GUIDELINE

Professional Engineers Providing Project Management Services

1991

Published by
Association of Professional Engineers of Ontario

CONTENTS

FOREWORD

Today, the project management approach is used in construction, aerospace, government agencies, research and development, manufacturing, electronics and many other industries, and the term project management may mean different things to different people depending upon the particular application, Generally, this guideline has been prepared with a view to its application to construction projects; however, the basic project management principles are applicable to a wide variety of projects such as major maintenance and repair projects, renovations, relocations and re-organizations.

This guideline has been prepared by a committee of the Association of Professional Engineers of Ontario and has been endorsed by the Council of the Association. It replaces the guideline published by the Association of Professional Engineers of Ontario in 1984. The guideline covers the broad spectrum of services that can be provided by professional engineers in the field of project management. It is not intended to be specific or limiting in scope but is intended to define what would normally be done in a given situation, not how to do it, or who is contractually responsible for carrying it out. Individual agreements for the provision of project management services should define the selected scope of services to be provided by the engineer on a specific project and the contractual responsibilities of the various parties involved.

While project management skills are quite distinct from engineering design skills, the requirements of good project management are not basically different from the requirements of good engineering or good management, and some overlap may therefore be evident when comparing this guideline with the guidelines and performance standard of the Association of Professional Engineers of Ontario relating to various specific engineering services.

This guideline is primarily intended to serve as a guide to professional engineers in respect of the suggested scope and extent of services which may be considered on an assignment involving the provision of project management services and also for the guidance of prospective clients who may wish to engage a professional engineer offering project management services. In many instances this guideline may also serve as a useful guide to "in-house" project managers.

Suggested fee arrangements for the provision of project management services have not been included in this guideline as the appropriate basis of remuneration is extremely variable, depending upon the scope of contractual responsibilities. For the guidance of clients contemplating the selection of a professional engineer to provide project management services or any other services, reference should be made to the separate document published by the Association of Professional Engineers of Ontario which covers the procedure for the selection of an engineer to provide professional services.

All professional engineers are governed in their practice by Regulations established by the Council of the Association including such matters as the Code of Ethics.

1.0 GENERAL INFORMATION AND DEFINITIONS

This guideline has been prepared for the consideration of the professional engineer who is responsible for a project in the capacity of project manager, and for the information of clients who may be contemplating engaging a professional engineer to provide project management services.

This guideline defines what functions the professional engineer would normally perform in a typical project situation. What the professional engineer ought to do will be determined by the particular circumstances and, most importantly, by the various contractual conditions and relationships which apply to the particular project situation.

The term 'engineer' means the professional engineer retained by the client to provide project management services in the capacity of a project manager.

The term "client" means the person, firm or authority, to whom the engineer is responsible.

The term 'consultant" means the person or firm recognized in its field of expertise, retained directly by the engineer, or by the engineer as agent of the client, or directly by the client, to provide advice, designs, plans or specifications, or other technical services to aid in the implementation of the project.

The term "construction manager' means the person or firm retained directly by the engineer, or by the engineer as agent of the client, or directly by the client, to act as agent, to oversee and manage the efforts of contractors and suppliers in the implementation of a project involving construction.

The term "contractor" means the person or firm that constructs, builds or otherwise implements any part of the project.

The term "supplier" means the person or firm that provides materials, equipment or services required for the construction or implementation of the project.

2.0 PROJECT MANAGEMENT

A project is defined as an undertaking of a non-routine, non-repetitive nature having prescribed objectives in terms of scope, time, quality and cost. Within the realm of project management such projects can be further defined as generally being complex, having a multi-disciplinary involvement and having various phases in their life span. The various phases of a project may be defined differently by different organizations but they generally fall into the following categories: concept (or feasibility), preliminary design, detailed design and engineering, implementation, and commissioning. The completion of each of these project phases is usually accompanied by a finished project of some sort.

Project management is the comprehensive management and control of any or all aspects of a project throughout all phases of its life to achieve those prescribed objectives defined in terms of scope, time, quality and cost. Through the application of appropriate management techniques, the engineer would direct and co-ordinate the efforts of the multi-disciplinary team to achieve the objectives of a project to meet the client's requirements.

3.0 SCOPE OF PROJECT MANAGEMENT SERVICES

Project management services are applicable in all phases of a project, from the initial concept through implementation, to the final commissioning and handover of an operational project. It is therefore important that a client be aware of the full scope of services that can be provided.

