



QUALITY MANAGEMENT GUIDELINES

DOCUMENTED CHECKS OF ENGINEERING AND GEOSCIENCE WORK

VERSION 1.3

PUBLISHED JANUARY 9, 2018



**ENGINEERS &
GEOSCIENTISTS**
BRITISH COLUMBIA

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ABBREVIATIONS

ABBREVIATION	TERM
BC	British Columbia
EIT	Engineer-in-Training
GIT	Geoscientist-in-Training
QM	Quality Management

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DOCUMENTED CHECKS OF ENGINEERING AND GEOSCIENCE WORK

1.0 DEFINITIONS

The following definitions are specific to this Quality Management (QM) guideline.

TERM	DEFINITION
Act	<i>Engineers and Geoscientists Act</i> [RSBC 1996] Chapter 116.
Bylaws	The Bylaws of Engineers and Geoscientists BC made under the <i>Act</i> .
Check (or derivatives)	A documented process to confirm that the professional engineering or professional geoscience work is complete, meets all Input Requirements, and is suitable for its intended use or purpose. Checks as defined encompass all of the various Checks that occur or ought to occur throughout the development, presentation, production, and performance of any professional engineering or professional geoscience work in any sector.
Corrective Action	Action taken to identify and eliminate root causes of non-conforming work to prevent the non-conformance from recurring.
Engineering/Geoscience Professional(s)	Professional engineers, professional geoscientists, and licensees who are licensed to practice by Engineers and Geoscientists BC
Engineers and Geoscientists BC	The Association of Professional Engineers and Geoscientists of the Province of British Columbia, also operating as Engineers and Geoscientists BC.
Input Data	Data used as the basis for the engineering or geoscience work that may include, but is not limited to, test and survey data, design assumptions, applicable standards and codes, preliminary designs or reports, work prepared by other professionals, and information provided by the client.
Input Requirements	Requirements that the process or deliverable must meet or satisfy that may include, but is not limited to, client objectives and requirements, design criteria, applicable standards, codes and legislation, organizational requirements and standards, and Engineers and Geoscientists BC practice guidelines.

TERM	DEFINITION
Organization	Any firm, corporation, partnership, government agency, sole proprietor, or other type of legal entity that employs Engineering/Geoscience Professionals and provides products and/or services requiring the application of professional engineering and/or professional geoscience.
Professional of Record	The Engineering/Geoscience Professional or licensee with the lowest level of direct professional responsibility for the engineering or geoscience work and any related engineering or geoscience documents produced, and whose seal appears on the documents. A test of “direct professional responsibility” is the ability of that Engineering/Geoscience Professional to alter or revise the engineering or geoscience content in the master documents.
Quality Assurance	A set of activities intended to establish confidence that requirements will be met.
Quality Control	A set of activities intended to ensure that requirements are actually being met.

2.0 PURPOSE AND SCOPE

- 2.1 Bylaw 14 states:
- “(b) Members and licensees shall establish and maintain documented quality management processes for their practices, which shall include, as a minimum:
- (2) regular, documented checks of engineering and geoscience work using a written quality control process appropriate to the risk associated with the work;”
- Scheduling, resourcing, and budgeting for Quality Assurance and Quality Control
 - Confirming and documenting Input Requirements
 - Gathering and Checking Input Data
 - Self-Checking or Check by others of calculations
 - Checking, verifying, and validating engineering or geoscience work
 - Documenting and retaining appropriate records of Checks, corrections, and Corrective Action
- 2.2 Proper and appropriate Checks are fundamental to upholding the Engineers and Geoscientists BC Code of Ethics, which first and foremost requires that all Engineering/Geoscience Professionals hold paramount the safety, health and welfare of the public, the protection of the environment, and promote health and safety in the workplace.
- 2.3 Each Engineering/Geoscience Professional must meet the requirement of establishing and maintaining documented Checks according to a documented process. This QM guideline is intended to assist Engineering/Geoscience Professionals in establishing and maintaining a documented process for regular, documented Checks of their engineering and geoscience work that meets the requirement in Bylaw 14(b)(2) including the following:
- Assessing the risk and level of Checking required
- 2.4 To comply with the Bylaws, Engineering/Geoscience Professionals must have established, or have access to, a documented Quality Control process that includes performing Checks appropriate to the risk associated with the work they are undertaking.
- 2.5 A documented Checking process is one that has been thought out and reduced to writing in suitable form. The process may be captured in a written procedure, process flowchart, checklists, forms to record Checks, or other documentation developed to suit the nature of the work undertaken by the Engineering/Geoscience Professional.

