.

Scenario 6: No Approved Drawings on Site – As-Built Condition Not Acceptable

- If the Field Engineer cannot immediately provide the field design services necessary to confirm that the as-built condition conforms with these guidelines and the applicable regulations and standards, the Field Engineer cannot complete the prior-to-pour inspection.
- In this case, Approved Drawings must be created. Depending on the project this can be accomplished in one of the following two ways:
  - The Field Engineer undertakes additional scope to provide supplementary field design services, per Section 3.4.2, to create the Approved Drawings. Once the Approved Drawings are provided to the Subcontractor, the field review by the Field Engineer may occur.
  - A Design Engineer is engaged to address the design issues. The Field Engineer communicates the problems encountered to the Design Engineer. The field review by the Field Engineer may only be completed once the revised Approved Drawings are signed, sealed, and issued to the site by the Design Engineer.

3.3.3.2 Initial Checks

To commence the field review stage, the Field Engineer should:

- confirm that the structural and architectural drawings referenced in the Approved Drawings match the document revisions on site being used for construction; and
- evaluate the assumptions listed on the Approved Drawings for their correctness against the current site conditions.

3.3.3.3 Formed Structure

The Field Engineer must review the Formwork from the top of the formed structure, to ensure that the slab and beam thicknesses, step locations, and slab outline are in conformity to the Approved Drawings. Often, changes to the concrete structure are made after the Formwork and Falsework drawings have been completed.

The Field Engineer should take this opportunity to ensure that there will be no surprises in the loads about to be supported.

Items to check include, but are not limited to:

- slab and beam thicknesses;
- beam widths;
- step locations and depths;
- slab outlines;
- openings in slab;
- wall and column locations;
- crane openings;
- pour break locations; and
- delay strips.

3.3.3.4 Site Conditions

The Field Engineer must review the Formwork from the underside of the Falsework platform, to ensure that the site conditions are consistent with the Approved Drawings.

Items to check include, but are not limited to:

- bearing conditions, to confirm they are adequate for the loads to be imposed (may require coordination with geotechnical engineer);
- slab on grade locations;
- openings in support slab below;
- special situations including electrical or mechanical equipment, or sumps or cisterns already in place; and
- elevations between slabs.

Any relevant changes to the site conditions from the Approved Drawings must be documented either on the site drawings or in the field report.

3.3.3.5 Formwork and Falsework Equipment

When under the Falsework platform, the Field Engineer must review the erected Formwork and Falsework equipment, to confirm that it has been erected in substantial conformity to the Approved Drawings.

The Field Engineer must check that:

- the correct equipment has been used and can be identified;
- the equipment is not damaged or missing parts, or is otherwise unfit for use;
- the Formwork is adequate for the vertical and horizontal forces to be placed upon it;
- joists, stringers, and stringer supports are spaced correctly;
- frame heights are correct, the frames are braced as required for frame configurations, and the height-to-width ratio exceeds CSA standards;
- screwjack extensions are appropriate for the anticipated loads;
- other supports such as post shores and 4 x 6 posts are appropriate;
- lateral support of the Falsework platform has been confirmed;
- the support system is adequately tightened; and
- there is a complete load path for both vertical and horizontal forces.

Once the field review has been completed, the Field Engineer must be confident that the equipment reviewed will take the load as required.

Any relevant changes to the Formwork or Falsework equipment from the Approved Drawings must be documented either on the site drawings or in the field report.

3.3.3.6 Reshore Equipment

In certain situations where the Formwork and Falsework equipment is bearing on a suspended slab or another structure that does not have capacity to support all the loads, Reshore is applied.

Where Reshore is used on a project, the Field Engineer must review the Reshore to confirm that it has been erected in substantial conformity to the Approved Drawings related to Reshore.

The Field Engineer must check that:

- the correct shoring props have been used and are at the predetermined spacing, in accordance with the design;
- the correct make and models have been used, as determined in the design;
- the prop extension matches the designed height, as listed in the design;
- if existing Falsework is used as Reshore elements, the equipment is cracked and reset to allow for the new loads to be transferred safely to the slab below; and
- shores are plumb and without damage or deformation, and are installed to refusal.

3.3.3.7 Deficiencies

Sometimes, the Formwork and Falsework equipment erected on site may not be built according to the Approved Drawings, or it may not be fully complete at the time of the site visit.

When there are deficiencies, they must be listed for the Subcontractor to complete. Proof of the completed deficiencies must be provided to the Field Engineer, either through another field review, or by providing proof through other means satisfactory to the Field Engineer, prior to the issuance of the prior-to-pour field review report and inspection certificate.

See Section 3.3.3.1 Field Conditions and Status of the Approved Drawings, for guidance on options available to the Field Engineer.

3.3.3.8 Field Design

Field design services typically include review of minor as-built changes made by the Subcontractor during the construction process, such as minor dimensional changes or equipment substitutions, or design changes to address design deficiencies identified on site. Creation of Approved Drawings where there are no prior existing Approved Drawings is not considered a typical basic service scope of work for a Field Engineer, and are covered as an additional service in Section 3.4.2 Supplementary Field Design Services.

In the case of required field design and/or site changes, the Field Engineer modifies the Approved Drawings and takes responsibility for the design modifications, thus assuming responsibility for modified areas and all areas affected by the modification. For example, when Approved Drawings contain terms such as “design details to be provided by others” or similar words, design changes must be made before the drawings can be considered acceptable.

All substantial changes to the design details must be documented and provided to the Subcontractor with the Field Engineer’s seal, including signature and date, before the Field Engineer can proceed with field review. Copies of such documents must be retained by the Field Engineer.

During field design activities, normal requirements for checking of engineering work still apply, per the provisions in Section 4.1.5 Documented Checks of Engineering Work. The Field Engineer, when determining what constitutes an adequate check of the field design and/or site changes, should use professional judgment to decide whether to consult the Design Engineer, to ensure the modified area does not compromise the existing design specifications or safety factors.

Examples of additional checking during this stage include the following:

- If the capacity of Formwork and Falsework needs to be increased by adding more components, the Field Engineer should complete additional calculations to ensure the modified structure is capable of supporting the extra load. Accordingly, the permanent structure and any required Reshore must also be reviewed for the additional loads.
- If changes need to be made to a specified procedure noted on the Approved Drawings, the Field Engineer should confirm the revision to the procedure, and the relevant drawing or other documents should be updated to clearly show the revisions.

3.3.3.9 Noncompliant Situations

In cases where as-built Formwork, Falsework, or Reshore structures are considered to be noncompliant with the CSA standard or the *OHSR*, caution should be exercised, and a higher standard of care must be followed.

If there are no Approved Drawings on site, the Field Engineer must inform the Subcontractor that the as-built Formwork, Falsework, and Reshore has been erected without an Engineering Professional’s approval and is noncompliant with the *OHSR*, section 20.17. This must be noted on the field review report.

Because the project is considered noncompliant with respect to the applicable regulations, standards, and these guidelines, the Field Engineer is required to provide an additional level of service under special

circumstances, to address the design stage considerations for the project. These additional supplementary field design services are noted in Section 3.4.2 Supplementary Field Design Services.

In such cases, if these noncompliant situations indicate a pattern of behavior on the part of a Subcontractor, the Engineering Professional should consider whether it is appropriate to notify WorkSafeBC.

3.3.3.10 Field Review Reports

The field review report must confirm that the constructed Temporary Structures are in substantial compliance with the Approved Drawings.

See Appendix B: Sample Field Report Outline for examples of field review reports that meet the intent of the *Quality Management Guides – Guide to the Standard for Documented Field Reviews During Implementation or Construction* (Engineers and Geoscientists BC 2021f).

3.4 ADDITIONAL ENGINEERING SERVICES

3.4.1 SPECIAL DESIGN APPLICATIONS

Special applications for the use of the Formwork and Falsework equipment may be required on occasion. The Design Engineer must be aware of these situations and document them adequately on the design drawings when relevant.

Examples include, but are not limited to:

- unequal loading;
- cantilever loading;
- stability of sloped forms;
- equipment bearing on sloped floors;
- delay strips;
- pour break locations; and
- special requirements from the SER.

As special applications are likely to require innovative designs, special equipment, or uncommon techniques, it is good practice for the Design Engineer to obtain an independent review of the concepts included in the design, to ensure that they are reasonable and proper for the proposed application.

