

**GUIDELINES FOR
MECHANICAL
ENGINEERING SERVICES FOR
BUILDING PROJECTS**



**ASSOCIATION OF
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS
OF BRITISH COLUMBIA**



February 4, 1993

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GUIDELINES FOR MECHANICAL

ENGINEERING SERVICES FOR BUILDING PROJECTS

1.0 INTRODUCTION

1.1 PURPOSE OF GUIDELINES

The "Guidelines For Mechanical Engineering Services For Building Projects" have been prepared by a sub-committee of the *Association* of Professional Engineers and Geoscientists of the Province of British Columbia (the "*Association*") and have been adopted by the Council of the *Association*.

The Guidelines have been prepared to set out the standards of practice which *Members* should meet and follow in providing professional engineering services. The *Association* and its Council have a commitment to improve the quality of the services *Members* provide to *Clients* and the public, and have published these Guidelines for that purpose.

It is anticipated that variations in the application of these Guidelines may be required. A *Member* must always exercise professional judgement in providing services. It is not intended that the Guidelines be used as a legal document or to alter contracts between *Members* and *Clients*.

However, a variation that detracts from the overall purpose of the Guidelines should never be made. The Guidelines are intended to establish minimum standards of practice which *Members* must meet to fulfil the *Member's* professional obligations, especially in regard to the primary duty to protect the public. The Council of the *Association* intends that failure to meet these standards may give rise to disciplinary proceedings.

The *Association* supports the proposition that *Members* should receive fair and adequate compensation for services rendered and that this principle applies to the services provided to comply with these Guidelines. In no event will low fees be justification for services which do not meet the minimum standards set out by these Guidelines. *Members* may wish to discuss these Guidelines with their *Clients* when receiving instructions for assignments and reaching agreements regarding compensation.

1.2 SCOPE OF GUIDELINES

These Guidelines apply to the practice of Mechanical Engineering for buildings governed by Part 3 and related Part 4 of the British Columbia Building Code and the City of Vancouver Building By-law.

The Guidelines outline the professional services which should generally be provided by the *Mechanical Engineer of Record (MER)* in a building project. They specify tasks which should be performed by the *MER* to achieve designs which are in the best interest of the *Client* and the public, and which are properly coordinated with the work of other design, fabrication and construction team participants. These Guidelines should assist in maintaining the integrity of the overall and detailed designs.

These Guidelines also take into account the commitments which municipalities may require from *Members* as set out in the Letters of Assurance.

1.3 QUALIFICATION

Notwithstanding the purpose and scope of the Guidelines in sections 1 through 4, the decision by the *MER* not to use one or more of these Guidelines does not mean that the *MER* is legally negligent or unprofessional in the performance of professional services as that judgment or decision will depend upon a detailed analysis of all the facts and circumstances to determine if another Mechanical Engineer in circumstances of a similar nature would have conducted himself/herself in a similar manner.

2.0 DEFINITIONS

Additional Services:

Services which the *MER* may provide in addition to the *Basic Services* as set out in section 4.3

Association:

The *Association* of Professional Engineers and Geoscientists of British Columbia.

As-Built Drawings:

Drawings which are prepared from measurements taken on site to depict accurately the location and actual sizes of elements of the construction. *Mechanical As-Built Drawings* should indicate variations from the mechanical construction documents which occurred during construction.

Authority Having Jurisdiction:

The governmental body (usually municipal) with authority to administer and enforce the British Columbia Building Code or the City of Vancouver Building By-law.

Basic Services:

The services provided by the *MER* as set out in section 4.2.

Client:

The party who engages the *Mechanical Engineer of Record* to provide professional mechanical engineering services.

Commissioning:

Commissioning consists of three parts:

- (a) static tests
- (b) operating tests
- (c) verification reports
- (d) demonstration of systems operation to building *Owner/users*

Commissioning is defined as the documentation and verification necessary so that the system will function to meet design intent and tuning of the systems necessary to meet the *Owner's* operational requirements. Generally the post-commissioning phase would include monitoring through the first year of seasonal operations.

Contract Documents:

All documents including the engineering and architectural drawings and specifications as defined in the construction contract(s) for the construction of the building.

Coordinating Registered Professional:

Often referred to as the "Prime Consultant", the *Coordinating Registered Professional* is the individual who or firm which is registered as a *Member* in good standing of the *Association* or the Architectural Institute of British Columbia and who or which has the responsibility to coordinate the design and *Field Reviews* of the various design professionals (such as electrical, structural, mechanical, geotechnical, architectural) for the project.

Field Services:

The services provided by the *MER* as set out in paragraph 4.2.5.3 to ascertain if the mechanical construction work is generally in accordance with the mechanical *Contract Documents*.

General Contractor:

The contractor who has a contract with the *Owner* for the construction of all or a portion of the building.

Maintenance Manual:

A binder containing all the necessary technical information on mechanical systems for the building *Owner* to carry out maintenance and operation of the equipment installed under the contract.

Mechanical Engineer Of Record:

The member with general responsibility for the mechanical integrity of the mechanical systems as provided by section 3.0 of the Guidelines.

Member:

A *Member* in good standing of the *Association*.

MER:

The *Mechanical Engineer Of Record*

Owner:

The party who owns the building.

Record Drawings:

Drawings which represent the final drawings following construction and which normally incorporate such items as addenda, change orders and significant modifications made during construction. Site measurements need not be incorporated onto these drawings unless significant differences from the specified dimensions occur or unless specifications require specific site measurements to be included on the Record Drawings. Variations from the contract documents may be noted, where appropriate, with remarks or comments.

Specialty Engineers:

The *Member* who prepares the design and supervises the preparation of documents for such specific elements of the project as sprinklers, seismic restraint, etc. The *Specialty Engineer* shall seal specific element designs and documents prepared by or under the supervision of the *Specialty Engineer* and is responsible for such elements.

Specifications:

A written description of the materials, standards of quality and construction requirements for the items included in a building project.