2.6 The Checking process may be as simple or as complex as the engineering or geoscience work warrants. It should define expectations, including work to be Checked, when Checks are to occur, qualifications of persons required to perform the Checks, level of detail included in Checks, and the method of recording Checks, corrections, and any Corrective Action. Checking may be carried out by a qualified individual independent of, or associated with, the work being Checked, or by the Engineering/Geoscience Professional who prepared the work.

2.7 Records of Checks must indicate what, if any, concerns were raised, how they were addressed, and what, if any, Corrective Action was identified, approved, and undertaken.

2.8 These obligations apply to Engineering/Geoscience Professionals working in their professional capacity in all sectors when their work applies to or is used in any of the following circumstances:

- Ongoing engineering and geoscience work
- Projects with a defined start and finish
- Products and services requiring the application of professional engineering or professional geoscience
- Engineering or geoscience deliverables such as reports, drawings, specifications, or other deliverables
- Implementation or use of engineering and geoscience work as may be found in a manufacturing facility, technology company, operations, or utilities work

- Construction or installation of engineering or geoscience work
- Implementation or construction carried out by others
- Implementation or construction being carried out by the Engineering/Geoscience Professional's Organization's own forces
- Engineering or geoscience work carried out for use internally within the Engineering/Geoscience Professional's Organization
- Engineering or geoscience work carried out for others

2.9 Terminology used across sectors may vary from terminology used in this QM guideline. However, the intent and obligations of Engineering/Geoscience Professionals in all sectors remain the same. Sectors may include but are not limited to the following:

- Aerospace
- Construction
- Consulting
- Education
- Government
- Healthcare
- High technology
- Light and heavy industry
- Marine engineering and naval architecture
- Manufacturing
- Natural resources
- Operations
- Research and development
- Utilities

2.10 This QM guideline is a minimum standard for Engineering/Geoscience Professionals. Failure to meet the intent of this QM guideline may be evidence of unprofessional conduct and may give rise to disciplinary proceedings by Engineers and Geoscientists BC.

3.0 GUIDELINES FOR PRACTICE

3.1 WHAT IS THE PURPOSE OF CHECKING

3.1.1 Checking is a Quality Control process to confirm that the work is complete, meets all Input Requirements, and is suitable for its intended use or purpose. Checking may be carried out by a qualified individual independent of, or associated with, the work being Checked or by the Engineering/Geoscience Professional who prepared the work. Checks are how the Engineering/Geoscience Professional confirms that work they prepare meets Input Requirements and the appropriate standard of practice¹ expected of them for similar work. Checks provide a second set of eyes or a second look by the Engineering/Geoscience Professional who prepared the work to confirm that the work is ready to be issued to those who will rely on it. Checks are critical to developing and maintaining the reputation of Engineering/Geoscience Professionals.

¹Standard of practice is a legal concept describing the care exercised by other reasonable, prudent, and competent professionals carrying out the same activity, at the time when and location where the work is being undertaken.

3.1.2 The Code of Ethics states that Engineering/Geoscience Professionals must undertake and accept responsibility for professional assignments only when qualified by training or experience. Projects or work should be carried out only when qualified resources are available with adequate time and budget to properly perform the work. No amount of Checking later can make up for lack of expertise and inadequate resourcing.

3.2 HOW MUCH CHECKING IS REQUIRED

3.2.1 LEVEL OF CHECKING REQUIRED

3.2.1.1 For Checks to be effective, proper planning must occur before engineering or geoscience work is carried out. When Engineering/Geoscience Professionals are preparing proposals, business cases, or project plans, they must assess the complexity and duration of the work being undertaken, the risk associated with that work, and the applicable documented Checking process, to determine the extent and frequency of documented Checks required to meet the appropriate standard of care.

3.2.1.2 Once the extent and frequency of Checking is determined, a plan or scope of work that includes appropriate Checking may then be developed, scheduled, budgeted, and resourced. The plan should indicate what Checks will be carried out, when, and by whom.

3.2.1.3 Effective resourcing involves assessing the competence, experience, expertise, and qualifications required to perform the Checks, and confirming the availability of appropriately qualified personnel to perform the Checks.

3.2.1.4 Insufficient time or budget to conduct appropriate Checks is not an excuse for failing to conduct appropriate Checks.

3.2.1.5 Engineering/Geoscience Professionals may not rely on the expectation that a client, owner, or regulatory authority will subsequently carry out reviews as a reason to reduce the Checking that the Engineering/Geoscience Professional conducts. Despite the expectation that the work will subsequently be Checked by others, the Professional of Record remains responsible for the engineering or geoscience work he or she has sealed.