3.4.2 SUPPLEMENTARY FIELD DESIGN SERVICES

In some cases, the Field Engineer may be requested to provide complete field design services. In such situations, the Field Engineer is tasked with describing an as-built design with no prior Approved Drawings available, thus taking responsibility for the entire design.

Therefore, the Field Engineer must produce or review Application Drawings to the extent required to sign and seal them as Approved Drawings, to the full extent of the design stage services noted in Section 3.3.2 Design Stage. This is the case whether these services are provided on site or are issued from the Field Engineer's office.

4.0 QUALITY MANAGEMENT IN PROFESSIONAL PRACTICE

4.1 QUALITY MANAGEMENT REQUIREMENTS

Engineering Professionals must adhere to applicable quality management requirements during all phases of the work, in accordance with the Engineers and Geoscientists BC Bylaws and quality management standards.

To meet the intent of the quality management requirements, Engineering Professionals must establish, maintain, and follow documented quality management policies and procedures for the following activities:

- Use of relevant professional practice guidelines
- Authentication of professional documents by application of the professional seal
- Direct supervision of delegated professional engineering activities
- Retention of complete project documentation
- Regular, documented checks using a written quality control process
- Documented field reviews of engineering designs and/or recommendations during implementation or construction
- Where applicable, documented independent review of structural designs prior to construction
- Where applicable, documented independent review of high-risk professional activities or work prior to implementation or construction

Engineering Professionals employed by a Registrant firm are required to follow the quality management policies and procedures implemented by the Registrant firm as per the Engineers and Geoscientists BC permit to practice program.

4.1.1 PROFESSIONAL PRACTICE GUIDELINES

Engineering Professionals are required to comply with the intent of any applicable professional practice guidelines related to the engineering or geoscience work they undertake. As such, Engineering Professionals must implement and follow documented procedures to ensure they stay informed of, knowledgeable about, and meet the intent of professional practice guidelines that are relevant to their professional activities or services. These procedures should include periodic checks of the Engineers and Geoscientists BC website to ensure that the latest versions of available guidance are being used.

For more information, refer to the *Quality Management Guides – Guide to the Standard for the Use of Professional Practice Guidelines* (Engineers and Geoscientists BC 2021a), which also contains guidance for how an Engineering Professional can appropriately depart from the guidance provided in professional practice guidelines.

4.1.2 AUTHENTICATING DOCUMENTS

Engineering Professionals are required to authenticate (seal with signature and date) all documents, including electronic files that they prepare or deliver in their professional capacity to others who will rely on the information contained in them. This applies to documents that Engineering Professionals have personally prepared and those that others have prepared under their direct supervision. In addition, any document that is authenticated by an individual Engineering Professional must also have a permit to practice number visibly applied to the document. A permit to practice number is a unique number that a

Registrant firm receives when they obtain a permit to practice engineering or geoscience in BC.

Failure to appropriately authenticate and apply the permit to practice number to Documents is a breach of the Bylaws.

Note that it is unacceptable to "pre-seal" drawings, field review reports, or inspection certificates. Such deliverable items may only be signed, sealed, and dated after they are completed.

Documents, particularly the Approved Drawings for Formwork, Falsework, and/or Reshore projects, should only be sealed when they are "complete for their intended purpose." In this context, this means that there is no missing information that requires clarification to be supplied by others in order to be complete for its intended purpose. In the case of Application Drawings that are provided by one Engineering Professional to another for the purposes of communicating interim design information, in this case the intended purpose is formal communication between professionals. These documents may be sealed in order to allow reliance by the receiving Engineering Professional, but this use of seal should be qualified. For example, such documents should state explicitly next to the seal that the document is "not for use as part of an Approved Drawing set until items A, B, and C are defined".

With respect to changes made to Approved Drawings as part of field design services, the Field Engineer for a Formwork, Falsework, and/or Reshore projects should qualify explicitly the scope of the design changes for which the Field Engineer is taking responsibility. In the case of minor revisions, care should be taken to ensure that the revisions are clearly marked, such that the Engineering Professional is only taking responsibility for the revisions and not the entirety of the design.

For more information, refer to the *Quality Management Guides – Guide to the Standard for the Authentication of Documents* (Engineers and Geoscientists BC 2021b).

4.1.3 DIRECT SUPERVISION

Engineering Professionals are required to directly supervise any engineering work they delegate. When working under the direct supervision of an Engineering Professional, an individual may assist in performing engineering work, but they may not assume responsibility for it. Engineering Professionals who are professional licensees engineering may only directly supervise work within the scope of their licence.

When determining which aspects of the work may be appropriately delegated using the principle of direct supervision, the Engineering Professional having ultimate responsibility for that work should consider:

- the complexity of the project and the nature of the risks associated with the work;
- the training and experience of individuals to whom the work is delegated; and
- the amount of instruction, supervision, and review required.

Careful consideration must be given to delegating field reviews. Due to the complex nature of field reviews, Engineering Professionals with overall responsibility should exercise judgment when relying on delegated field observations, and should conduct a sufficient level of review to have confidence in the quality and accuracy of the field observations. When delegating field review activities, Engineering Professionals must document the field review instructions given to a subordinate. (See Section 4.1.6 Documented Field Reviews During Implementation or Construction.)

Of particular interest with respect to direct supervision is the Design Engineer–Designer relationship described in Section 2.2.6.1 Designer Role and in Appendix C: Common Project Organizational Structures. Depending on the organization of the project, the Design Engineer may or may not directly supervise the Designer. Engineering Professionals acting in the capacity of a Design Engineer should take prudent measures to ensure that work provided by Designers either occurs under their direct

supervision or is appropriately reviewed per the *Quality Management Guides – Guide to the Standard for the Authentication of Documents* (Engineers and Geoscientists BC 2021b)

Field Engineers, when delegating field review tasks to others, must ensure that:

- there are clear and detailed written instructions provided that define the procedures to collect the observations required to meet the objectives of the field review task(s);
- the person(s) on site performing the Field Review tasks document their work to the extent required by the written procedures, and that those records are provided promptly to the Field Engineer; and
- they implement control checks that allow them to establish that the records collected by others are a true representation of the constructed items under review.

For more information, refer to the *Quality Management Guides – Guide to the Standard for Direct Supervision* (Engineers and Geoscientists BC 2021c).

4.1.4 RETENTION OF PROJECT DOCUMENTATION

Engineering Professionals are required to establish and maintain documented quality management processes to retain complete project documentation for a minimum of ten (10) years after the completion of a project or ten (10) years after an engineering document is no longer in use.

These obligations apply to Engineering Professionals in all sectors. Project documentation in this context includes documentation related to any ongoing engineering work, which may not have a discrete start and end, and may occur in any sector.

Many Engineering Professionals are employed by firms, which ultimately own the project documentation. Engineering Professionals are considered compliant with this quality management requirement when reasonable steps are taken to confirm that (1) a complete set of project documentation is retained by the organizations that employ them, using means and methods consistent with the Engineers and Geoscientists BC Bylaws and quality management standards; and (2) they consistently adhere to the documented policies and procedures of their organizations while employed there.

Note that the requirement to retain project documentation applies to records created both in the design stage and the field review stage that contain information that provides evidence of a decision or action.

With respect to work performed in the field, all documents produced or modified on site by the Field Engineer are subject to these requirements, and copies of these documents must be retained per the provisions of the applicable quality management guide.

For more information, refer to the *Quality Management Guides – Guide to the Standard for Retention of Project Documentation* (Engineers and Geoscientists BC 2021d).

4.1.5 DOCUMENTED CHECKS OF ENGINEERING WORK

Engineering Professionals are required to perform a documented quality checking process of engineering work, appropriate to the risk associated with that work. All Engineering Professionals must meet this quality management requirement.

The checking process should be comprehensive and address all stages of the execution of the engineering work. This process would normally involve an internal check by another Engineering Professional within the same organization. Where an appropriate internal checker is not available, an external checker (i.e., one outside the organization) must be engaged. In some instances, self-checking may be appropriate. Where internal, external, or self-checking has been carried out, the details of the check must be documented. The documented quality checking process must include checks of all professional deliverables before being finalized and delivered.