Sub-Contractors:

Contractors who have a sub-contract with the *General Contractor* to provide labour, materials and equipment for the execution and quality control of portions of the work shown in the *Contract Documents*. The *Sub-Contractor's* work is generally performed under the direct supervision of the *General Contractor*.

Submittal(s):

Items required by the *Contract Documents* to be submitted by the *General Contractor*, such as requests for payment, progress reports, shop drawings, manufacturer's literature on equipment, schedules, etc. *Submittals* are normally used by the *MER* to aid in determining if the work and work products conform with the intent of the *Contract Documents*.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

3.1 COMMON FORMS OF PROJECT ORGANIZATION

Project organizations vary according to the needs of the project and the parties. Some common organizational charts are included in the Appendix.

3.2 RESPONSIBILITIES OF ORGANIZATION PARTICIPANTS

3.2.1 Owner

3.2.1.1 In order that the design and construction of the project may be carried out in a manner that meets appropriate standards of public safety and the requirements of applicable building regulations, the *Owner* should:

- (a) retain or cause to be retained qualified design professionals including a *Coordinating Registered Professional* and a *MER* with responsibility for the design of the mechanical systems of the building;
- (b) cooperate with the *MER* to set out a written description of the scope of the *MER's* services as referred to in paragraph 3.2.3.5;
- (c) not proceed with the contemplated project without adequate financing;
- (d) cooperate with the *Coordinating Registered Professional* so that an adequate written description of the project is developed;
- (e) before the commencement of the *MER's* services, finalize or cause to be finalized, a written agreement with the *MER* (directly with the *Owner* or with the *Coordinating Registered Professional* or with another appropriate party);
- (f) cooperate with the *Coordinating Registered Professional* and the *MER* to establish a realistic schedule for the provision of the *MER's* services;
- (g) authorize in writing any additional services that may be required beyond the scope of the *MER'S* contract;
- (h) assure that all required approvals, licences and permits from the *Authorities Having Jurisdiction* are obtained;
- (i) recognize that, since no design team nor its design is perfect, some unforeseen changes may occur and that accordingly a reasonable contingency should be included in the *Owner's* budget;
- (j) recognize that drawings, *Specifications* and other documents prepared by the *MER* are for the project and that such documents should not be used or copied for other projects without the agreement of the *MER* and without advice from a qualified design professional;

- (k) recognize that because code interpretations of the *Authority Having Jurisdiction* may differ from the *MER*, some changes may occur.

3.2.1.2 If the *Owner* fails or refuses to carry out the obligations as set out in paragraph 3.2.1.1, the *MER* should:

- (a) consider giving written notice to the *Owner* advising the *Owner* of the *MER*'s recommendations;
- (b) consider whether the *MER* can continue with the project,

because in any event the *MER* must comply with the minimum requirements of these Guidelines.

3.2.2 Coordinating Registered Professional (Prime Consultant)

To enable the *MER* to perform his duties properly, the *Coordinating Registered Professional* (Prime Consultant) should:

3.2.2.1 Interpret and define the needs of the *Owner* and in doing so should define the *Owner's* intended functions and needs. The *Coordinating Registered Professional* (Prime Consultant) should identify any special design criteria such as equipment and other requirements and should advise the *MER* accordingly;

3.2.2.2 Outline the scope of assignment to each design professional for design, preparation of *Contract Documents*, review of work during construction and contract administration;

3.2.2.3 Inform the *MER* of fees submitted by all engineers invited to submit service proposals for engineering services;

3.2.2.4 Provide timely information in sufficient detail as required to adequately perform the *MER* duties;

3.2.2.5 Coordinate and review the designs, drawings and other *Contract Documents* produced by all participants of the design team;

3.2.2.6 Coordinate communication of information between the *Owner* and the contractor and the design professionals including the *MER* so that the work proceeds in a manner that complies with applicable codes and regulations and meets the *Owner's* needs.

3.2.3 Mechanical Engineer of Record

3.2.3.1 The *Mechanical Engineer of Record (MER)* is responsible for the mechanical integrity of the mechanical systems shown on *Contract Documents* prepared by the *MER*.

3.2.3.2 The *MER* may rely on other *Members (Specialty Engineers)* to be responsible for elements of the mechanical and related systems but the *MER* has the overall responsibility to see that all design is undertaken as is necessary to achieve a mechanical system that meets acceptable engineering standards. In this event the *MER* must require the other *Members* to sign and seal the documents for such elements.

3.2.3.3 Unless otherwise noted, the *MER* is responsible to assure that the design and field review of any seismic restraint for mechanical elements is completed. This review may be by the *Specialty Engineer*. When a *Specialty Engineer* is retained to design the seismic restraint elements, the *MER* shall review the design details prepared by the *Specialty Engineer* for the seismic restraint elements for completeness. The *MER* shall provide the seismic restraint information to the Structural Engineer of Record for coordination with the building structural system.

3.2.3.4 The *MER* signs the Assurance Of Professional Design And Commitment For *Field Review* regarding the mechanical design plans and supporting documents which he prepares.

3.2.3.5 The *MER* together with the *Client* is responsible for setting out a written description of the scope of the *MER's* services sufficient to enable and permit the *MER* to meet the design and *Field Review* requirements of these Guidelines and applicable building regulations.

3.2.4 Specialty Engineers

3.2.4.1 The *MER* should define clearly the scope of work to be performed by the *Specialty Engineer*. The *Specialty Engineers* are responsible for the integrity of their design. If specified by the *MER*, *Specialty Engineers* engaged by the Owner or contractor can be retained to prepare designs and drawings for such specific elements of the project as sprinklers, seismic restraint, etc.

3.2.5 General Contractor

3.2.5.1 The *General Contractor* has a contract with the *Owner*. This contract usually provides that the *General Contractor* shall be responsible for the labour, materials and equipment for the work and that the *General Contractor* is responsible for the construction methods, techniques, sequences, procedures, safety precautions and programs associated with the construction work, all as set out in the *Contract Documents*.