3.2.2 CHECKING BY OTHERS VERSUS SELF-CHECKING

3.2.2.1 Do not use self-Checking as the only Check when any of the following apply:

- The Engineering/Geoscience Professional considers the probability of occurrence or the magnitude of the potential result are unacceptable for self-Checking

- The work uses innovative rather than established methods
- The work involves a structural design that falls under the requirement for an independent review
- The work is complex

3.2.2.2 Some Engineers and Geoscientists BC practice guidelines may not permit self-Checking as the only Check. Engineering/Geoscience Professionals must refer to related Engineers and Geoscientists BC practice guidelines to confirm whether a Check by others is required for the activity. As well, some Organizations may specifically require a Check by others, or disallow self-Checks as the only means of Checking in their QM system.

3.2.2.3 Sole practitioners may use a different means of analysis at a later time to self-Check their work. Before proceeding to self-Check their work, sole practitioners must ask themselves whether self-Checking alone will meet the standard of care that would be exercised by other reasonable, prudent, and competent Engineering/Geoscience Professionals performing the same work.

3.2.2.4 Even when a Check by others is performed, Engineering/Geoscience Professionals must self-Check their work and not rely on others to find any errors or omissions.

3.3 WHAT SHOULD BE CHECKED AND WHEN

3.3.1 INPUT REQUIREMENTS

3.3.1.1 Planning for the work must include confirming and documenting the Input Requirements that must be met by, or used as the basis for, the engineering or geoscience work. Carrying out the engineering or geoscience work without a complete and confirmed set of Input Requirements may lead to costly rework or, in the worst case, a failure. The record of these Input Requirements will also be used by the personnel performing the Checks to verify that the deliverable (output) meets the Input Requirements.

3.3.2 INPUT DATA

3.3.2.1 Engineering and geoscience involves Input Data that is used as the basis for developing the engineering or geoscience work. Input Data must be gathered and Checked to confirm that it is current, complete, accurate, suitable, and sufficient for the purposes for which it will be used. Some examples of Checks of Input Data include the following:

- Confirming that the government or industry standard being used is the most current
- Confirming that the geotechnical report includes relevant information appropriately located for the construction
- Checking that materials used in a process have been tested and certified to meet Input Requirements

- Checking that a preliminary design to be used for detailed design has been approved by the client

3.3.2.2 Input Data Checking does not mean recalculating or carrying out detailed Checks of work that is outside of the professional practice of the Engineering/ Geoscience Professional, or that has been certified by a recognized authority. Once Input Data is incorporated into the engineering or geoscience work, the Professional of Record is confirming its suitability for his or her engineering or geoscience work.

3.3.3 DESIGN SOFTWARE

3.3.3.1 Calculations performed using design software or spreadsheets can only be as accurate as the software, spreadsheet, or Input Data used. Ideally, the software should be validated periodically by using it to perform a known design calculation, such as one included in a textbook exercise or confirmed in past work. Alternatively, the software can be validated against a hand calculation. Keep a record or log of when the validation was last conducted, by whom, and what, if any, Corrective Action was needed.

3.3.4 ENGINEERING AND GEOSCIENCE WORK

3.3.4.1 Depending on the type, duration, and complexity of the engineering or geoscience work, Checks may occur periodically throughout the project or work, or at pre-defined stages.

- 3.3.4.2 Most structural designs will require an independent review. Refer to the Engineers and Geoscientists BC *Quality Management Guidelines – Documented Independent Review of Structural Designs* (Engineers and Geoscientists BC 2018a) for more information about these requirements.
- 3.3.4.3 Third party or independent review of the engineering or geoscience concept and deliverables may be necessary in other disciplines besides structural, before they are used for construction, implementation, or operations. Carrying out independent reviews may arise from legislative requirements; the complexity of the work; elements at risk; availability, quality, and reliability of background information and field data; client requirements; Engineers and Geoscientists BC practice guidelines; or the Engineering/Geoscience Professional's judgment, training, and experience.
- 3.3.4.4 Calculations used as the basis for the professional engineering or professional geoscience work should be independently Checked or, if acceptable in the opinion of the Engineering/Geoscience Professional and allowed in the Organization's Quality Control procedures, they may be self-Checked only.
- 3.3.4.5 Professional engineering or professional geoscience work that is prepared and delivered to others who will use and rely on it must be Checked and sealed by the Professional of Record.