Engineering Professionals are responsible for ensuring that the checks being performed are appropriate to the level of risk associated with the item being checked. Considerations for the level of checking should include:

- the type of item being checked;
- the complexity of the subject matter and underlying conditions related to the item;
- the quality and reliability of associated background information, field data, and elements at risk; and
- the Engineering Professional's training and experience.

As determined by the Engineering Professional, the individual doing the checking must have current expertise in the discipline of the type of work being checked, be sufficiently experienced and have the required knowledge to identify the elements to be checked, be objective and diligent in recording observations, and understand the checking process and input requirements.

Note that work performed as part of field design services as noted in Section 3.3.3.8 Field Design and Section 3.4.2 Supplementary Field Design Services is fully subject to documented checking requirements. Engineering Professionals making changes on site must ensure that their work is appropriately checked by a person qualified to provide an adequate level of checking for the changes being made.

For more information, refer to the *Quality Management Guides – Guide to the Standard for Documented Checks of Engineering and Geoscience Work* (Engineers and Geoscientists BC 2021e).

4.1.6 DOCUMENTED FIELD REVIEWS DURING IMPLEMENTATION OR CONSTRUCTION

Field reviews are reviews conducted at the site of the construction or implementation of the engineering work. They are carried out by an Engineering Professional or a subordinate acting under the Engineering Professional's direct supervision (see Section 4.1.3 Direct Supervision).

Field reviews enable the Engineering Professional to ascertain whether the construction or implementation of the work substantially complies in all material respects with the engineering concepts or intent reflected in the engineering documents prepared for the work.

Services during the field review stage are described in Section 3.3.3 Field Review Stage of these guidelines. The primary output of the field review stage is a field review report or inspection report, as outlined in Appendix B: Sample Field Review/Inspection Report Outline.

Engineering Professionals should use caution when delegating field review tasks to others without visiting the worksite, as noted in Section 4.1.3 Direct Supervision. All delegated field review tasks must be appropriately documented in writing.

For more information, refer to the *Quality Management Guides – Guide to the Standard for Documented Field Reviews During Implementation or Construction* (Engineers and Geoscientists BC 2021f).

4.1.7 DOCUMENTED INDEPENDENT REVIEW OF STRUCTURAL DESIGNS

Engineering Professionals developing structural designs are required to engage an independent review of their structural designs. An independent review is a documented evaluation of the structural design concept, details, and documentation based on a qualitative examination of the substantially complete structural design documents, which occurs before those documents are issued for construction or implementation. It is carried out by an experienced

Engineering Professional qualified to practice structural engineering, who has not been involved in preparing the design.

The Professional of Record must conduct a risk assessment after conceptual design and before detailed design to (1) determine the appropriate frequency of the independent review(s); and (2) determine if it is appropriate for the independent reviewer to be employed by the same firm as the Professional of Record, or if the independent reviewer should be employed by a different firm.

The risk assessment may determine that staged reviews are appropriate; however, the final independent review must be completed after checking has been completed and before the documents are issued for construction or implementation. Construction must not proceed on any portion of the structure until an independent review of that portion has been completed.

As Formwork, Falsework, and Reshore designs are considered structures, they are subject to the requirement for independent review; Temporary Structures are not exempt from the requirements. However, it is recognized that the majority of these Temporary Structures are likely to be considered as subject only to periodic independent review as they are either:

- a repetitive design, as described in Section 3.4.3.1 of the *Quality Management Guides – Guide to the Standard for Documented Independent Review of Structural Designs*; or
- manufactured structural components, as described in Section 3.4.3.3 of the *Quality Management Guides – Guide to the Standard for Documented Independent Review of Structural Designs*.

In both cases, the structural systems or components must be reviewed prior to their initial use with periodic (e.g., annual) independent reviews of their ongoing suitability for their intended use. Likewise, if the design of these structural elements changes in ways that significantly alters the repetitive use of the system or components, they must undergo a new independent review.

Furthermore, it is expected that innovative designs such as those produced as part of special design applications services (see Section 3.4.1 of these guidelines) undergo independent review.

For more information, refer to the *Quality Management Guides – Guide to the Standard for Documented Independent Review of Structural Designs* (Engineers and Geoscientists BC 2021g).

4.1.8 DOCUMENTED INDEPENDENT REVIEW OF HIGH-RISK PROFESSIONAL ACTIVITIES OR WORK

Engineering Professionals must perform a documented risk assessment prior to initiation of a professional activity or work, to determine if that activity or work is high risk and requires a documented independent review.

If the activities or work are deemed high risk, and an independent review is required, the results of the risk assessment must be used to (1) determine the appropriate frequency of the independent review(s); and (2) determine if it is appropriate for the independent reviewer to be employed by the same firm as the Professional of Record, or if the independent reviewer should be employed by a different firm.

The documented independent review of high-risk professional activities or work must be carried out by an Engineering Professional with appropriate experience in the type and scale of the activity or work being reviewed, who has not been involved in preparing the design.

The documented independent review must occur prior to implementation or construction; that is, before the professional activity or work is submitted to those who will be relying on it.

For more information, refer to the *Quality Management Guides – Guide to the Standard for Documented Independent Review of High-Risk Professional Activities or Work* (Engineers and Geoscientists BC 2021h).

4.2 OTHER QUALITY MANAGEMENT REQUIREMENTS

Engineering Professionals must also be aware of any additional quality management requirements from other sources that are relevant to their work, which may include but are not limited to:

- legislation and regulations at the local, regional, provincial, and federal levels;
- policies of authorities having jurisdiction at the local, regional, provincial, and federal levels;
- agreements and service contracts between clients and Engineering Professionals or their firms; and/or
- standards for engineering firms, particularly those that apply to quality management system certification, such as the ISO 9000 family.

Engineering Professionals should assess any areas of overlap between the Engineers and Geoscientists BC quality management requirements and the requirements of other applicable sources. If the requirements of different sources overlap, Engineering Professionals should attempt to meet the complete intent of all requirements.

Where there are conflicts between requirements, Engineering Professionals should negotiate changes or waivers to any contractual or organizational requirements which may conflict with requirements of legislation, regulation, or the Engineers and Geoscientists BC Code of Ethics. Generally, no contractual obligation or organizational policy that may apply to an Engineering Professional will provide justification or excuse for breach of any of the Engineering Professional's obligations under any legislation, regulation, or the Engineers and Geoscientists BC Code of Ethics. Where such conflicts arise and cannot be resolved, Engineering Professionals should consider seeking legal advice from their own legal advisers on their legal rights and obligations in the circumstances of the conflict, and they may also seek practice advice from Engineering and Geoscientists BC on any related ethical dilemma that they may face in the circumstances.

4.3 PRACTICE ADVICE

Engineers and Geoscientists BC provides their Registrants and others with assistance addressing inquiries related to professional practice and ethics.

Practice advisors at Engineers and Geoscientists BC can answer questions regarding the intent or application of the professional practice or quality management aspects of these guidelines.

To contact a practice advisor, email Engineers and Geoscientists BC at practiceadvisor@egbc.ca.

5.0 PROFESSIONAL REGISTRATION & EDUCATION, TRAINING, AND EXPERIENCE

5.1 PROFESSIONAL REGISTRATION

Engineering Professionals must have met minimum education, experience, and character requirements foradmission to their profession. However, the educational and experience requirements for professional registration do not necessarily constitute an appropriate combination of education and experience for Formwork, Falsework, and Reshore projects. Professional registration alone does not automatically qualify Engineering Professionals to take professional responsibility for all types and levels of professional services in this professional activity.

It is the responsibility of Engineering Professionals to determine whether they are qualified by training and/or experience to undertake and accept responsibility for carrying out Formwork, Falsework, and Reshore project work (Code of Ethics Principle 2).

In British Columbia, and in accordance with the *Occupational Health and Safety Regulation*, Approved Drawings and field review documents for these projects must be issued by Engineering Professionals.

Both the Design Engineer and Field Engineer on Formwork, Falsework, and Reshore projects must be Registrants of Engineers and Geoscientists BC.

5.2 EDUCATION, TRAINING, AND EXPERIENCE

Professional engineering services provided on Formwork, Falsework, and Reshore projects, as described in these guidelines, require minimum levels of education, training, and experience in many overlapping areas of engineering.