3.2.5.2 The *General Contractor* is responsible for coordinating the work of the *Sub-Contractors* and for checking the *Sub-Contractor's* work prior to field review by the *MER*.

3.2.5.3 The *General Contractor* is responsible for providing reasonable notice to the *MER* when components are ready for *Field Review*.

3.3 SELECTION OF CONSULTANTS

The recommended procedures for selecting a consultant are as described in the "Outline of Services and Schedule of Fees to Sub-Consultants" booklet published by the *Association of Professional Engineers and Geoscientists of B.C.* and the *Consulting Engineers of B.C.*

4.0 GUIDELINES FOR PROFESSIONAL PRACTICE

The following are outlines of the services which the *MER* should consider providing as part of good practice. These outlines may assist the *MER* in explaining his services to a *Client*. These outlines are not intended to be exhaustive, and should not be interpreted to detract in any way from the provisions of these Guidelines herein.

4.1 SCOPE OF SERVICES

Before commencement of design services, the *MER* shall meet with the *Client* who generally is the *Owner* or the *Coordinating Registered Professional* but who may be others such as the contractor in a design-build contract to:

4.1.1 Determine the terms of reference and the scope of work for *Basic Services* and *Additional Services*;

4.1.2 Reach agreement on fees, payment schedule and professional liability insurance coverage;

4.1.3 Reach agreement on a contract. (Documents No. 31, 32 or 32-S prepared by the Association of Consulting Engineers of Canada are recommended as a basis for this contract.);

4.1.4 For a "fast-track" project, in addition to the above, the *MER* should:

- (a) Establish with the *Client* the terms and conditions under which preliminary or partially complete *Contract Documents* may be issued in advance and clearly define the requirements for partially complete *Contract Documents*;
- (b) Advise the *Client* that no part of the mechanical documents can be considered complete before all *Contract Documents* including architectural, structural, mechanical and electrical drawings are completed.

4.2 BASIC MECHANICAL ENGINEERING SERVICES

The usual stages of the *Basic Services*, as discussed below, are generally organized in an agreement according to the sequential stages of a typical project. Each stage of the *Basic Services* generally contains those items which pertain most typically to the progress of work for that construction stage. Because of the requirements of a specific project, certain *Basic Services* activities may be required to be performed out of the normal sequence or in different stages than indicated in the scope of services.

4.2.1 "Conceptual" or "Schematic" Design Stage

In the Conceptual or Schematic Stage, the *MER* may:

4.2.1.1 Attend, as required, periodic meetings with the *Client* and design team to obtain the *Client's* instructions regarding the Client's functional, aesthetic, cost and scheduling requirements to prepare a preliminary design concept and to report on the mechanical systems considering economy, performance, capital cost, compatibility with other design elements and requirements of relevant codes and authorities;

4.2.1.2 If required, assist the *Coordinating Registered Professional* (Prime Consultant) or *Owner* in:

- (a) Defining the need for any specialty consulting services which may be required for the project, e.g., acoustical, fire protection, code and Certified Professional;
- (b) Developing or reviewing the project schedule including any milestone dates;
- (c) Determining channels of communication;
- (d) Determining drawing standards and *Specifications* format;
- (e) Determining the number and timing of project team meetings during each stage of the project;

4.2.1.3 Establish dates by which information affecting the mechanical design will be needed from other disciplines;

4.2.1.4 Conduct field reviews and review existing drawings where appropriate;

4.2.1.5 Establish criteria for the seismic consultant and other consultants as required. Comment on reports presented;

4.2.1.6 Identify mechanical design criteria, prepare preliminary calculations and establish base load requirements for HVAC, plumbing and fire protection systems, etc.;

4.2.1.7 Develop the mechanical scheme for the mechanical systems. Develop alternate schemes where appropriate. Consider materials and systems suitable to the project requirements. Consider the requirements of the other design professionals and provide the information they require;

4.2.1.8 Check applicable codes, regulations and restrictions, insurance requirements and other factors affecting the design of the project;

4.2.1.9 Prepare a preliminary cost estimate or cooperate appropriately with others responsible for reporting the estimate;

4.2.1.10 Determine the allocation of suitable space for mechanical rooms and other major mechanical installations;

4.2.1.11 Determine equipment weights, size, noise, vibration, seismic requirements, and other physical characteristics that are to be considered in the building mechanical design.

Determine the impact of noise and vibration from the mechanical systems on the *Client's* operational requirements and recommend solutions through the use of a specialist if necessary;

4.2.1.12 Establish, where appropriate, comparative information to be used in selection of mechanical systems for the project;

4.2.1.13 Provide, if required, brief outline *Specifications* for proposed materials;

4.2.1.14 Describe the major mechanical system(s) and each significant component and material;

4.2.1.15 Explain in writing to the *Client* all new construction materials or new techniques proposed for use in the project and their alternatives, including the risks, advantages and disadvantages over both the short and long term, so that the *Client* can weigh the choices and make an informed decision before the *MER* proceeds further;

4.2.1.16 If required, advise the *Client* of the recommended mechanical systems. Review the effect of these systems on the mechanical construction budget for the project;

4.2.1.17 Prepare a summary report which defines the mechanical systems selected for the project and outlines the reasons involved in the selection.

4.2.1.18 A *Client* may assume responsibility for all or some of the foregoing Conceptual or Schematic Design Stage activities provided:

- (a) the *MER's* ability to satisfy the requirements of the subsequent stages of these Guidelines is unimpaired;
- (b) the responsibility for such preliminary design activities is clearly defined in writing;
- (c) the *Client*, in writing, waives the *MER's* responsibility for such preliminary design activities and their effect on the selection of the mechanical systems.