3.3.5 TYPES OF CHECKS

- 3.3.5.1 Depending on the complexity of the work; elements at risk; availability, quality, and reliability of background information and field data; client requirements; and the Engineering/Geoscience Professional's judgment, training, and experience, types of Checking may include the following:
- Self-Check or Check by others of calculations
 - Intra-disciplinary Checks to identify and solve any problems, and to verify that work prepared by any one discipline meets the Input Requirements
 - Inter-disciplinary Checks to coordinate the work of a number of disciplines to identify and solve any problems, and verify that the work of all disciplines collectively meets the Input Requirements and does not conflict
 - Revision Checks throughout the project or work, as the engineering or geoscience work is revised
 - Checks to confirm compliance with applicable codes, standards, regulations, and bylaws
 - Constructability or operational Checks to confirm that work can be constructed as shown or will operate as planned
 - Health, safety, and environmental Checks to assure that the end product is safe in operation and will not have an inappropriate impact on the environment
 - Verification to confirm that the completed work satisfies Input Requirements

- Validation to confirm that the engineering or geoscience work is capable of meeting its intended purpose and will perform under expected conditions
- Deliverable Checks to see that the work is represented clearly, consistently, completely, and professionally
- Checks by an independent party to verify that the work satisfies the Input Requirements (commonly called peer reviews)
- Testing or surveying of a process, installation, program, or product
- Third-party Checks for a stakeholder to confirm that the work satisfies their Input Requirements
- Sub-consultant or supplier Checks to confirm that work prepared by the sub-consultant or supplier meets all Input Requirements and does not conflict with other work before it is incorporated into the design or used in the product

3.3.6 DOCUMENTS AND DELIVERABLES

- 3.3.6.1 Professional work and deliverables that may need to be Checked include the following:
- Proposals
 - Agreements and contracts
 - Drawings
 - Specifications
 - Reports
 - Engineering or geoscience related letters
 - Other deliverables prepared and delivered that contain or represent

engineering or geoscience work, including those related to manufacturing, high technology, computer software development, operations, and maintenance activities

3.4 WHO IS QUALIFIED TO CHECK

- 3.4.1 Checks must be carried out by professional engineers, professional geoscientists, licensees, EITs, GITs, or other parties who are appropriately qualified. The supervising Engineering/Geoscience Professional may be the person performing the Check.

To be qualified, personnel conducting Checks must:

- have current expertise in the discipline and type of work being Checked;
- be sufficiently experienced and have the required knowledge to identify the elements to be Checked;
- understand the Checking process;
- have reviewed and understood all relevant Input Requirements;
- be objective;
- be thorough and diligent in Checking and recording observations, corrections, and Corrective Action; and
- be aware of any tools required to assist in the Checking.

- 3.4.2 Although the person conducting the Check is not assuming professional responsibility for the work, the checker will be responsible for the quality of Check that he or she carries out.

3.5 HOW ARE CHECKS DOCUMENTED AND WHAT RECORDS ARE RETAINED

- 3.5.1 Checks must be documented. These records must be retained to confirm that a required Check has occurred. The record must identify the project or work, the Engineering/Geoscience Professional of Record, the person performing the Check, the purpose of the Check, and when the Checking occurred. The documentation may include mark-ups of Checked work, completed forms or checklists, or emails or other communications documenting comments, corrections, and Corrective Action. Documentation may be electronic or hard copy.
- 3.5.2 Checklists and other tools act as reminders of aspects of the work that must be Checked. They can also be used as a record that the Check occurred. Checklists and other tools may be developed based on the discipline, type of work, stage or phase of work, deliverable or product, or other content and structure suited to the Engineering/Geoscience Professional's work. Checklists and other tools must never replace the professional judgment of the person performing the Check.
- 3.5.3 The detail and volume of Check records retained will depend on the complexity and duration of the work.

- 3.5.4 As stated in the Engineers and Geoscientists BC *Quality Management Guidelines – Retention of Project Documentation* (Engineers and Geoscientists BC 2018b), retaining complete and easily retrievable project documentation, which includes records of Checks, allows for an orderly handoff from one project manager or other team member to another, even when the requirement to do so comes without warning. By maintaining records of Checks, a new engineer or geoscientist picking up the file will, after reviewing its content, be able to understand the status of the engineering or geoscience Checks that were carried out.

3.6 IN CONCLUSION

- 3.6.1 Regular documented Checks are fundamental to professional practice and must be a part of all engineering and geoscience work.

4.0 REFERENCES AND RELATED DOCUMENTS

Engineers and Geoscientists Act [RSBC 1996], Chapter 116.

Engineers and Geoscientists BC. 2018a. Quality Management Guidelines: Documented Independent Review of Structural Designs. Version 1.4. Burnaby, BC, Canada: Engineers and Geoscientists BC. [accessed: 2018 Jan 2]. <https://www.egbc.ca/Practice-Resources/Quality-Management-Guidelines>.

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