

GUIDELINE

**Professional Engineers  
Providing Mechanical and  
Electrical Engineering  
Services in Buildings**

1997

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## FOREWORD

The Professional Engineers Act states that the principal mandate, or object, of the association is to regulate the practice of professional engineering and to govern its members\*, in order that the public interest may be served and protected. To assist in this, the Act lists several additional objects, one of which includes establishing standards of practice.

The association's publications on practice take two forms: guidelines, which are advisory, and performance standards, which are mandatory. Performance standards are made mandatory by including them in the Regulation made under the Professional Engineers Act. The association has decided that only standards of practice called for in "demand-side legislation"\*\* will be developed as performance standards. The remainder will be guidelines to advise on the standards that would normally be expected of a reasonable and prudent engineer.

The guidelines have been prepared by the association's Professional Practice Committee, and endorsed by the Council of the association, to assist in defining the scope of recommended services to be provided in the practice of professional engineering. They are not intended to be specific, limiting, or exhaustive in their coverage.

In addition, it is not intended that all listed services be provided on all projects. Certain projects, because of their nature, size, or complexity may require unusual treatment, possibly including such additional or special services as those listed in the guidelines. Engineers must exercise their professional judgment in recommending to clients which of the services listed in the guidelines should be applied to specific projects. They should also be cautious in making these recommendations; because of the comprehensive approach taken in compiling the guidelines, mandatory material is not always identified as such.

The association's suggested fee schedules give suggested fees on a time basis and on a percentage basis. The percentage-basis fee schedules are directly related to the guidelines, and are usually considered adequate to cover the expense of providing the basic engineering services outlined in the guidelines.

Individuals taking responsibility for professional engineering work in Ontario must be registered as Licensees (Members) or Temporary Licensees with the association, in accordance with the provisions of the Professional Engineers Act. In addition, individuals or firms offering or providing professional engineering services to the public must hold a Certificate of Authorization from the association.

The association may designate qualified professional engineers as Consulting Engineers, as an indication of these engineers' experience in providing consulting engineering services to the public. Qualified engineering firms that apply may also call themselves consulting engineers. Only those designated may use the title "Consulting Engineer(s)".

For further information on professional engineering services in general, or in relation to specific cases, contact: Director, Professional Practice, Professional Engineers Ontario, 25 Sheppard Avenue West, Suite 1000, Toronto, Ontario M2N 6S9; telephone: (416) 224-1100 or (800) 339-3716.

\* "Members" in this context includes "holders of Certificates of Authorization", "holders of temporary licences" and "holders of limited licences".

\*\* "Demand-side legislation" is provincial legislation that contains a requirement that a service, such as an opinion or review, be provided by a professional engineer, e.g. the Building Code Act.

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## INTRODUCTION

This guideline addresses the services offered by engineers for mechanical and electrical engineering work in buildings. The services are of two types: basic engineering services and special engineering services, which are additional services that may be performed for an extra fee.

The basic service is a full engineering service, comprising the individual services included in preliminary design, preparation of final plans and specifications and general review during construction. Each of these three phases of the basic service is dealt with separately in this guideline.

Fees for basic services are not presented in this guideline, but may be found in the PEO *Schedule of Fees for Engineering Services*.

Special, or additional, services do not usually include all of the three phases within the basic services category. For example, a study of indoor air quality, which is a special service, would not require the general review component of the complete basic services package. However, the engineering services for certain intricate fighting installations, which may also be a special engineering service, would probably require many components of all three phases.

Since special services are by definition non-standard, no fee schedule is available. The engineer and the client should mutually determine the appropriate fee or fee basis.

Regardless of the category of engineering service, an uncompromising application of engineering knowledge and experience is necessary to provide effective, functional and economical designs and executions. An inappropriate reduction of engineering fees will generally have a negative impact on construction and operation costs, and on long-term viability. If fees are less than those given in the PEO *Schedule of Suggested Fees* for basic engineering services, or when they do not reflect the additional requirements of special services, they may be inadequate to provide a level of engineering service that is in the long-term best interests of clients, engineers and users.

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## 1. PROJECT TEAM ORGANIZATION AND RESPONSIBILITIES OF TEAM MEMBERS

### 1.1 Project Team Organization

Every engineering project involves three key participants: the client, who determines the scope, specific needs and budget for the project; the engineer, who provides technical advice and guidance and translates the client's needs into a set of tender documents; and the contractor, who implements the requirements of the drawings and specifications and constructs the project to produce an operating entity that satisfies the client's needs.

For the interests of the client, the public and the project team to be best served, it is essential that team members be effective and efficient as individuals, and cooperate with and support each other as a well coordinated unit. The result will be a synergy of accomplishment that will provide extra benefits to all concerned. Not the least of these will be a valuable contribution to developing our ability to compete globally as complete project teams and as individual service providers.

Changing world conditions, new market locations, technological developments, foreign competition, energy conservation concerns and other socio-economic factors are rapidly increasing the challenges facing engineering service providers. Meeting these challenges requires innovative technology and designs, and new organization structures, e.g. the custom-designed project teams and organizations required to complete complex major construction projects successfully in the future.