Engineering Professionals who take responsibility for Formwork, Falsework, and Reshore must adhere to the second principle of the Engineers and Geoscientists BC Code of Ethics, which is to “practice only in those fields where training and ability make the Registrant professionally competent” and, therefore, must evaluate their own qualifications and must possess the appropriate education, training, and experience to provide the services.

The level of education, training, and experience required of Engineering Professionals should be adequate for the complexity of the project. This section describes indicators that Engineering Professionals can use to determine whether they have an appropriate combination of education and experience.

Note that these indicators are not an exhaustive list of education and experience types that are relevant to Formwork, Falsework, and Reshore projects. Satisfying one or more of these indicators does not automatically imply competence in Formwork, Falsework, and Reshore.

Typical qualifications for the lead Engineering Professional working in the capacity of a Design Engineer and/or Field Engineer should include the following education and experience:

- a minimum of four years of relevant experience as a Formwork and Falsework Designer; or
- having worked under the direct supervision of a professional engineer experienced in Formwork, Falsework, and Reshore design and field review for a minimum of four years.

The academic training for the above skill sets can be acquired by taking formal university or college courses or through continuing professional development. There may be some overlap in courses and specific courses may not correlate to specific skill sets. An Engineering Professional should also remain current with evolving topics, through continuing professional development. Continuing professional development can include taking formal courses; attending conferences, workshops, seminars, and technical talks; reading technical publications; searching the web; and participating in field trips.

5.2.1 EDUCATIONAL INDICATORS

Certain indicators show that Engineering Professionals have received education that might qualify them to participate professionally in Formwork, Falsework, and Reshore projects. Educational indicators are subdivided into formal education (such as university or engineering school) and informal education (such as continuing education).

Formal educational indicators include having obtained or completed the following:

- An undergraduate-level degree in civil or structural engineering or a related engineering field from an accredited engineering program

Informal educational indicators include having participated in or undertaken one or more of the following:

- Training courses facilitated by the Engineering Professional's employer that focus on Formwork, Falsework, and Reshore structures
- Continuing education courses or sessions offered by professional organizations (such as Engineers and Geoscientists BC) that focus on Temporary Structures, including Formwork, Falsework, and Reshore structures
- Conferences or industry events that focus on Temporary Structures
- A rigorous and documented self-study program involving a structured approach that contains materials from textbooks and technical papers on Formwork, Falsework, and Reshore structures

5.2.2 EXPERIENCE INDICATORS

Certain indicators show that Engineering Professionals have an appropriate combination of experience that might qualify them to participate professionally in Formwork, Falsework, and Reshore projects.

Experience indicators include having completed one or more of the following:

- For an extended duration (typically greater than four years) and/or as an Engineering-in-Training (EIT), participated in design and field review of Formwork, Falsework, and Reshore structures under the direct supervision of an Engineering Professional with an appropriate combination of education and experience
- Participated in past projects working alongside experienced Formwork, Falsework, and Reshore Engineering Professionals, and developed a sufficient knowledge of such Temporary Structures
- Participated in academic or industry working groups that focus on Temporary Structures.

5.3 REQUIREMENTS OF PROVINCIAL LEGISLATION AND NATIONAL DESIGN STANDARDS

Design Engineers and Field Engineers must familiarize themselves with all provincial regulations, codes, and standards for the applicable authority having jurisdiction where the project resides. Refer to Appendix A: Legislative Requirement for a partial list of regulations, codes, and standards relating to the design, construction, and field reviews of Formwork, Falsework, and Reshore projects.

Formwork, Falsework, and Reshore design involves both the design of the Formwork, Falsework, and Reshore components, and the structure formed from the components.

The Design Engineer for a Formwork, Falsework, and Reshore project is responsible for selecting the appropriate components and preparing a design. Different types of Formwork, Falsework, and Reshore structures should not be mixed, unless they are identified as compatible in the manufacturer's instructions.

5.4 LEGISLATIVE REQUIREMENT

All construction work using concrete Formwork, Falsework, and Reshore in British Columbia is governed by the *Occupational Health and Safety Regulation* (*OHSR*). In particular, *OHSR* sections 20.16.1 to 20.26 apply directly to concrete Formwork, Falsework, and Reshore.

Design Engineers and Field Engineers must be familiar with the requirements of WorkSafeBC and the *OHSR* regarding these projects.

For a brief summary of the intent of each section of the *OHSR* noted above, refer to Appendix A: Legislative Requirement.

6.0 REFERENCES AND RELATED DOCUMENTS

Documents cited in these guidelines and appendices appear in this section.

6.1 LEGISLATION

The following legislation is referenced in these guidelines:

Professional Governance Act [SBC 2018], Chapter 47.

Workers Compensation Act [RSBC 1996], Chapter 492.

Workers Compensation Act, Occupational Health and Safety Regulation, B.C. Reg. 296/97.

6.2 REFERENCES

The following documents are referenced in these guidelines:

Engineers and Geoscientists BC. 2021a. Quality Management Guides – Guide to the Standard for the Use of Professional Practice Guidelines. Version 1.1. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 May 20]. https://www.egbc.ca/Practice-Resources/Individual-Practice/Quality-Management-Guides.

Engineers and Geoscientists BC. 2021b. Quality Management Guides – Guide to the Standard for the Authentication of Documents. Version 3.0. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 Apr 14]. https://www.egbc.ca/Practice-Resources/Individual-Practice/Quality-Management-Guides.

Engineers and Geoscientists BC. 2021c. Quality Management Guides – Guide to the Standard for Direct Supervision. Version 2.0. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 Apr 14]. https://www.egbc.ca/Practice-Resources/Individual-Practice/Quality-Management-Guides.

Engineers and Geoscientists BC. 2021d. Quality Management Guides – Guide to the Standard for Retention of Project Documentation. Version 2.0. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 Apr 14]. https://www.egbc.ca/Practice-Resources/Individual-Practice/Quality-Management-Guides.

Engineers and Geoscientists BC. 2021e. Quality Management Guides – Guide to the Standard for Documented Checks of Engineering and Geoscience Work. Version 2.0. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 Apr 14]. https://www.egbc.ca/Practice-Resources/Individual-Practice/Quality-Management-Guides.

Engineers and Geoscientists BC. 2021f. Quality Management Guides – Guide to the Standard for Documented Field Reviews During Implementation or Construction. Version 2.0. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 Apr 14]. https://www.egbc.ca/Practice-Resources/Individual-Practice/Quality-Management-Guides.

Engineers and Geoscientists BC. 2021g. Quality Management Guides – Guide to the Standard for Documented Independent Review of Structural Designs. Version 2.0. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 Apr 14]. https://www.egbc.ca/Practice-Resources/Individual-Practice/Quality-Management-Guides.

Engineers and Geoscientists BC. 2021h. Quality Management Guides – Guide to the Standard for Documented Independent Review of High-Risk Activities or Work. Version 1.0. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 Apr 27]. https://www.egbc.ca/Practice-Resources/Individual-Practice/Quality-Management-Guides.

Engineers and Geoscientists BC. 2019. Professional Practice Guidelines – Structural Engineering Services for Part 3 Building Projects. Version 4.0. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 Apr 13]. https://www.egbc.ca/app/Practice-Resources/Individual-Practice/Guidelines-Advisories.

6.3 CODES AND STANDARDS

The following codes and standards are referenced in these guidelines.

BC Building and Safety Standards Branch. 2018. BC Building Code. [accessed: 2021 Apr 14]. http://www.bccodes.ca.

CSA S269.1-16, Falsework and Formwork

7.0 APPENDICES

APPENDIX A: LEGISLATIVE REQUIREMENT

Construction work using concrete Formwork, Falsework, and Reshore in British Columbia is governed by the *Occupational Health and Safety Regulation* (*OHSR*).

This appendix summarizes the requirements of the *OHSR* sections specific to concrete Formwork (sections 20.16.1 to 20.26), as of the date of publication of these guidelines.

Certain details have been omitted or edited for brevity and to align with the content of these guidelines. Refer to the *OHSR* for current details of the regulation, policies, and guidelines.