4.2.2 Design Development Stage

In the Design Development Stage when the selected scheme is developed in sufficient detail to enable commencement of the final design and construction documents by all participants of the design team, the *MER* may:

4.2.2.1 Attend, if required, meetings with the *Client* and design team;

4.2.2.2 Review results of studies by specialist consultants, such as geotechnical, fire protection and code, etc.;

4.2.2.3 Prepare preliminary mechanical analysis and design calculations for typical mechanical elements of the mechanical systems. Select appropriate equipment;

4.2.2.4 Prepare preliminary service drawings based on information coordinated with other consultants;

4.2.2.5 Prepare preliminary design and drawings showing layouts of typical areas;

4.2.2.6 Prepare or edit the "outline *Specifications*" for mechanical items, as required;

4.2.2.7 Coordinate mechanical design with space and servicing criteria to meet the requirements of the other design team participants. In particular, notify the Electrical Engineer of Record of all points of interface between the two disciplines and determine as soon as possible the electrical characteristics and electrical requirements of all mechanical loads and potential conflicts between the mechanical and electrical riser locations;

4.2.2.8 Submit design development documentation for review and approval by the *Client*.

4.2.3 Contract Document Stage

4.2.3.1 General:

- (a) Design the mechanical systems;
- (b) Determine and specify in the *Contract Documents* which mechanical elements are to be designed by *Specialty Engineers*;
- (c) Attend periodic coordination meetings, as required;
- (d) Coordinate with the *Authority Having Jurisdiction*, as required;
- (e) Establish testing and inspection requirements;
- (f) Comply with fire resistance requirements as determined by the *Coordinating Registered Professional* or specialty consultants.
- (g) Seal documents per Engineers and Geoscientists Act.

4.2.3.2 Mechanical Calculations

The *MER* must prepare mechanical calculations to support all mechanical designs. The mechanical calculations should be prepared legibly and presentably and filed by the *MER* for record purposes. Hard copy of input and output of any computer analysis should be included as well as description of the software used.

In general, mechanical calculations include but are not limited to:

- (a) Design criteria:
 - Discussion and description of design basis including assumptions;
 - Building codes used with edition dates;
 - List of mechanical design parameters and provisions greater than building code requirements as requested by the *Client* or otherwise used by the *MER*;
- (b) Location diagrams for mechanical elements;
- (c) Computer analysis and design results, if applicable;
- (d) Special studies and analysis where required by Code;
- (e) For critical design elements and where required by Code, work done by an engineer with limited experience shall be checked by an independent engineer, not necessarily from a separate company;
- (f) The names of the mechanical design engineer(s) and design check engineer;
- (g) Table of contents for or index to the mechanical calculations.

4.2.3.3 Mechanical Drawings

Prepare complete, contract drawings. The drawings should be made, where possible, to the same scale as that of the building layout drawings and should define the work:

- a) Where scale of drawings or complexity of work make drawing difficult to be read and interpreted, separate drawings should be provided for such areas of the work as:
 - plumbing drainage
 - heating, ventilating and air conditioning
 - fire protection
 - process piping and equipment
 - other special systems as necessary;
- b) Schematics and diagrams should be provided as required for all major systems with notes to describe the function of control, flow and operation;

- c) Plot plans and/or site plans showing water supply, gas supply, sanitary and drainage arrangements and connections to public utility services as required, complete with invert elevations, should be included;
- d) Symbol lists and typical details should be included, where required, for all equipment, accessories, piping and duct systems;
- e) Floor plan layouts for all piping and duct systems should be provided. Complete duct and pipe sizing should be shown on these documents. Sizes, types, locations and capacities of all supply and exhaust air terminals together with type and location of valves should be shown;
- f) To avoid conflicts, supplementary details should be provided for boiler, equipment and fan rooms and congested areas. For clarity, such details should be drawn in plan and elevation views at a scale of 1:50 (1/4" to the foot) or larger;
- g) Piping and duct work can be shown in single line except where necessary to show arrangements and clearance for piping or duct work in ceiling spaces, shafts, header trenches, pipe chases and for tight or close-coupled equipment. This piping and duct work should be shown in double-line detail with appropriate valves, fittings and accessories;
- h) Schedules should be included to provide capacities and details of performance of fans, air-handling units, pumps, etc. Alternatively, these schedules may be included in the *Specifications*;
- i) All drawings as well as details, elevations and sections should be properly cross-referenced.

4.2.3.4 *Specifications*

- (a) Prepare *Specifications* using a format suitable for inclusion with the overall *Contract Documents*;
- (b) The *Specifications* should include information on:
 - standards, codes, by-laws governing work;
 - *Submittals* required;
 - quality control requirements;
 - materials;
 - workmanship and fabrication;
 - tolerances;

- information for temporary works and erection information where necessary to ensure the intent and integrity of the design;
 - construction inspection and testing;
 - notification by the contractor before significant segments of the work are begun;
 - warranties;
 - performance criteria for design and detailing by *Specialty Engineers*.
- (c) Where appropriate, the *Specifications* may be abbreviated and become part of the drawings;
- (d) The *Specifications* generally set out that the *MER's* review of *Submittals* and inspection of work as well as any testing by independent agencies reporting to the *Client* are undertaken to inform the *Client* of the quality of the contractor's performance and that this review and testing are not for the benefit of the contractor. The contractor must provide his own independent quality control program.

4.2.4 Tendering Stage

- 4.2.4.1 Assist in the preparation of pre-qualification documents, if required;
- 4.2.4.2 Assist in reviewing bidder's qualifications, if required;
- 4.2.4.3 Assist *the Client* in obtaining required approvals, licences and permits. Prepare and supply Letters of Assurance and documents required by the *Authority Having Jurisdiction*;
- 4.2.4.4 Assist in analysis and evaluation of tenders submitted;
- 4.2.4.5 Provide assistance to the *Client* in answering queries raised by the bidding contractors and issue mechanical addenda and clarification of mechanical documents, as required;
- 4.2.4.6 Assist in the preparation of the contract, if required.

4.2.5 Construction Stage

It is essential that *Field Services* be provided for all systems for which the *MER* is responsible to ascertain whether or not the work is generally in accordance with the mechanical *Contract Documents*.

It is preferable that the *Field Services* be provided by the *MER*; however, where practical the *MER* may delegate these duties to others.