Complicating the structure of future project teams is the changing approach to how project specifications are written, e.g. performance specifications versus prescriptive specifications; the increasing use of large prefabricated components; the trend toward involving private sector professionals in the building inspection process; changes to the assignment of responsibility and liability to project team members; increased interest in the various levels of commissioning of buildings and their components; growth in project complexity and the need for specialist consultants; and identification of further areas where a duty of care must be accepted, for example, out-gassing of materials in buildings or noise pollution.

Whether as prime consultant, consultant, or employee engineer, the professional engineer may be involved in a variety of project organizations that cannot be predicted in advance and for which individual guidelines cannot be provided. The engineer, however, should be able to serve effectively in most arrangements.

Regardless of structure, however, all of these organizations should not only optimize the benefits clients will ultimately derive from the project, but also optimize the potential for the engineer to exercise full professional responsibility. The engineer's position in the project management hierarchy may be critical in this respect. Some professionals give so much importance to this matter that they feel it necessary to crystallize reporting relationships in formal organization charts.

## **1.2 Responsibilities of Team Members**

For a project team organization to be completely effective, it is essential that each member operates efficiently and in full cooperation with the other members. There must be a common and accepted understanding of the organizational structure and its method of operation and of the project's objectives, performance criteria and general expectations. Not only must the members work together in the project organization as a well coordinated unit, but the total project responsibilities must also be divided carefully among the members and clearly delineated. This will help to avoid gaps or overlaps in coverage, misunderstandings and disputes.

Technological advancement, increasing socio-economic concerns and general changes in the environment in which engineering services are provided have greatly increased the scope of an engineer's professional responsibilities and the potential for additional services, e.g. environmental or conservation duties of care. Some of these new services are mandated by legislation; others are at the option of project clients. In any event, they are services that engineers should bring to the attention of project clients. Engineers should also ensure that the project organization and contractual documentation will allow at least those that are mandatory to be fully and appropriately delivered. Unless engineers exercise due caution, project and organizational complexity can cause an inadvertent failure to provide a complete engineering service. In summary, the detailed assignment of responsibilities to each team member should be unequivocally clear. Besides avoiding misunderstandings and simplifying project management, this extra detail will help in arriving at a rationalized total fee allocation and a fee allocation among the various service providers.

Unfortunately, the background work that would be required to realize the foregoing concepts fully to the degree of sophistication indicated has not yet been carried out; however, the increasing complexities of the engineering environment and the growing litigiousness of the business world may accelerate its completeness. In the meantime, the engineer will appreciate that while nearly all projects are becoming more complex, many small projects are not encumbered by the extreme complications of large undertakings and are therefore still relatively free from difficulty.

Pending development of a comprehensive and standardized documentation procedure, we will continue to be served by an extensive accumulated history of experience. This history forms a helpful understanding of the delivery of mechanical and electrical engineering services as part of project teams. It is a tribute to our industry and our professions that these incompletely documented traditions or understandings have served the industry so well up to now and have made possible the use of short-form contracts or agreements on many occasions.

The following sections of this guideline attempt to set forth some of the underlying notions that would form the basis of a responsibility/team member/fee matrix. The first sections outline some of the responsibilities of the different team members. The next sections deal with the services that are considered to be part of basic mechanical and electrical engineering services in buildings. The final sections deal with those services that are deemed to be special or additional services.

Underlying all of the recommendations is the basic premise that all project team members recognize, respect and accept all members' professional responsibilities, standards, codes of practice and ethics, and respected traditions, which should be neither breached nor compromised.

## **1.3 Responsibilities of Clients**

(See also PEO's *Agreement for Professional Engineering Services Between Client and Engineer*)

Clients are normally responsible for:

- ◆ giving the engineer authority to act as the client's agent in all matters falling within the scope of the engineer's services;
- ◆ designating in writing a representative to have authority to transmit instruction to and receive

information from the engineer;

- ◆ engaging specialist consultants directly when required by engineers to perform services necessary to enable them to carry out their duties fully. For example, such services might include a legal survey of the site, site services data, geotechnical reports and appropriate testing;
- ◆ supplying all relevant data and information necessary to define the client's requirements, and providing this material in reasonable time to allow the engineer to perform all required duties effectively and efficiently. This material should include such information as design objectives, constraints and criteria, special equipment and systems, site requirements and construction budget. The engineer should be entitled to rely upon the accuracy and completeness of all such information and data furnished through the client or client's consultants, whether or not such consultants are engaged at the request of the engineer;
- ◆ arranging and making provision for engineers' entry and access to public and private property and project sites in the performance of their duties;
- ◆ reviewing and providing prompt response on all sketches, drawings, reports, recommendations, tender documents and other matters referred by the engineer or prime consultant;
- ◆ obtaining all necessary permits, approvals, licences and consents from authorities having jurisdiction;
- ◆ arranging and paying for tender advertising and any necessary legal, financial, or insurance counselling services required for the project;
- ◆ immediately notifying the engineer whenever the client or the client's representative becomes aware of a defect or deficiency in the work or the contract documents;
- ◆ providing written authorization for any additional engineering services that may be required beyond the scope of the engineer's contract;
- ◆ paying the engineer and contractor(s) in accordance with the agreement between the parties in a timely fashion on the basis of progress and work completed.