A1 PLANS AND SPECIFICATIONS

Section 20.17 of the *OHSR* assigns responsibility to the employer of construction work activity to ensure that a set of plans and specifications is prepared by an Engineering Professional, and is available at the site during the erection, use, and removal of the concrete Formwork, Falsework, and Reshore. Furthermore, employers must ensure that any changes to the plans are approved by an Engineering Professional.

Section 20.18 of the *OHSR* requires that an Engineering Professional certifies that the worksite-specific plans meet the requirements of *CSA S269.1-16, Falsework and Formwork.*

Furthermore, the plans must contain the information required, per Section 20.20 of the OHSR, including:

1. sufficient plan view, section views, and connection details, enlarged where necessary, to clearly describe the Formwork, Falsework, and Reshore, and permit accurate erection;
2. the quality and grade of materials to be used for the components and their connections;
3. an accurate description of proprietary items, including fittings, to permit field identification;
4. the load-bearing capacity required of the material upon which sills are to be placed and, if necessary, details of procedures to be used to develop and maintain the required capacity;
5. the minimum dimensions of sills and other foundation members;
6. procedures for erection, use, and dismantling that require special attention, including, where applicable, handling multi-use Formwork panels;
7. details of supports necessary to maintain lateral stability and resist sidesway and racking, specifying the materials, dimensions, and locations of external braces, ties, and other support devices;
8. if structural components connect together, the connection details necessary to prevent accidental displacement or rotation of the components;
9. details of the form or mould into which concrete will be placed;
10. the maximum concrete slump that the form or mould is able to withstand;
11. sufficient load and deflection information to permit an Engineering Professional to understand the design of the Formwork and Falsework; and
12. the sequence, method, and rate of load placement necessary to prevent overloading of any part of the Formwork or Falsework.

In the case of Flyforms, additional drawing details and supplementary instructions are required, as per the OHSR section 20.21; Flyform handling requirements are specified in the OHSR section 20.22 and noted below in Section A6 Flyform Drawings and Flyform Handling of this appendix.

A2 SUPERVISION

Section 20.23 of the *OHSR* mandates that:

- a qualified supervisor experienced in the construction of temporary support structures must supervise the erection and use of Formwork, Falsework, and Reshore; and
- workers must be properly instructed on the hazards to which they may be exposed, and on precautions to be taken while working around or on Formwork, Falsework, and Reshore.

A3 RESPONSIBILITY FOR DESIGN AND CONTINUITY OF ENGINEERING

Section 20.18 of the *OHSR* assigns the responsibility to the Engineering Professional for all field designs, details, and changes, including the effect they may have on the original design. Field designs and changes must be documented as required by section 20.20 of the *OHSR*, and must be available at the site before and during placement of concrete or other significant loading of the Formwork or Falsework.

Section 20.19 of the *OHSR* assigns the responsibility to the employer to ensure continuity of the Formwork, Falsework, and Reshore design; construction and inspection in the event of a change of Engineering Professionals; or if the separate work of two or more Engineering Professionals is involved.

A4 EQUIPMENT REQUIREMENTS

Section 20.24 of the *OHSR* mandates that equipment, material, and hardware that cannot be identified as meeting the standards specified in the Engineering Professional's drawings and specifications must not be used.

A5 CONCRETE PLACEMENT HAZARDS

Section 20.25 of the *OHSR* sets the following rules to mitigate hazards associated with the placement of concrete:

1. The employer must ensure that protruding objects that create a risk of injury are removed or effectively guarded.
2. During placement of concrete or other significant loads on the Formwork, a person must be restricted from the areas underneath where the loads are placed.
3. After placement of concrete or other significant loads on the Formwork, a person must be restricted from the areas underneath where the loads were placed until it can be confirmed by a qualified person that the Formwork is withstanding the loads.
4. Placement of concrete or other loads must stop if any weakness, undue settlement, or excess distortion of Formwork or Reshore becomes apparent, or if any unanticipated or dangerous condition occurs. Placement of concrete may only restart after the Formwork has been repaired or strengthened as specified by a Engineering Professional.
5. Loads must not be applied to uncured concrete structures except as permitted by the worksite-specific plans.

A6 FLYFORM DRAWINGS AND FLYFORM HANDLING

Section 20.21 of the *OHSR* sets minimum design criteria for Flyforms, as follows:

1. Application Drawings for Flyforms must be detailed to show:
   a) a plan view, a longitudinal section, and a cross section for each type of Flyform panel; and
   b) the weight, the calculated position of the centre of gravity, and the position of the pickup points for each type of Flyform panel.
2. The design on the Application Drawings and supplementary instructions for a Flyform panel must provide that, as soon as a Flyform panel is landed on a supporting surface, before anyone climbs or walks on the panel, and before reinforcing steel or concrete is placed on the panel, the panel must:
   a) be able to resist a minimum horizontal load of 3.6 kN (800 lb) applied in any direction on the top edge;
   b) have a minimum safety factor against overturning about any possible axis of
      i. 1.6 when dead load, plus most severe live load configuration, plus horizontal loads are considered, and
      ii. 2.0 when dead load, plus most severe live load configuration or dead load, plus horizontal loads are considered;
   c) have a minimum safety factor of 1.5 against the panel sliding along the supporting surface; and
   d) have Flyform legs placed as necessary to attain the required safety factor against overturning.
3. If any of the requirements of subsection (2) cannot be obtained for a panel, the panel must, before being unhooked from the crane or hoist, be secured to the permanent structure or an adjacent panel in a manner specified by the Formwork Designer.
4. When all Flyform panels have been assembled to form a continuous piece of concrete Formwork, the concrete Formwork, Falsework, and Reshore must meet the requirements of section 20.17(1) of the *OHSR*. Section 20.22 of the *OHSR* sets some additional requirements to be included in the Application Drawings specifying Flyforms, as follows:
   a) The Erection Drawings and supplementary instructions for Flyforms must show a step-by-step procedure for all phases of each cycle of assembly, flying, use, dismantling, and reuse of each Flyform panel, including special procedures for non-typical floors.
   b) If any Flyform panel is not inherently stable for all possible conditions of load, special notation on the Flyform Application Drawings must draw attention to the procedure for obtaining stability.
   c) The employer must ensure that the Application Drawings and supplementary instructions required by subsections (1) and (2), including special procedures required for non-typical floors, must be made available to workers involved in any part of the assembly, flying, use, dismantling and reuse of each Flyform panel.

A7 INSPECTION

Section 20.26 of the *OHSR* assigns the responsibility to the employer to ensure a prior-to-pour inspection of the Formwork is conducted to ensure the Formwork is safe for use. The regulation requires that the inspection be conducted by an Engineering Professional, and a certificate indicating that the Formwork, Falsework, and Reshore were erected and shored in accordance with the latest Erection Drawings and supplementary instructions must be provided.

The *OHSR* allows for an exemption from inspection by an Engineering Professional in the case of gang forms that have been reused on the same worksite without

any modification to their design or method of erection; however, the *OHSR* still requires that the gang forms be inspected by a qualified person.

The *OHSR* also sets criteria for the minimum information to be included on the prior-to-pour certificate, as follows:

1. Subject to subsection (4), immediately before placement of concrete or other intended loading of specific Formwork and any associated Falsework or Reshore, the employer must ensure that:
    a) the Formwork, Falsework, and Reshore is inspected by an Engineering Professional; and
    b) the Engineering Professional issues a certificate that
        i. indicates the specific areas inspected, and
        ii. certifies that the concrete Formwork, Falsework, and Reshore has been erected in accordance with the up-to-date worksite-specific plans.
2. The certificate required by subsection (1)(b) must be available at the site for inspection by an officer.
3. If a gang form is being reused on the same worksite and there has been modification to the gang form design or method of erection, subsection (1) applies in relation to the reuse of the gang form.
4. If a gang form is being reused on the same jobsite without modification to the gang form design or method of erection certified under subsection (1), immediately before placement of concrete or other intended loading, the employer must ensure that the gang form is inspected by a qualified person who:
    a) confirms that the gang form has been erected in accordance with up-to-date worksite-specific plans; and
    b) documents the inspection and the confirmation, including the specific location at which the gang form is being reused and the date of inspection.
5. The documents required by subsection (4)(b) must be available at the site for inspection by an officer.

APPENDIX B: SAMPLE FIELD REVIEW REPORT OUTLINE

This appendix presents an outline of the items that must be present in a field review report for a Formwork, Falsework, and Reshore project, as well as an example of a form for such a report.