Project management services would normally include certain basic services such as the following:

- planning and scheduling;
- budgeting and estimating;
- cost control and accounting;
- quality control;
- regular reporting.

In addition to these basic services, depending upon the particular project, project management services would also include the following items:

- translating the client's requirements, operational needs and constraints into the language of the technology needed for the project;
- defining the project requirements, including scope, quality and overall budget and schedule of work;
- preparing project policies and procedures;
- assisting in securing project financing and arranging sale/leaseback or other appropriate financial arrangements;
- advising the client of decisions required in relation to legal and insurance considerations;
- advising the client as to the suitability of alternative sites or premises under consideration for the project;
- advising and assisting the client in respect of the approval process with statutory authorities and the procurement of requisite permits;
- structuring the project into manageable sub-entities;

- prequalifying, recommending, selecting, and negotiating contracts with consultants;
- managing the design for conformity with the agreed project requirements and budget, and administering design changes;
- suggesting alternatives, evaluating them, and assisting the client in deciding between them so as to best meet the needs of the client in terms of scope, time, quality and cost;
- identifying dates when user requirements and decisions or approvals by the client are required, and documenting them. Advising the client of the effect on the project of delayed decisions/approvals;
- identifying to the client the impact (scope, time, quality, cost) of proposed changes, so that the client may make well-informed decisions whether to proceed with the proposed changes;
- arranging and co-ordinating the procurement, expediting and quality control of all required materials, equipment and services, including those supplied by the client;
- procuring construction/implementation, including pre-qualification, tendering, contract negotiation, contract administration, and expediting, as appropriate;
- managing construction/implementation for conformity with approved design, including detailed scheduling and co-ordination, management of inspection, administration of construction changes, approvals of progress claims, completion certificates, management of deficiency and warranty work, commission, operating manuals and record documentation;
- assisting the client in start-up and/or operating procedures including staff training.

In defining the scope of services to be provided, the client and the engineer should review the above listing in detail, consider additional items which might be appropriate in the particular case and establish the items, and the related scope, to be included in the services contract between them. Depending on the in-house resources of the engineer, the engineer would either carry out the above functions, or arrange to have them carried out by another party. Generally (but dependent on the particular contractual conditions), the engineer would manage and be responsible to the client for these functions and would advise the client of the functions required to be performed by the client and/or others as necessary to fulfil all requisite project responsibilities.

Amplification of the above functions and/or services is contained in the following sections of this guideline.

4.0 CLIENT'S REQUIREMENTS AND SCOPE OF WORK

Normally, the client would prepare a statement of the client's requirements and scope of work, addressing such items as:

- project definition in functional terms and/or as performance objectives;
- constraints, especially regarding time, cost, cash flow, quality, procurement procedures, and interfaces with third parties;
- the interface between the engineer and the client's own procedures and policies, including reporting and accountability;
- the responsibility and authority that the engineer is to assume, including a statement of who takes the risk of variances between the project as planned and the final outcome, particularly in relation to the project budget and the final costs.

The engineer should be prepared to assist the client in the assembly of the statement of the client's requirements and scope of work and to offer advice, based on experience, with respect to the definition, consistency, practicability and controllability of all aspects of the project.

The establishment of a fee for the engineer's services should normally follow a mutual understanding of the client's requirements and scope of work. Fee arrangements should include provision for means of arriving at fees applicable to changes to scope and delays or extra services arising out of such situations as strikes, litigation, etc. In addition, provision should be included for project staffing requirements. In order to enable them to arrive at a mutual understanding, the client and engineer may agree on an interim fee basis providing for initial services.

5.0 CONCEPTUAL STUDIES AND FEASIBILITY

In the conceptual phase of a new project, prior to the client's decision to proceed, the engineer can offer the client substantial assistance. It is at this time, when the client may be considering whether or not a project is to proceed, that the engineer can assist by drawing together the varied resources required to carry out the activities necessary to assess the feasibility of the project. These could include conducting or arranging for economic feasibility studies, assisting in financing arrangements, conducting or arranging for market surveys or other special studies (e.g. traffic, environmental, etc.). The feasibility of many construction projects hinges on site selection and the engineer can assist in site selection as well as arranging for investigation into such associated legal preliminaries as zoning by-laws, easements and other restrictions. The engineer can help draw together sufficient information for the client to assess whether the project is feasible and should proceed, and can assist the client in assessing the risk involved.