#### **1.4 Responsibilities of Engineers**

Engineer should:

- ◆ prepare "tender drawings" that are of sufficient detail to enable those tendering to interpret the design for the work and to submit competitive tenders for the execution of the work;
- ◆ exercise all reasonable skill, care and diligence in discharging the agreed duties. If in performing these duties the engineer must use discretion in balancing the needs of the client and the subcontractor, the engineer should exercise this discretion fairly;
- ◆ recommend, where appropriate, that specialist consultants, suppliers and/or contractors should design and execute a part or parts of the work. The engineer should clearly define the scope of the work to be performed by these specialists;
- ◆ assist the client in obtaining all necessary permits, approvals, licences and consents from authorities having jurisdiction;
- ◆ review and provide response promptly on all sketches, drawings, reports, recommendations, tender documents and other matters referred by the prime consultant, contractor or others;
- ◆ coordinate the designs and general review of all of the project systems and system components within the assigned scope of services, when a prime or supervising consultant;
- ◆ sign and seal all contract documents in accordance with the Engineers Act and Regulations.

#### **1.5 Responsibilities of Contractors**

Contractors are normally responsible for:

- ◆ the labour, materials and equipment for the work;

- ◆ the construction methods, techniques, sequences, procedures, safety precautions and programs associated with the construction work, as set out in the contract documents;
- ◆ reviewing tender documents and notifying the engineer of any observed ambiguities or omissions;
- ◆ providing a complete operating system with all necessary components to meet the performance levels specified in the contract;
- ◆ coordinating work with other affected trades, to ensure a proper and complete installation;
- ◆ coordinating and checking the work of subcontractors;
- ◆ preparing “installation drawings”, to assist in coordinating all services. Drawings should be detailed sufficiently to enable all services to be installed efficiently where a multiplicity of materials or apparatus are involved;
- ◆ altering services without charge where the contractor has installed the services improperly;
- ◆ starting-up and testing the systems and instructing clients in their proper use;
- ◆ providing “as-built” drawings and manufacturer’s data/information, as required in the construction contract;
- ◆ carrying out the construction contract according to the design documents, relevant codes and standards, requirements of authorities having jurisdiction and good construction practice;
- ◆ providing warranties and guarantees, as specified in the construction contract;
- ◆ providing bonds and obtaining insurance, as specified in the construction contract;
- ◆ providing reasonable notice to the engineer when work is ready for general review;
- ◆ cooperating fully with all authorities having jurisdiction, e.g. building inspectors, boiler inspectors, electrical inspectors;
- ◆ paying suppliers and subcontractors, according to all agreements, in a timely fashion on the basis of progress and work completed.

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## 2. BASIC MECHANICAL AND ELECTRICAL ENGINEERING SERVICES

Basic engineering services may be conveniently divided into three natural groupings, or phases, according to their usual sequence in an engineering project.

The three phases are:

- ◆ preliminary design;
- ◆ final plans and specifications;
- ◆ general review during construction.

Because of a particular project’s requirements, it may be necessary for certain of these basic services to be performed out of their normal sequence, or in different phases than indicated in this guideline. Also, as previously noted, the list of services is not intended to be specific, limiting, or exhaustive in its coverage; not every service need be provided on every project and some additional services may be negotiated. The engineer must exercise professional judgment in recommending to a client which of the services should be included. However, all parties to a contract should be cautious in this process, since some of the services listed in this guideline *are mandatory* and must be included in every construction project, e.g. general review during construction is legislated, while some *are only recommended* for consideration on every project.

### 2.1 Phase 1-Preliminary Design

#### 2.1.1

In the preliminary design phase, engineers should define client requirements, establish parameters governing designs, and prepare preliminary/conceptual designs for the systems for which they are



responsible. This design should be based upon good engineering practice, which partly includes considerations of economy, performance, capital cost and operating cost, life expectancy, compatibility with other design elements and requirements of relevant codes and authorities. Engineers should also be mindful of their full professional responsibilities regarding environmental impacts, conservation of resources, personal security, health and other socio-economic concerns.

### 2.1.2

In performing the responsibilities outlined in 2.1.1, engineers should:

- ◆ meet with clients and other members of the design team;
- ◆ obtain clients' instructions on functional, aesthetic, cost, schedule and other requirements;
- ◆ confirm project team organization, channels of communication, operating protocol, number and timing of project team meetings, drawing and specifications standards and critical dates;
- ◆ visit the site and review existing drawings, where appropriate;
- ◆ identify and study reasonable alternative concepts, considering their relative capital, operating and maintenance costs and such other relevant factors as environmental impacts, personal security and indoor air quality;
- ◆ ensure conformance with applicable codes, regulations and restrictions, insurance requirements and other factors binding the design of the project;
- ◆ identify and consider any relevant non-binding guidelines;
- ◆ prepare and analyze the alternatives (including recommendations), when included in the scope of work, and obtain clients' approval;
- ◆ prepare design criteria, schematic layouts of systems and outline specifications for the major components and materials to be used, based on clients' direction regarding the alternative concepts, and obtain clients' approval before proceeding further;
- ◆ make preliminary estimates of equipment sizes, weights, noises, vibrations, fumes, heat emissions and other physical characteristics that should be considered in the building design. Engineers should make a preliminary determination of the impact of noise, vibration, and the other physical characteristics of the mechanical or electrical systems on clients operational requirements. Engineers should inform clients of the estimated impacts, and recommend solution(s), where appropriate. Specialists should be engaged for this purpose, if necessary;
- ◆ make recommendations to clients when such additional qualified professionals as acoustic or communication specialists are required, prepare terms of reference for these additional professionals, apprise the client of the arrangements when such additional professionals are engaged as specialists, and report and comment on the work of the additional professionals, where necessary;
- ◆ determine and request allocation of suitable spaces for equipment rooms, ducts, piping, vaults, motor control centres, and other major items of the mechanical or electrical installations;
- ◆ consider the requirements of the other design professionals and provide timely information, as required;
- ◆ prepare preliminary cost estimates, or cooperate appropriately with others responsible for the estimate. Where detailed cost estimating becomes a priority concern, clients should ask engineers to prepare a more detailed estimate as a special service, or engage a cost consultant for this task;
- ◆ consider and make recommendations regarding the project's commissioning;
- ◆ finalize the preliminary design, including appropriate sketches and conceptual drawings, descriptions of the major mechanical and electrical systems, components and materials, and revisions of cost estimates, following completion of the preceding steps.