A complete field review report contains the following items, at a minimum:

- Project address
- Name, organization, and contact details of the client
- Name, organization, and contact details of the Engineering Professional performing the field review
- References to the applicable Formwork, Falsework, and Reshore drawings, including issue/revision numbers
- Details of the project area under review (location within project, specifics of items)
- Statement(s) of conformance or nonconformance of the constructed/erected items to the Approved Drawings and the *Occupational Health and Safety Regulation*
- In case of nonconformance, details as to the nature of the nonconformances must be noted, along with the actions that have been taken, or that are required to be taken, in order to obtain conformance
- Marked up or reissued drawings should be clearly noted in the comments
- A specific statement noting that the inspected Temporary Structures are either ready for the placement of concrete, or further correction of deficiencies and reinspection is required
- Signed and dated seal of the Engineering Professional responsible for the field review

SAMPLE FIELD REVIEW REPORT

ABC ENGINEERING CO. 1234 MAIN ST. CITY NAME, BC, V1A 1A1 604-555-5555					
Project Address:		Job Contact:		Project/Job #:	
				Date/time:	
Approved Drawings:					
Inspection Location:					

Notes / Comments / Deficiencies / Additional Instructions (attach additional pages as required)

Initials	The above noted formwork, falsework, and reshore have been reviewed and are in substantial conformity with the latest approved drawings and supplementary instructions and are ready for placement of concrete.	
Initials	Deficiencies have been identified that require corrective action prior to placement of concrete.	
Initials	Previously noted deficiencies have been corrected, and the above noted formwork, falsework, and reshore have been reviewed and are in substantial conformity with the latest approved drawings and supplementary instructions, and are ready for placement of concrete.	Seal and Signature of Engineering Professional Issuing the Inspection Report
Initials	Provided drawings are incomplete or not sufficient for inspection. Re-inspection is required.	Name of Engineering Professional

APPENDIX C: COMMON PROJECT ORGANIZATIONAL STRUCTURES

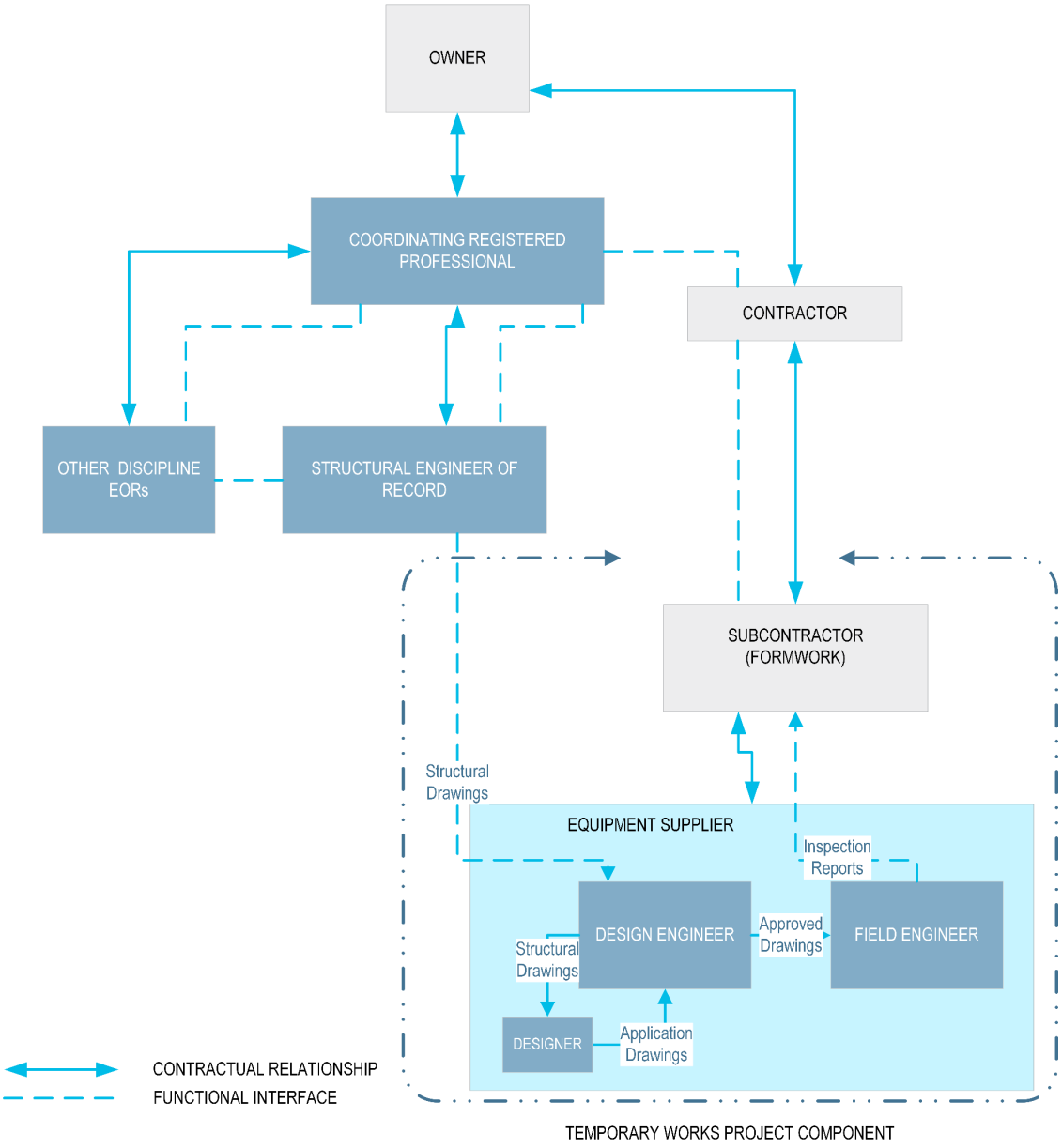
This appendix presents a number of organizational charts that illustrate various common organizational structures that may apply to Formwork, Falsework, and Reshore projects.

Note that these organizational configurations are intended as an overview, and do not address every role that may be present on such projects.

However, these examples do outline the main professional and associated project roles identified in Section 2.0 Roles and Responsibilities, along with the contractual and functional connections between the roles.