Field Services by the *MER* should not be construed to relieve the contractor of the contractor's responsibility for building the project in accordance with the *Contract Documents*, controlling the progress, providing safe working conditions, and correcting any deviations from the project requirements.

Some items reviewed by the *MER* may also require review by other members of the design team or by testing and inspection agencies. Such work may include proprietary products and mechanical elements designed by others.

4.2.5.1 *Field Services* During Construction:

Field Services should include, but not necessarily be limited to, the following and may vary depending on the complexity of the job.

- (a) Attend construction meetings, if required;
- (b) Confirm communication channels and procedures;
- (c) Assist in confirming, reporting and scheduling procedures for testing and inspections;
- (d) Assist in confirming procedures for shop drawings and other *Submittals*;
- (e) Confirm that the qualifications of manufacturers meet the *Specifications*;
- (f) Advise the contractor and the *Coordinating Registered Professional* on the interpretation of the mechanical drawings and *Specifications* and issue supplementary details and instructions during the construction period as required;
- (g) If requested, advise the *Client* on the validity of charges for additions to or deletions from the contract and on the issue of change orders;
- (h) Review and comment on, if requested by the *Client*, the contractor's applications for progress payments. Estimate, if required, completed work and materials on site for payment according to the terms of the construction contract;
- (i) Review reports from the testing and inspection agencies to determine if the agency has verified compliance of the reported item of work with the mechanical *Contract Documents*. Initiate any necessary action;
- (j) Conduct substantial and total performance field reviews of the mechanical components of the project, note deficiencies and inspect completed corrections;
- (k) Submit, if required, Letters of Assurance and *Record Drawings* to the *Authority Having Jurisdiction*;

- (l) Attend the start-up of the mechanical systems and respond as required to any design-related operational difficulties. Arrange and perform field review when the contractor has applied for substantial completion of the project; prepare a list of deficiencies (workmanship, completeness and function) and, when these have been rectified, issue the final report.

4.2.5.2 Review of *Submittals*

Submittals should be reviewed for general compliance with the mechanical *Contract Documents* and do not include: checking dimensions or quantities or the review of the contractor's safety measures or methods of construction.

- (a) Review the shop drawings and other *Submittals* for conformance with the *Contract Documents* and the intent of the design;
- (b) Confirm that the *Submittals* have been reviewed by the *General Contractor* and relevant *Sub-Contractor* before review by the *MER*;
- (c) When required by the *Contract Documents*, confirm that the shop drawings bear the signature and professional seal of the *Specialty Engineer* responsible for the design of such specialty systems as seismic elements and connections, sprinklers. Responsibility for the detail design remains with the *Specialty Engineer* whose seal and signature appear on the drawings. To clarify responsibility, the *Specialty Engineer* may qualify the extent of work which has been designed by the *Specialty Engineer*;
- (d) Review *Record Drawings* prepared and submitted by the contractor on white prints or mylar copies to reflect "Record" condition of the project as turned over to the *Client*. The *Client* shall be advised that these drawings are prepared by the contractor and have been reviewed only for general conformity to the drawing standards and the intent of the design and that the *MER* cannot accept responsibility for their accuracy;
- (e) Arrange for the contractor to submit and review operating and *Maintenance Manual* for the equipment/systems supplied on this project. The data submitted should include manufacturer's recommendations for maintenance of each piece of equipment and other such information which will enable the *Client* to assume operation of the building.

4.2.5.3 Field Review

- (a) Visit the site at intervals appropriate to the stage of construction to observe the quality and the progress of the construction of those elements designed by the *MER*. At the discretion of the *MER*, proprietary products, connections and other seismic restraint elements which have been designed by *Specialty Engineers* should be inspected by those *Specialty Engineers* at the appropriate stage of construction and reported in writing to the *MER*;

- (b) Prepare site visit reports outlining observations and deficiencies in the work and bring them to the attention of the contractor's site representative;
- (c) Distribute site visit reports to the *Coordinating Registered Professional* and other parties such as the *General Contractor* and *Owner*, as required. Where the *Owner* directly retains the services of the *MER*, it is recommended that the *Owner* also be sent copies of the reports;
- (d) Conduct a final project review and advise the *Client* of continuing or newly-observed defects or deficiencies in the project.

4.3 ADDITIONAL MECHANICAL ENGINEERING SERVICES

In addition to the *Basic Services*, the *MER* may provide the following *Additional Services* if the *MER* and the *Client* reach appropriate mutual agreements. They are generally not considered intrinsic parts of the basic mechanical design services, as discussed in paragraph 4.2, and are not part of the minimum services which the *MER* should provide under these Guidelines, except as agreed upon in a contract.

The *Client* should retain the *MER* as an *Additional Service* to review items designed by others to confirm compatibility with the design of the mechanical systems.

Examples of *Additional Services* are:

4.3.1 Design work resulting from changes to the project as originally described and agreed to under the contract between the *MER* and *Client* such as changes in scope, complexity, diversity or magnitude of the project;

4.3.2 Preparation of alternate mechanical designs and related documentation after selection of the mechanical system made during the conceptual and schematic design stages;

4.3.3 Review, design and documentation of alternate or substitute systems if requested by the *Coordinating Registered Professional* (Prime Consultant), the *Client* or the contractor, for tendering to obtain competitive bids for items such as proprietary products;

4.3.4 Work connected with the preparation of documents for tendering segregated contracts, pre-tendered contracts, phased or fast-track construction;

4.3.5 Review of alternate designs or products after completion of the *Contract Documents*;

4.3.6 Work resulting from changes necessary because of construction cost over-run which is outside the control of the *MER*;

4.3.7 Translation of *Contract Documents* into a second language, conversion to other units, special preparation of drawings for reduction;