### 2.1.3

Engineers should obtain approval of preliminary designs from clients before proceeding to Phase 2 - Final Plans and Specifications. This approval process may include a review of the design criteria, expected performance, forecasts of anticipated design, construction or operating issues, preliminary cost estimates, scheduling recommendations and any other relevant matters that should be considered before making a commitment to prepare the final plans and specifications.

## 2.2 Phase 2—Final Plans and Specifications

Based on preliminary designs approved by clients, engineers should develop final designs for the systems, including preparing suitable plans and specifications such that the systems will be safe, functional and in accordance with prevailing codes, regulations and good engineering practice, if built according to the plans and specifications. In this work, engineers should fully respect the performance, economic, conservation, environmental protection and other design criteria approved by clients during the preliminary design phase. Engineers should also continue to consider the other socio-economic concerns and responsibilities that are intrinsic to the pursuit of professional engineering excellence.

### 2.2.1 Final Plans and Specifications

In preparing final plans and specifications, engineers should:

- ◆ design systems in conformance with relevant regulations and standards, good engineering practices and the design criteria approved in 2.1.2;
- ◆ select appropriate equipment to meet design criteria and the results of the calculations performed;
- ◆ cooperate with other design professionals during design of the systems, and make known to them, through the prime consultant, any functional or aesthetic aspects of the systems that may affect the design of their systems. In addition, engineers should take into account design requirements of other design professionals. In particular, engineers should notify other design engineers of points of interface among the disciplines and determine as soon as possible the horsepower and other electrical requirements of all mechanical loads and the potential conflicts between the electrical and mechanical riser locations and distribution strata, sprinkler piping, etc.;
- ◆ submit progress reports, drawings and draft specifications, as agreed with the client or prime consultant.

### 2.2.2 Final Plans

#### 2.2.2.1

Engineers should prepare complete and clear contract drawings and specifications, to enable the required work to be carried out with a minimum of errors, omissions, conflicts with other work and changes not initiated by the client;

#### 2.2.2.2

Where possible, drawings should be made to the same scale as the building layout drawings, and should clearly define the work. In addition, engineers should:

- ◆ provide separate larger scale and/or more detailed drawings, if the drawings' scale or the work's complexity makes drawings difficult to read and interpret. For example, separate drawings will generally be required for any special systems requiring greater clarity and for such standard mechanical systems as:
  - i) plumbing and drainage;
  - ii) heating, ventilating and air conditioning;
  - iii) fire protection;
  - iv) process piping and equipment;and such electrical work such as:
  - i) lighting and power distribution systems;
  - ii) communication and signal systems;
  - iii) electrical space heating;
  - iv) underfloor raceways.
- ◆ provide schematics and diagrams, as required, for all major systems, with notes describing the functions of controls and with large-scale details to show plans and elevations of equipment;
- ◆ include symbol lists and typical details for all equipment, accessories, piping and duct systems, where required;

- ◆ provide typical details that indicate clearly the complexity of the work, possible interferences, critical dimensions and locations of equipment and services. Where variations or differences from the typical details are required, these locations should be indicated and the deviations should be described;
- ◆ cross-reference all drawings, as well as details, elevations and sections;
- ◆ include plot plans showing connections to such public utility services as water supply, gas supply, sanitary drainage, electric power and communications. Include depths or elevations relating to finished grade;
- ◆ include schedules that provide capacities and details of performance of fans, air handling units, pumps and other equipment. Alternatively, these may be included in the specifications;
- ◆ provide floor plan layouts for all pipe and duct systems. Show complete duct and pipe sizing on these drawings and indicate locations where changes in elevation occur. Show sizes, types, locations and capacities of all radiators, convectors and other heating devices, supply and exhaust diffusers and grilles, as well as the types and locations of valves, dampers, splitters, etc.;
- ◆ provide supplementary details for boiler rooms, equipment rooms and fan rooms, to facilitate consideration of alternatives when tendering and to facilitate construction. Also, provide such details as are necessary to illustrate capability to meet design intent for other congested areas, such as critical service cross-overs and junctions. In general, draw such details at 1:50 (1/4" to the foot) or larger in plan view and elevation, and include sufficient supplementary detail to clarify the work and to illustrate that adequate clearances are available for all equipment and distribution routes;
- ◆ show piping and ductwork in single line, except where necessary to show arrangements and clearance of piping or ductwork in ceiling spaces, shafts, header trenches, pipe chases and for tight or close-coupled items of equipment. In these cases, show piping and ductwork in double-line detail and in adequate scale, and include appropriate valves, fittings and accessories;
- ◆ clearly show all circuiting and switching on lighting plans. Reference dimensions to the reflected ceiling layouts are prepared by the prime consultant;
- ◆ detail power distribution drawings as single-line diagrams showing conductor capacities and calculated connected loads;
- ◆ show communication and signal systems by riser diagrams with locations of equipment, outlets and devices shown by symbols on the floor plans.