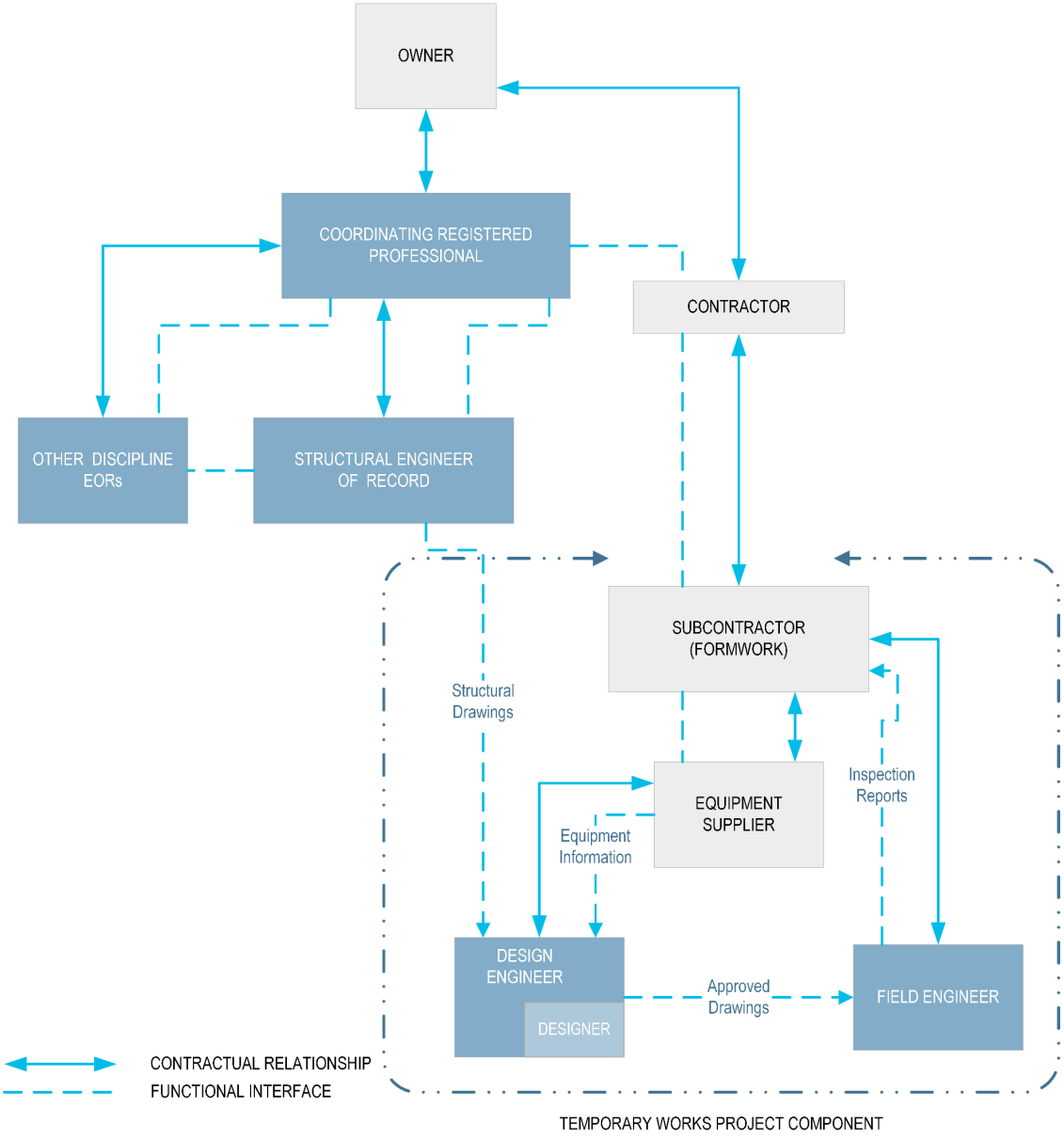
- Figure C1: Design Engineer, Designer, and Field Engineer, All with the Same Organization
- Figure C2: Design Engineer and Designer with the Same Organization, and Field Engineer from a Different Organization
- Figure C3: Design Engineer and Field Engineer with the Same Organization, and Designer from a Different Organization
- Figure C4: Design Engineer, Designer, and Field Engineer, All from Different Organizations

FIGURE C1: DESIGN ENGINEER, DESIGNER, AND FIELD ENGINEER, ALL WITH THE SAME ORGANIZATION



In this example, the Design Engineer, Designer, and Field Engineer all work for the same organization, which in this case is the equipment supplier.

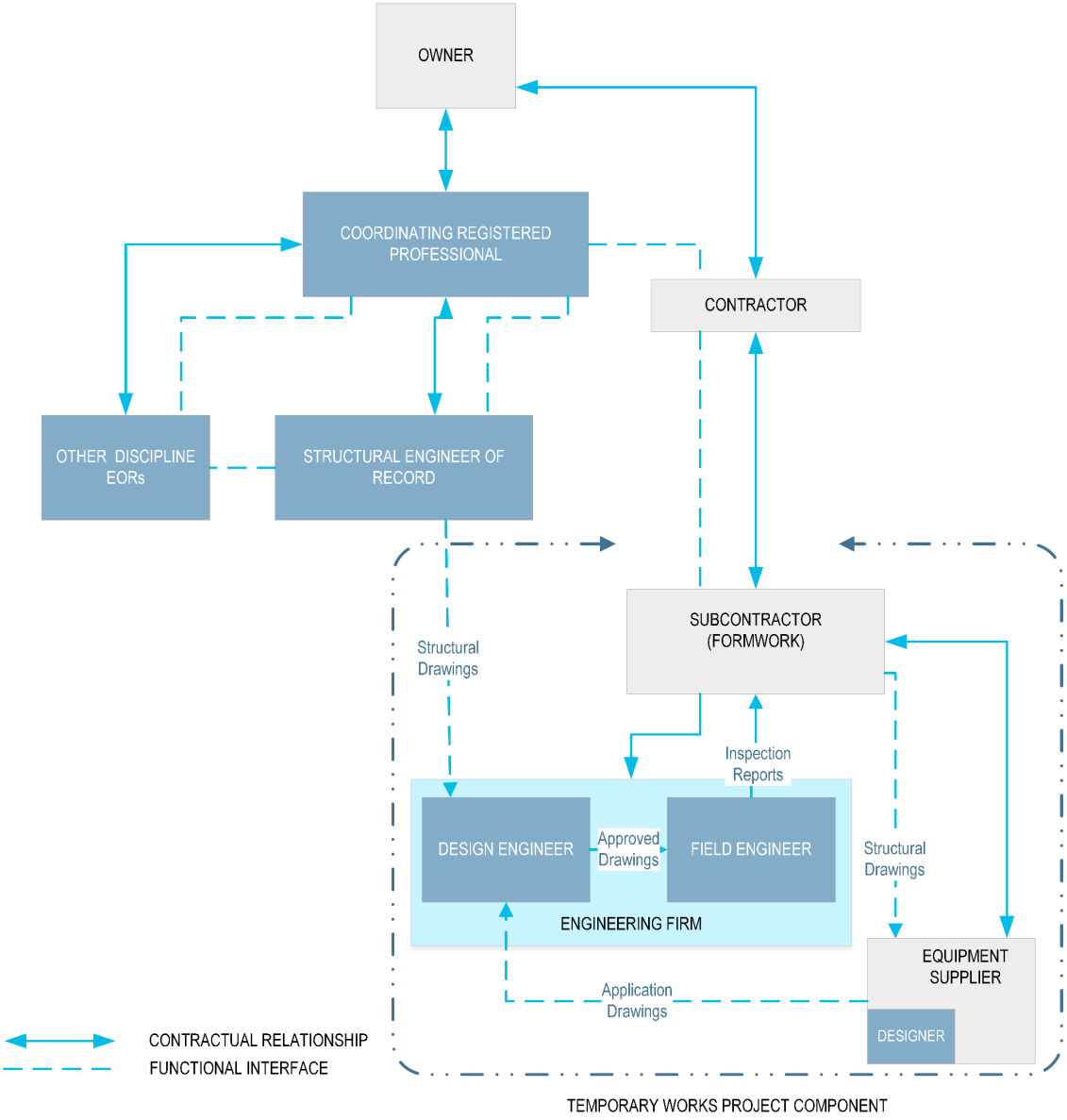
FIGURE C2: DESIGN ENGINEER AND DESIGNER WITH THE SAME ORGANIZATION, AND FIELD ENGINEER FROM A DIFFERENT ORGANIZATION



In this example, the Design Engineer and the Designer work for the same organization and are contracted by the equipment supplier to provide the design stage services. The Field Engineer is contracted separately by the Formwork Subcontractor to provide the field review stage services.

As noted in Figure C2, engineering coordination must occur between the Design Engineer and Field Engineer despite the fact that they are contracted separately.