- 4.3.8 Programming of such items as *Owner's* equipment and mechanical systems where investigation and analysis must determine user requirements for a statement of system requirements, materials and performance;
- 4.3.9 Analysis of long range plans as defined by the *Coordinating Registered Professional* (Prime Consultant) and attendant preliminary sketches and reports (master planning);
- 4.3.10 Preparation of alternative building or system designs and attendant documentation when required by the *Coordinating Registered Professional* (Prime Consultant) or *Client* either for review or for competitive tender prices;
- 4.3.11 Travelling time outside of normal requirements;
- 4.3.12 Construction or project management services;
- 4.3.13 Energy analysis and value engineering (life cycle costing) analysis including schematics where required by the *Coordinating Registered Professional* (Prime Consultant) or *Client*;
- 4.3.14 Preparation of designs and documentation for future implementation not included in construction contract;
- 4.3.15 Preparation of Bills of Material or Schedules of Material at any time during the project;
- 4.3.16 Resident engineering services during construction. Supply resident staff on the project to determine if the contractor is carrying out his work in accordance with the *Contract Documents*. If required by the *Coordinating Registered Professional* (Prime Consultant), resident services may include the recording of all details of construction for final revision of the plans or drawings to show the work on *Record Drawings*. "Services" as described do not include the direction of persons or the selection, direction or approval of methods and equipment employed by the contractor in any phase of the construction or the placing in operation of any plant or equipment;
- 4.3.17 Preparation of drawings, *Specifications* and change orders and administration of contract additions and/or deletions which are initiated by the *Client* but either have not been implemented or result in a reduction in the contract price;
- 4.3.18 Certification inspections and testing of life safety systems where required by the *Authority Having Jurisdiction*;
- 4.3.19 Testing of building systems requiring confirmation of conformance with *Specifications*;
- 4.3.20 Preparation of operating or maintenance manuals;

4.3.21 Preparation of *Record Drawings* where requested. (The *MER* does not guarantee the accuracy of information provided to him by the contractor);

4.3.22 Providing services after expiry of the period of one (1) year following Certification of Substantial Performance;

4.3.23 Complete or partial revision of design documents previously approved by the *Client* or in keeping with written instruction or drawings previously received from the *Client*;

4.3.24 *Commissioning* of building mechanical systems including training of personnel and providing operating and maintenance assistance;

4.3.25 Advisory services which include: testimony; consultation and advice; appraisals; valuations; research; other services leading to specialized conclusions and recommendations;

4.3.26 Surveys of existing mechanical equipment which include: elaborate surveys or measurements and evaluation of existing mechanical equipment, i.e., securing of information on special existing loadings such as unusual equipment requirements or unusual construction;

4.3.27 Balancing of air and water/liquid systems which involves: the actual detailed balancing and adjustment of air and water/liquid systems including adjustment of heating, air conditioning, ventilation systems, and piping networks as installed.

N.B. It is customary to include in the *Specifications* a detailed outline of the balancing procedure and to provide an allowance in the construction contract for the services of a skilled technician who will supervise and assist the contractor in the proper balancing procedure and prepare the balancing reports for submission to the *MER*.

4.3.28 Computerized energy analysis involves the use of computer programs to simulate the amount of energy used in building. The program optimizes the effects of varying architectural features, mechanical systems and electrical systems.

4.3.29 Fast-track construction. To facilitate an earlier-than-normal construction start, the prime consultant or project manager may request the *MER* to prepare several separate bid packages instead of the normal one. In this case, complete tender documentation necessitating extra work on the part of the *MER* is required for each bid package;

4.3.30 Site work elements beyond the property line;

4.3.31 Seismic restraints designed by *Specialty Engineers* for mechanical systems;

4.3.32 Review of design drawings or *Specifications* prepared by others to determine adequacy of anchorage of seismic elements for mechanical equipment;

4.3.33 Preparing or assisting with the preparation of detailed cost estimates. The *MER* shall inform the *Client* of the variables inherent in the estimate and the expected degree of

variation from the estimate. Where the degree of variation is critical, the *Owner* should have the estimate independently verified;

- 4.3.34 Filing application for and obtaining permits;
- 4.3.35 Preparation of demolition documents;
- 4.3.36 Tenant-related design services;
- 4.3.37 Design or review of the effects of the contractor's methods, procedures or construction equipment on the structure;
- 4.3.38 Work resulting from corrections or revisions required because of errors or omissions in construction by the contractor;
- 4.3.39 Work due to extended time schedules for design or construction;
- 4.3.40 Services as an expert witness in connection with any public hearing, arbitration or court proceedings concerning the project, including attendant preparation of same;
- 4.3.41 Work resulting from damage as the result of fire, man-made disasters, or natural disasters;
- 4.3.42 Authorized overtime work requiring premium pay.

4.4 FABRICATION DRAWINGS AND DOCUMENTS

The fabricator or manufacturer shall produce all necessary drawings and documents to represent the work covered by his contract with the contractor. These drawings and documents are prepared following a review of the drawings, *Specifications* and *Contract Documents* supplied by the *MER* and following the resolution of any errors or requested changes. They usually include:

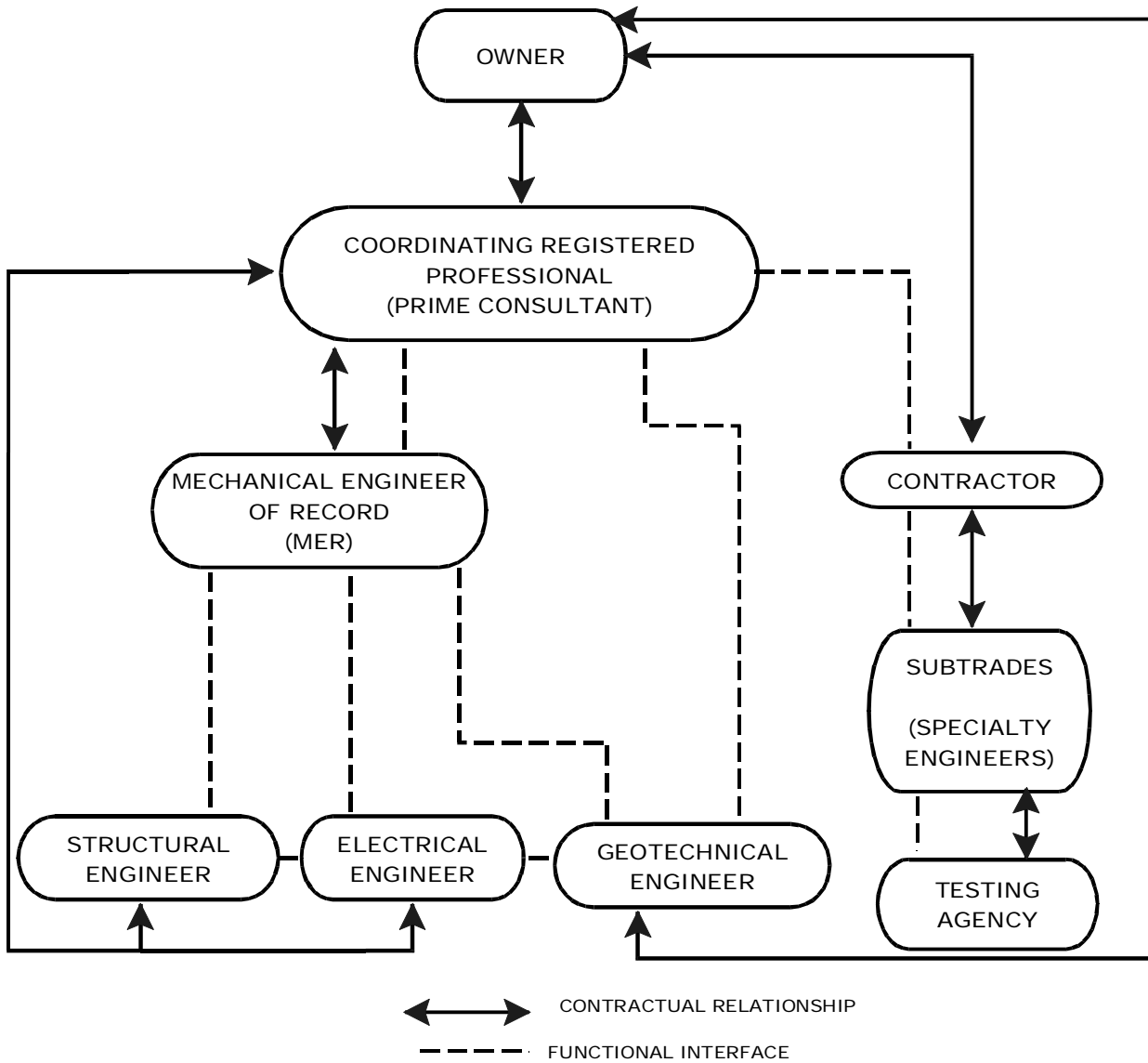
4.4.1 Shop Drawings

These are drawings produced by the fabricator to provide all information necessary for shop personnel to fabricate and assemble the items. The drawings shall be sealed, signed and dated when incorporating design by the *Specialty Engineer*.

COMMON ORGANIZATIONAL STRUCTURES

COMMON ORGANIZATION CHARTS

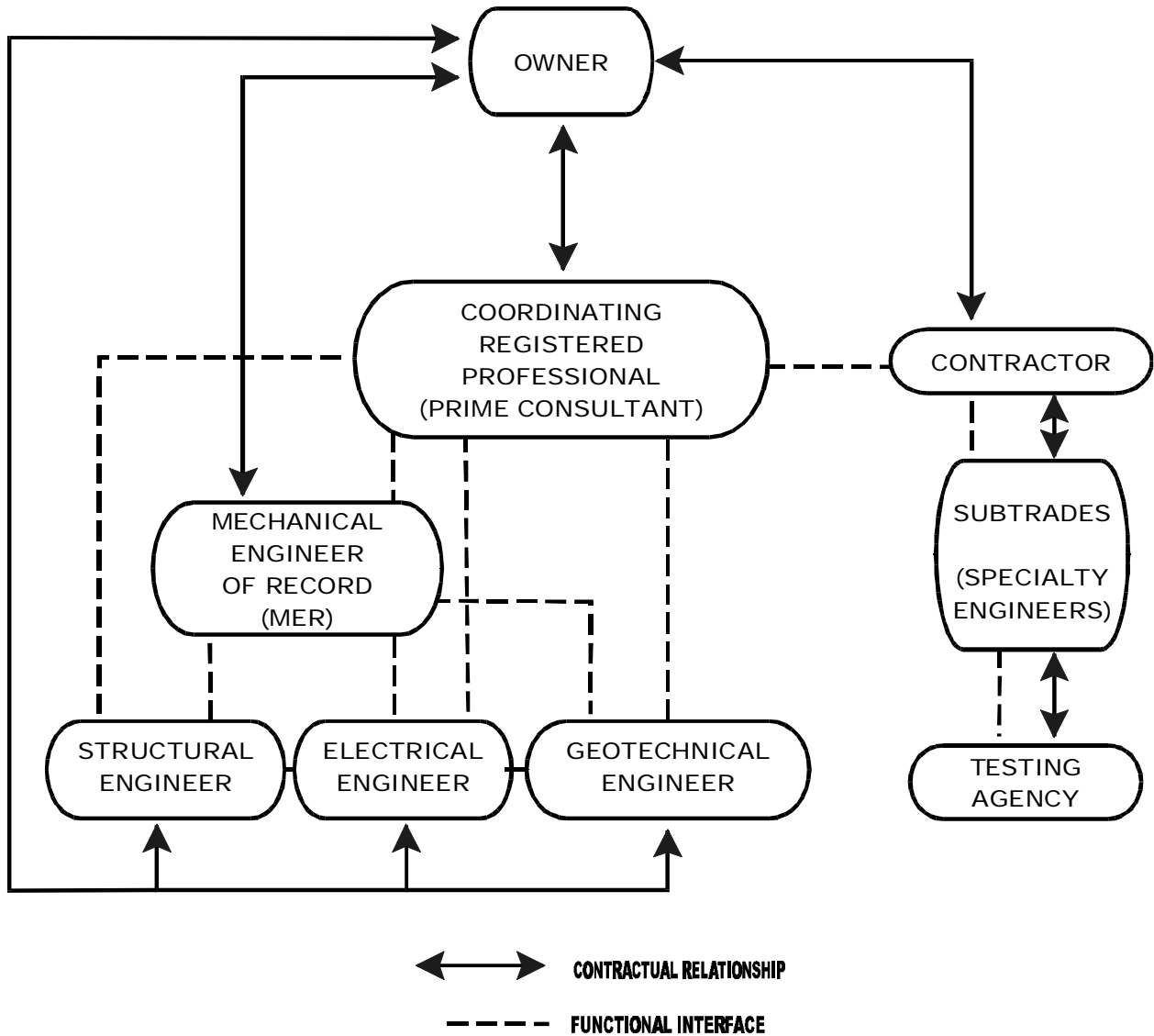
1. Mechanical Engineer of Record (MER)/Prime Consultant Contract