## 2.2.3 Final Specifications

### 2.2.3.1

Engineers should prepare specifications for all work for which they are responsible.

### 2.2.3.2

Specifications should be complete, clear and concise, with a statement setting forth the general scope of work, followed by an adequate description of the various classes of work segregated under proper sections and headings. Each section and heading should be numbered/identified for easy reference and indicated in a table of contents.

### 2.2.3.3

Use standard terms for materials and processes and adopt the same nomenclature as used by the prime consultant.

### 2.2.3.4

The specifications should include the designer's description of how the systems are to operate optimally, including required performance levels, testing, tolerances, workmanship, quality control, start-ups, submissions and warranties.

### 2.2.3.5

When an engineer's specification is based on one particular manufacturer but the engineer lists one or more other manufacturer(s) as being acceptable, the engineer should verify that the listed manufacturers' products will all physically fit in the space provided.

### 2.2.3.6

Engineers should assist clients in preparing specifications for finishes that affect the work.

#### 2.2.3.7

If an engineer will consider products or manufacturers besides those listed in the specifications, the engineer should clearly detail requirements regarding the proposal and use of such alternatives.

#### 2.2.3.8

To facilitate construction and coordination of large projects involving several subcontractors, engineers should recommend that the prime consultant include in the specifications that the general contractor should identify “coordinating” mechanical, electrical or mechanical and electrical contractors.

#### 2.2.3.9

Engineers should specify that coordinating contractors or, where none are designated, individual contractors should:

- ◆ faithfully follow the engineer’s design principles and requirements in preparing the construction/installation drawings and carrying out the construction;
- ◆ prepare the construction/installation drawings, considering the needs of all other project contractors.

Such drawings should:

- i) maintain project economics and performance for the client;
- ii) promote proper use and preservation of the designer’s space allocations;
- iii) provide sufficient detail to disclose critical interferences of major equipment and services and to ensure adequate accessibility;
- iv) indicate sleeves, openings and stress points (such as anchors, guides and inserts);
- v) indicate deviations in sizes and weights and also in water, drainage, electric power or other service requirements for all equipment proposed as alternatives to those shown on the contract drawings;
- vi) be provided to other project team members, to facilitate project coordination;
- vii) be updated after completion of construction to become part of the set of “as-built” drawings showing actual locations of major equipment, services, access doors, shut-off valves, electrical distribution boxes, etc.

### 2.2.4 Cost Estimates and Tendering

Engineers should supply final tender drawings and specifications according to the requirements of the contract between clients and engineers. (For comments on stamping and signing of drawings and specifications see Section 9.2 of PEO’s *Guideline to Professional Practice*, 1998 Revision.)

When included as a special service in the scope of work, engineers should provide clients with a more detailed cost estimate of the work, or comment on the work of independent cost consultants. Engineers should indicate that they cannot guarantee the accuracy of estimates, since actual costs are partially dependent on circumstances beyond their control.

Engineers should provide clients with all conditions governing unit prices, alternative prices and separate prices that contractors are to submit in tendering on the project.

When required, engineers should assist clients or prime consultants in calling and analyzing tenders.

Engineers should assist clients or prime consultants in answering queries raised by the bidding contractors during the tendering period, and prepare addenda when necessary.

If required, engineers should make recommendations on selecting contractors, subcontractors, and desired materials, equipment or systems.

## 2.3 Phase 3-General Review During Construction

### 2.3.1 General

During Phase 3, either the engineer who provided the design service or another appropriately qualified engineer is required by the Building Code Act to provide “general review” services during con-

struction, alteration or enlargement of a building. PEO's performance standards for the general review of a building must be followed during the course of Phase 3. These mandatory performance standards are found in the Regulation made under the Professional Engineers Act. They are reproduced in the Appendix to this guideline.

The performance standards state that an engineer performing a "general review" should "make periodic visits to the site to determine, on a rational sampling basis, whether the work is in general conformity with the plans and specifications for the building".

It is important that engineers and other project team members understand the engineer's responsibilities with respect to "general review", including the meaning of the term "rational sampling".

Before commencing office or field review duties, engineers should define for clients, the details and extent of the rational sampling procedures they propose to follow in the general review of the contractor's performance.