FIGURE C3: DESIGN ENGINEER AND FIELD ENGINEER WITH THE SAME ORGANIZATION, AND DESIGNER FROM A DIFFERENT ORGANIZATION

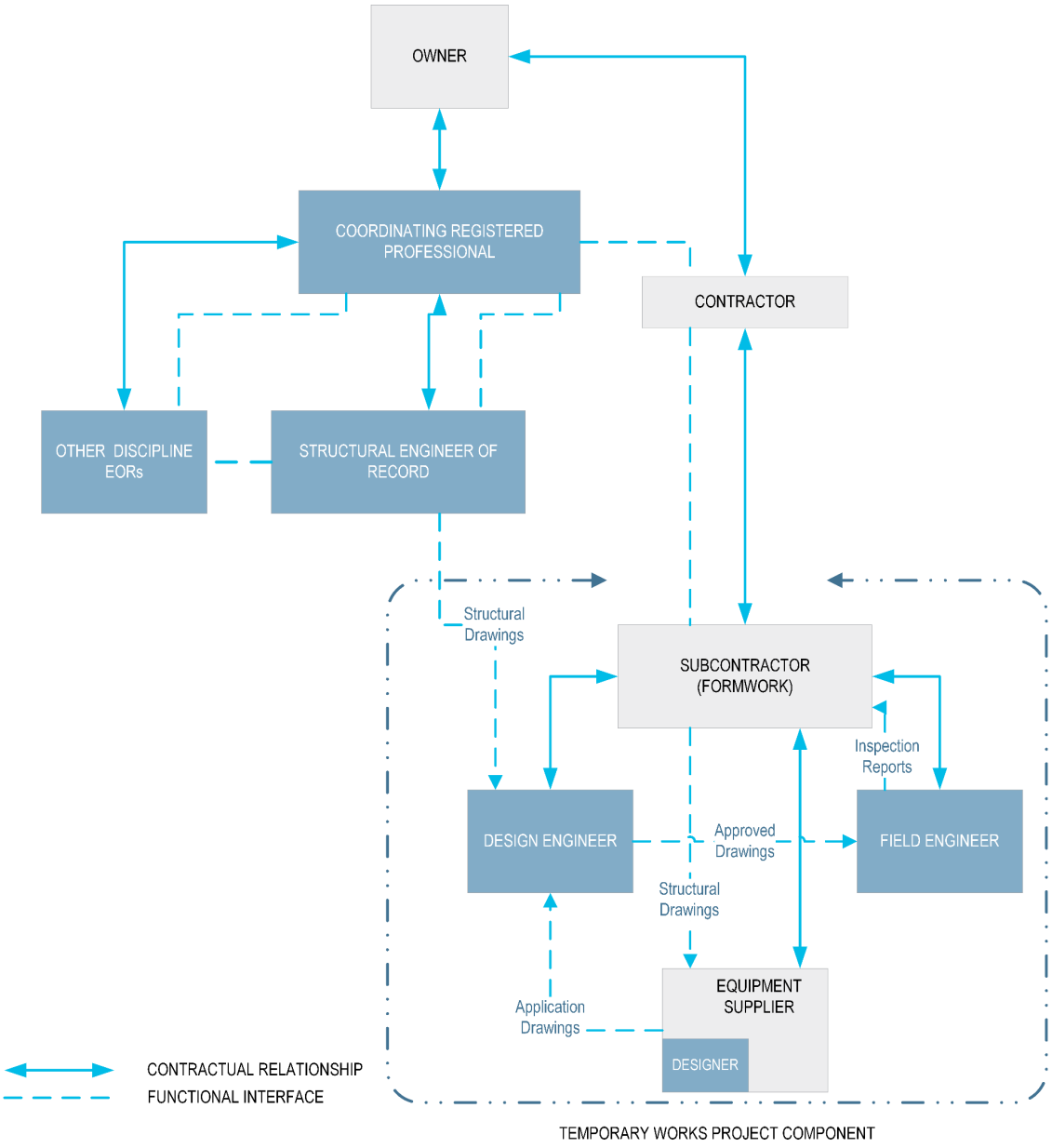


In this example, the engineering services for the Design Engineer and Field Engineer are provided by an engineering firm, while the Designer role is provided by the Formwork equipment supplier. Both entities are contracted to the Formwork Subcontractor.

The Designer provides Application Drawings to the Design Engineer, and the Designer does not work under the direct supervision of the Design Engineer. However, the Design Engineer retains all of the engineering responsibility for the design stage, as noted in Section 3.3.2 Design Stage.

The Designer is expected to provide Application Drawings that are complete, with no need for significant clarification or questions by the Design Engineer. However, where appropriate, the Designer can identify items to be supplied and/or designed by others, which could include the Subcontractor; such obligations must be clearly marked. When the Designer's drawings identify work by others or by the Subcontractor, the Design Engineer has an obligation to identify any additional design details needed in order to provide a complete design.

FIGURE C4: DESIGN ENGINEER, DESIGNER, AND FIELD ENGINEER, ALL FROM DIFFERENT ORGANIZATIONS



In this example, the Design Engineer, Designer, and Field Engineer are all from different organizations that are contracted by the Formwork Subcontractor.

In such cases, the professional functional relationships are not significantly different from those in Figure C3, although care must be taken to ensure the contractual terms between the Formwork Subcontractor and the Design Engineer, Designer, and Field Engineer are sufficiently clear, to allow for:

- proper delineation of the areas of responsibility and work tasks required of each role; and
- unencumbered professional communication between these roles, whether or not it is directly facilitated by the Formwork Subcontractor.

APPENDIX D: EXAMPLES OF PROFESSIONAL RESPONSIBILITY ALLOCATION

This appendix provides examples of scenarios where professional coordination is involved in the execution of design stage and field review stages of Formwork, Falsework, and Reshore projects.

In general, as per Section 3.2 Basic Engineering Services of these guidelines, Engineering Professionals are responsible for determining their scope of engagement in discussion with their client, in conformance with these guidelines, and with appropriate coordination with other Engineering Professionals engaged on the construction project.

D1 FORMWORK DESIGNER ENGAGED FOR PARTIAL SCOPE OF TEMPORARY STRUCTURE SYSTEM

- Designers who are engaged to provide only partial scope for a Temporary Structure system should clearly define the limits of their engagement, and should advise their client as to the remaining design stage services that must be provided by a Design Engineer to meet the full intent of these guidelines.
- When Designers produce Application Drawings that do not meet the full intent of Approved Drawings per Section 3.3.2.2 Approved Drawings, the Designer should identify on the drawings:
  - assumptions or design criteria to be confirmed by the Design Engineer; and
  - details to be provided by the Design Engineer.
- When Application Drawings are sealed by an Engineering Professional, they should be marked as “Not for use as Approved Drawings”. In such cases, the receiving Design Engineer is entitled to rely upon the information contained within as a basis upon which to perform the remaining design stage services.

D2 MULTIPLE DESIGN ENGINEERS ENGAGED ON OVERALL CONSTRUCTION PROJECT

- When different Design Engineers are engaged to provide design stage services for portions of an overall construction project, the project area(s) where each Design Engineer is providing services must be clearly defined, preferably with reference to the Structural Drawings.
- Design Engineers should inform their client of the requirement to coordinate all Formwork, Falsework, and Reshore designs, per the *Occupational Health and Safety Regulation* (*OHSR*), section 20.19. One Design Engineer should be identified in the respective service agreements as being responsible to take the lead role in coordinating design aspects.
- Interfaces between Temporary Structure systems designed by different Design Engineers must be coordinated between the involved Design Engineers. Interfaces can include but are not limited to:
  - matching of physical dimensions;
  - coordination of loads; and/or

  - coordination of concrete placement sequences and/or Temporary Structure stripping procedures.
- Coordinated interface locations, design attributes, and assumptions should be made clear in the Approved Drawings provided by the involved Design Engineers, such that they are readily apparent to the Field Engineer tasked to review the constructed designs.

D3 FIELD ENGINEER RESPONSIBILITES WHEN INSPECTING BASED ON APPROVED DRAWINGS PROVIDED BY MULTIPLE DESIGN ENGINEERS

- Per the *OHSR*, the client should coordinate the design activities with the respective Design Engineers to ensure that any responsibility overlaps or gaps are appropriately covered.
- In such cases, the Field Engineer, when reviewing Approved Drawings, should ensure that areas requiring design coordination were appropriately addressed and referenced in the design criteria.
- If designs produced independently are not properly coordinated, the Field Engineer must execute field design services (see Section 3.3.3.8 Field Design), to ensure that there are not unidentified coordination issues that require resolution prior to concrete placement.

D4 FIELD ENGINEER RESPONSIBILITIES WHEN DETAILS PROVIDED BY OTHERS ARE NOT INCLUDED ON APPROVED DRAWINGS

- In cases where relevant construction details are not included in Approved Drawings because they are not required under the *OHSR*, section 20.17(1), the Field Engineer is responsible for determining that the constructed works do not invalidate the design criteria, site conditions, or other assumptions, as noted on the Approved Drawings. If the construction is not in compliance with the Approved Drawings in this regard, the Field Engineer must identify the deficiencies to the client, as per Section 3.3.3.7 Deficiencies, and fail the inspection until the situation is remedied. In this case, the Field Engineer is not responsible for the other construction details beyond determining their conformance to the conditions stated in the Approved Drawings.
- In cases where the relevant construction details should have been included in the Approved Drawings, the Field Engineer should provide field design services (see Section 3.3.3.8 Field Design), or refer the matter back to the issuing Design Engineer.

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