NOTE: The *Specialty Engineer* may be hired by the *Owner*, the *Mechanical Engineer of Record* or by contractors.

COMMON ORGANIZATION CHARTS

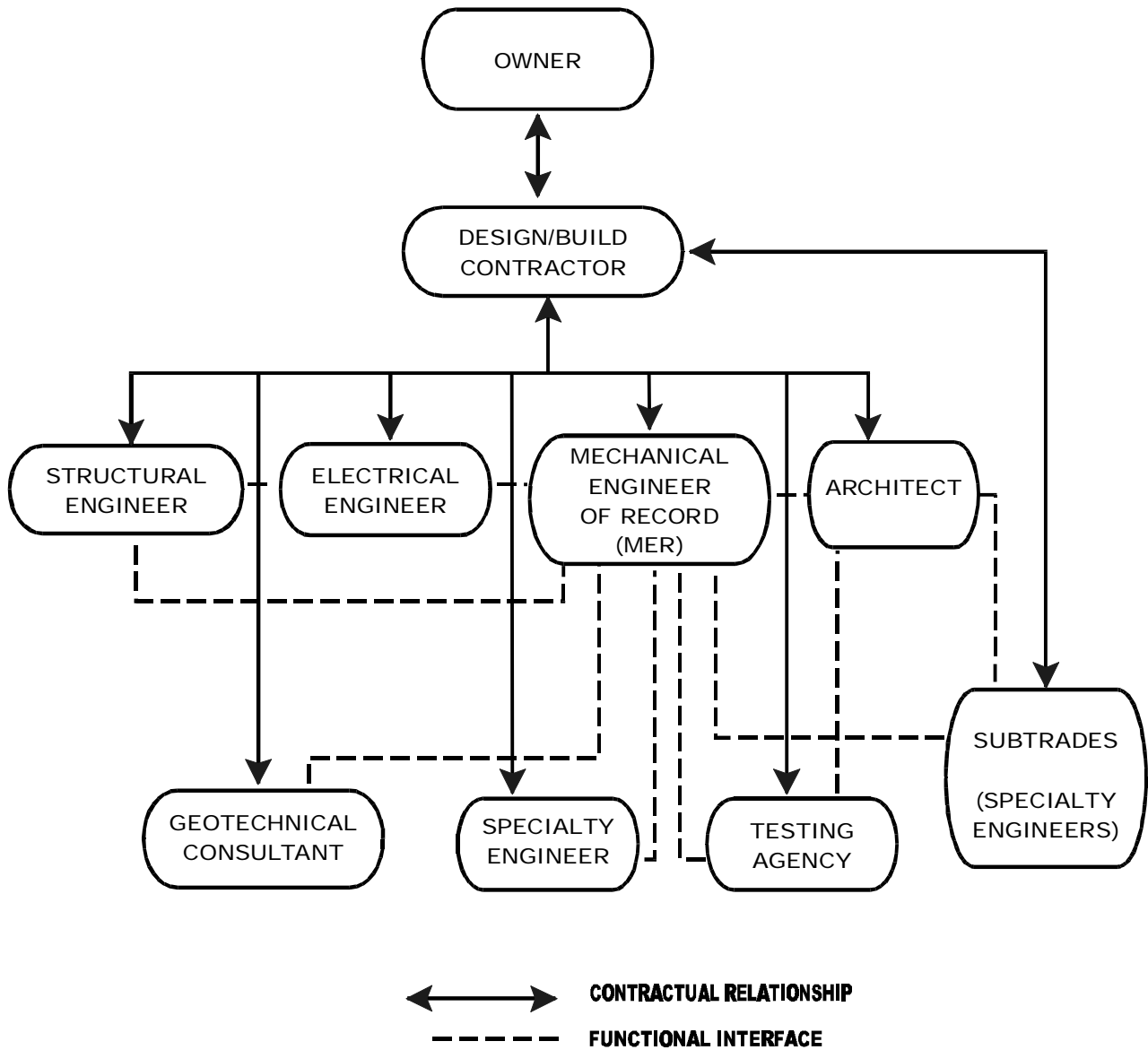
2. Mechanical Engineer of Record (MER)/Owner Contract



- NOTE:**
1. The *Specialty Engineer* may be hired by the *Owner*, the *Mechanical Engineer of Record* or by contractors.
 2. The *Coordinating Registered Professional* shall be responsible for coordination of the subconsultants even though they are hired by the *Owner*.

COMMON ORGANIZATION CHARTS

3. Design/Build Contract



NOTE: The *Specialty Engineer* may be hired by the *Owner*, the *Mechanical Engineer of Record* or by contractors.

6.0

BIBLIOGRAPHY

"Document No. 31", Association of Consulting Engineers of Canada.

"Outline of Services and Schedule of Fees for General Engineering Practice", Association of Professional Engineers and Geoscientists of British Columbia and Consulting Engineer of British Columbia.

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OF BRITISH COLUMBIA**