### 2.3.2 Office Functions of an Engineer Providing General Review

Engineers should:

#### 2.3.2.1

advise contractors on interpreting the drawings and specifications, and issue supplementary details and instructions during the construction period, as required. If a professional engineer other than the design engineer carries out the general review, that other engineer should consult the design engineer whenever assistance is required in interpreting the drawings and specifications, or when changes to the original plans are contemplated;

#### 2.3.2.2

prepare terms of reference covering the work of independent inspection and testing companies and review their reports in conjunction with the engineer's own general review, when part of the agreed scope of services;

#### 2.3.2.3

review submitted shop drawings, equipment tests, samples and balancing reports to the degree necessary to assure themselves of consistency with the intent of the contract, plans, specifications and applicable codes and standards;

#### 2.3.2.4

ensure that shop drawings that incorporate design by another engineer are sealed, signed and dated by that specialty engineer. Other submissions, such as test results, should have similar professional endorsement, as appropriate. To clarify responsibility, a specialty engineer may indicate the extent of the work that has been designed by the specialist;

#### 2.3.2.5

ensure that submissions have been reviewed by the prime contractor.

*Note.- Shop drawing review does not generally include detailed checking of dimensions or quantities nor the review of the contractor's safety measures or methods of construction. The engineer must assume that shop drawings have been prepared competently and to standard industry practice;*

#### 2.3.2.6

provide clients with copies of all relevant correspondence affecting construction and costs;

#### 2.3.2.7

review and respond to the construction schedule proposed by the contractor, with regard to clients' operations and other contracts;

#### 2.3.2.8

review charges for contract additions or deletions and draft applicable change orders, as appropriate;

#### 2.3.2.9

recommend the withholding of an appropriate amount of payment for faulty or incomplete work;

#### 2.3.2.10

review and transmit to clients all guarantees, warranties, bonds, etc.;

#### 2.3.2.11

review “as-built” drawings submitted by contractors. “As-built” drawings should reflect the as-built condition of the project when turned over to the client. Clients should be made aware that these drawings, sometimes called “record drawings”, are prepared by the contractor and have been reviewed only for general conformance to the drawing standards and the intent of the design, and that the engineer cannot accept responsibility for their completeness and accuracy;

#### 2.3.2.12

arrange for contractors to submit operating and maintenance data for the equipment and systems supplied on the project. Review this data to ensure it is appropriate. The data submitted should include: manufacturers’ recommendations for maintenance of each piece of equipment, spare parts lists, wiring diagrams, normal operating ranges of equipment, limitations of equipment and other information that will enable clients to assume operation of the building in accordance with building design criteria. *Note: “Commissioning” and preparing operating and maintenance manuals go beyond basic engineering services and are included in the special additional mechanical and electrical engineering services,*

#### 2.3.2.13

execute responsibilities that may be specified in a related commissioning contract.

### 2.3.3 Site Functions of an Engineer Providing General Review

Engineers should:

#### 2.3.3.1

make periodic visits to the site during construction, to ascertain that the work is being executed in general conformance with the plans and specifications, with particular attention to life safety systems. Immediately notify the contractor regarding any emergency matters. Submit after each visit a written progress/deficiency report to clients/contractors and building authorities as necessary. This report must include actions required to rectify the deficiencies;

#### 2.3.3.2

check and make appropriate recommendations on the contractor’s applications for progress payments. This includes estimating completed work in place. Materials on site but not yet installed are not generally included in the progress payment;

#### 2.3.3.3

schedule testing and inspection of materials and work by an inspection and testing company, when the contract calls for such testing and inspection;

#### 2.3.3.4

attend site meetings to clarify contract documents, or advise on project coordination issues or other issues raised by the general contractor, the various trades, or other project team members, and to monitor progress of the work;

#### 2.3.3.5

attend the start-up of major systems and major system components and respond as required (including written documentation) to any operational difficulties encountered relating to the design. Arrange and perform final inspections once contractors have given notification of substantial completion of the project. Prepare and submit a list of deficiencies (workmanship, completeness and function) and when these have been rectified, issue the final report;

#### 2.3.3.6

execute responsibilities that may be specified in a related commissioning contract, which has been undertaken as an additional service.

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### **3. SPECIAL/ADDITIONAL MECHANICAL AND ELECTRICAL ENGINEERING SERVICES**

The following are special services that do not form part of the basic services, or that exceed the extent or level of the normal basic services provided by engineers under preliminary design, final plans and specifications and general review during construction. Engineers may provide the following special/additional services within the scope of their experience and ability. These extra services should be clearly and fully detailed as part of the service requirements in the project description or contractual agreement.

#### **3.1 Advisory Services**

These extra services include appearing as an expert witness in connection with any public hearing, arbitration or court proceeding; other testimony; consultation and advice; appraisals; valuations; research, or other services leading to specialized conclusions and recommendations, including preparation, attendance and presentation expenses.

#### **3.2 Feasibility Studies**

These extra services comprise preliminary engineering studies and the collation and processing of information to assess the feasibility of a project or to select one of several alternative systems or courses of action relative to the project. Generally included are such matters as gathering data on site conditions affecting design, analysis of systems or of several alternative plans; economic study of capital and operating costs and other financial considerations; and environmental impact studies and similar matters leading to conclusions on which recommendations regarding the project will be based. These services include detailed discussions with municipal authorities on the systems proposed.

#### **3.3 Surveys of Existing Mechanical/Electrical Equipment**

These extra services include detailed surveys, measurements or evaluations of existing mechanical/electrical equipment or systems. This may include securing information on existing physical plant or loadings, e.g. unusual machinery or construction; electrical load distribution.

#### **3.4 Balancing Air and Water/Liquid Systems**

This extra service involves the actual detailed balancing and adjustment of air and water/liquid systems, including heating, air conditioning and ventilation systems and piping networks as installed. *Note: It is customary to include in the specifications a detailed outline of the balancing procedure to be performed by a skilled engineer with experience in this field. This engineer, acting as a subcontractor, will supervise and assist the contractor in the proper balancing procedure. The contractor will also prepare the balancing reports for submission to the engineer. Alternatively, the balancing contractor may work directly for the client or owner. where provision is made in the engineer's fee, the balancing contractor may work for the engineer.*

#### **3.5 Indoor Air Quality Studies**

This extra service may involve surveys, measurements, analysis and recommendations for remedial measures relating to indoor air quality in buildings.

#### **3.6 Computerized Energy Analysis**

This extra service involves using computer programs to simulate the amount of energy used in the building. The program is used to optimize the effects of varying architectural features, mechanical systems and electrical systems.

#### **3.7 Revisions to Designs, Drawings and Specifications**

These extra services include extensive revisions to designs, drawings or specifications caused by client-originated changes after commencement of final plans and specifications. Examples are changes in scope, size, complexity, diversity, equipment, function and performance levels.

### **3.8 Detailed Construction Review**

This extra service involves providing directly assigned field staff for resident inspection of construction. Note that under general review of construction, only periodic visits to the site are provided. Where more detailed checking of field work is deemed necessary, engineers may be engaged to provide field staff on a part-time or full-time (resident) basis.

These review/inspection services do not include the broader management responsibilities covered in construction management or project management, nor do these services include directing personnel or selecting, directing or approving methods and equipment employed by the contractor in any phase of construction. The start-up of any plant or equipment is also *not* included.

### **3.9 Provision of “As-Built” Drawings**

This extra service involves providing revised or completely new drawings as necessary to show “as-built” conditions. *Note: It is customary for engineers to include in the specification a requirement for providing white prints marked up “as-built” by the contractor. These prints would probably be the basis for preparing the formal “as-built” or “record” drawings. Engineers cannot guarantee the accuracy of information provided by contractors.*

### **3.10 Preparation of Bills of Materials**

This extra service involves preparing bills of materials or schedules of materials at any time during the project.

### **3.11 Preparation of Operating Manuals and Start-up Assistance**

This extra service involves preparing operating and maintenance instructions or manuals beyond those included as part of the general basic service contract. This service may include such work as the description of operating characteristics of systems and equipment under full load and all phases of partial loading. Another example is development of computerized maintenance and operating schedules.

Start-up assistance beyond that reasonably included in the basic service may also be requested for complex projects.

See the sections on “Commissioning” and “Post-construction Inspection”.

### **3.12 Translation, Conversion, Change of Scale**

This extra service involves translating contractual documents into a second language, converting from metric to imperial units or the reverse, or preparing drawings of reduced or expanded scale.

### **3.13 Commissioning**

Commissioning of a project is an extra service that may vary widely in scope and that may involve working with clients’ and contractors’ personnel. It is intended generally to ensure that systems are operating safely, efficiently and according to their design performance objectives. *Note: Commissioning is a broad concept that goes beyond system start-up. It is usually contractors’ responsibility to install and start up a fully operational system as required by the design specifications and drawings. Sometimes engineers may be requested to aid in this start-up process, since, as the system designers, engineers are the most knowledgeable about how it is intended to operate and how to adjust it. This start-up assistance is deemed to be an extra service.*

In full commissioning projects in which the performance of all building systems is tested and optimized, engineers may be in complete charge of the commissioning project. In projects that are less comprehensive, engineers may be asked to assist others with certain specific assignments. For example, engineers may be requested to assist with certification inspection and testing of life safety systems, or to obtain smoke emission certificates.

During commissioning, the client’s operating personnel may require a variety of assistance. This could range from explanation of the system’s operating characteristics to minor design changes or adjusting a system to achieve satisfactory operation. More elaborate commissioning services could involve formal education/training programs, fully comprehensive operating and maintenance manuals and



adjustments for optimum system performance. (See “Preparation of Operating Manuals and Start-up Assistance” and “Post-construction inspection”.)

### **3.14 “Fast Track”, Phased and Other Bid Packages**

As an extra service, engineers may be requested by prime consultants or project managers to prepare several separate bid packages, instead of the normal single package. This may facilitate an earlier-than-normal start of construction or other benefits. In the case of a very large project, engineers may be requested to split the work into more manageable packages to increase competition. In these cases, complete tender documentation and supporting services will be required for each bid package, necessitating extra work on engineers’ part.

### **3.15 Post-construction Inspection**

As an extra service and before the project guarantee period(s) expire, engineers may be requested by owners to re-inspect the project, as an extra service, Engineers making the inspection should concentrate on equipment or system deficiencies relating to faulty installation or equipment. A request to inspect for maintenance-related deficiencies should be treated as a separate service. Note the relationship of these extra post-construction inspections to commissioning.

### **3.16 Building Permits and Other Permits**

This extra service covers the work involved in filing an application for and obtaining a building, demolition, or other permits. Generally, the owner will pay the municipality for the permit(s).

### **3.17 Detailed Cost Estimates**

This service provides for preparing or assisting with preparing a detailed cost estimate. Engineers should clearly state the variables in the estimate and the inherent variance involved. Where the degree of variance is critical, they should obtain a second independent estimate.

### **3.18 Models and Simulations**

This extra service includes preparing physical models and using them in design work. Some amount of computer modeling or other simulations may be included as part of the basic engineering service.

### **3.19 Preparation Of Client Programs/Standards**

This extra service covers preparing programs or standards for such items as a client’s mechanical or electrical equipment or systems. Developing these programs requires an investigation and analysis of user requirements and their translation into specific standards for systems, equipment, materials and their performance criteria.

### **3.20 Construction Management or Project Management**

This extra service involves extra supervisory or management services beyond those included in the engineer’s standard “general review” requirements. Note that the comprehensive management service provided here exceeds the review/inspection responsibilities covered under detailed construction review, although these may be included as part of the management service.

### **3.21 Confirmation of Compatibility of “Other” Equipment**

This extra service provides for review of items to be supplied by the client, to confirm their compatibility with the mechanical or electrical systems.

### **3.22 In-factory Or Pre-delivery Testing**

This extra service covers visits to factories or other locations to inspect material or equipment or to witness performance tests prior to acceptance for delivery to the construction site.

### **3.23 Electrical Coordination/Circuit Breaker Verification**

This extra service provides for coordination studies of electrical distribution systems, including confirmation of circuit breaker and fuse reaction times and adjustment of reaction times on site as required.

### **3.24 Communication Systems and Security Systems Studies**

These extra services involve the required investigation and analysis to develop proposals for such communications systems as intercommunication systems and the various types of security alarm systems.

### **3.25 Specialized Lighting Designs**

This extra service involves designing special lighting to meet unusual technical or architectural requirements, or to create such special effects as building design features, e.g. theatre lobby lighting, special display lighting, hotel public area lighting, etc.

### **3.26 Preparation of Additional Designs and Documentation**

These extra services include preparing (or reviewing) and any related administration of additional/alternative designs and related documentation:

#### **3.26.1**

as additional conceptual or schematic presentations beyond those that could reasonably be expected as a preliminary design service;

#### **3.26.2**

after work has started on final plans and specifications based on a design concept selected and agreed on in the preliminary design phase;

#### **3.26.3**

when requested in order to obtain competitive bids for proprietary products;

#### **3.26.4**

resulting from necessary changes caused by a construction cost overrun beyond the engineer's control;

#### **3.26.5**

caused by work resulting from corrections or revisions required because of contractors' errors or omissions in construction.

### **3.27 Engineering Services for Future Construction**

These extra services include preparing designs and documentation for future implementation and are not included in a current contract for construction.

### **3.28 Long Range Planning**

These extra services include preparing, analyzing or reviewing conceptual designs, reports or sketches for future implementation, e.g. master plans.

### **3.29 Environmental Assessments and Environmental Approvals**

#### **3.29.1**

See "Feasibility Studies" and "Building Permits and Other Permits".

### **3.30 Reports and Documents Required for Financing a Project**

This extra service covers preparing material that may be required to arrange financing for a project.

### **3.31 Coordination of Specialist Consultants**

This extra service covers the pre-engagement and subsequent coordination work of the engineer relating to a specialist consultant engaged and paid directly by the client.

### **3.32 Work Necessitated by Special Circumstances**

This extra service covers work caused by damage due to fire, environmental contamination, or other human-induced disasters and such natural disasters as floods or earthquakes.

### **3.33 Scheduling Changes**

This extra service results from accelerating or decelerating a project. It may extend time schedules for design or construction, thereby increasing costs or decreasing time schedules, which will then require an overtime premium or other cost changes

### **3.34 Demolition Documents**

This extra service includes the work in preparing engineering documentation and general review for projects, such as building demolition or plant dismantling.

### **3.35 Tenant-related Design Services**

This extra service covers building tenants' engineering requirements that are not included in the base contract.

### **3.36 Unusual Travelling Time Requirements**

This extra service arises when a project requires the expenditure of an unreasonable amount of time in travelling.

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## **APPENDIX 1. PERFORMANCE STANDARDS**

### **Section 78:**

Excerpt from R.R.O 1990, Regulation 941:

“The following are prescribed as performance standards with respect to the general review of the construction, enlargement or alteration of a building by a professional engineer as provided for in the building code made under the *Building Code Act*:

1. The professional engineer, with respect to the matters that are governed by the Building Code, shall:
  - i) make periodic visits to the site to determine, on a rational sampling basis, whether the work is in general conformity with the plans and specifications for the building;
  - ii) record deficiencies found during site visits and provide the client, the contractor and the owner with written reports of the deficiencies and the actions that must be taken to rectify the deficiencies;
  - iii) review the reports of independent inspection and testing companies called for in the plans and specifications and that pertain directly to the work being reviewed;
  - iv) interpret plans and specifications when requested to do so by clients, contractors or owners; and
  - v) review shop drawings and samples submitted by the contractor for consistency with the intent of the plans and specifications.
2. The professional engineer shall not review work in disciplines in which he or she is not qualified.
3. The professional engineer may delegate one or more of the functions described in paragraph 1 to another person where it is consistent with prudent engineering practice to do so and the functions are performed under the supervision of the professional engineer.
4. In paragraph 1, ‘plans and specifications’ means a plan or other document which formed the basis for issuing a building permit, and includes all changes thereto that were authorized by the chief official as defined in the Building Code Act. O. Reg. 421-86, s91a.”



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