At this stage, the engineer can also arrange for conceptual studies to be carried out together with the preparation of preliminary schedules and preliminary budgets for the scope that is identified. These budgets would have a confidence level based on the level of accuracy of information provided, and would be identified to the client as such.

6.0 PRELIMINARY REQUIREMENTS

Following the client's decision to proceed with a particular project, the engineer could assist in providing services to look after those preliminary requirements which are necessary before work can proceed. This could include but not be limited to the following items:

- verifying what standards are applicable to the project:
- obtaining or arranging for various permits depending on the nature of the work to be undertaken;
- advising the client to obtain insurance as recommended by the client's insurance broker;
- arranging for other early site arrangements, such as site surveys, soils or other geological investigations, in the case of a construction project.

7.0 POLICIES AND PROCEDURES

Effective management of a project calls for the early establishment of policies and procedures for its implementation. During the initial phase of the project, therefore, the engineer, in conjunction with the client and other interested parties, would establish clearly defined and properly documented project policies and procedures that meet the client's operational requirements and satisfy the needs of effective management and accountability.

The project policies and procedures would be specifically developed to suit the size, complexity and scope of the particular project and would normally cover the following topics:

- overall project implementation policies, including a statement of the broad project implementation plan and overall strategy and project objectives;
- project organization, including the structure of the project team, which may change through the different phases of the project, and the project organizational structure of the various participants in the project team, including approval requirements;
- personnel functions, including definitions of the functions, responsibilities and authority limits of the various positions within the project organizational structure, including that of the client;
- administrative and control procedures, including such topics as communications, meetings, interfaces with other organizations (government and private sector), commitment authorization limits, cost control, accounting, reporting and the schedule requirements of such administrative procedures;

- technical design criteria, including a broad outline of the technical design criteria and technical quality requirements for the project and the basis of technical review and control;
- documentation standards, including a definition of the format and standards to be followed in the preparation of all project documentation;
- quality control procedures, including a definition of responsibilities;
- record keeping, including a definition of the requirements for the degree of record keeping on the project.

All of the above topics would be incorporated into a comprehensive project policies and procedures manual, which would be issued to all participants in the project, including the client.

The client should be encouraged to arrange for an audit of the implementation of all established project procedures to be carried out from time to time throughout the course of a project.

8.0 LEGAL AND INSURANCE CONSIDERATIONS

The engineer is normally not qualified to provide professional advice to the client on matters of law or insurance, but should have sufficient awareness of the legal and insurance implications of a project to assist the client in protecting the client's interests in good time. The engineer would normally be expected to anticipate and deal with any problems which may arise in a timely fashion and know what documentation and records should be maintained in the best interest of the client.

The engineer would normally be expected to know when and where to call for specialist legal and insurance advice and to suggest to the client that such specialist advice is obtained as necessary to protect the client's interests.

The following items are common to many projects and can influence whether the project objectives are achieved:

- the legal status of the engineer vis-a-vis the client; e.g. whether the engineer has the status of an agent, a limited Power of Attorney or authority to spend the client's money and to what limits;
- in the case of a construction project, the identity of who is legally the constructor and who is legally responsible for safety on a site;
- contracts between the several parties, and their legal responsibilities, including client/engineer, client/consultant, engineer/consultant, client/ contractor, engineer/contractor, client/supplier, engineer/supplier and the formation of joint ventures;
- in the case of failure to perform a contract (with and without bankruptcy of the party involved), the protection that a client could expect;
- contract termination clauses and related implications;
- protection available, and limitations thereof, in the form of such instruments as bid bonds, labour and material bonds, performance bonds, general liability insurance, builders risk insurance, and errors and omissions insurance;
- choice of union or non-union labour resources;
- claims, disputes and methods of settling them;
- professional liability and stamping of drawings, including the implications of the client and/or engineer overriding advice of consultants, or the client overriding advice of the engineer;
- ownership of design, copyrights, licensing agreements and royalties;
- building codes, by-laws, approval processes, permits, zoning, easements, statutory requirements and applicable construction lien legislation;
- the political process as it may affect the implementation of the project;
- any limitations on interfaces with third parties, including the public and the press;
- property acquisition, project finance, mortgages, sales and leasebacks.

9.0 SCHEDULING

Scheduling (or time management) is one of the key functions of managing a project. A failure to achieve time objectives normally adversely affects the project costs, and the client's anticipated benefits/revenues from the project and can also result in consequential costs. There are usually four separately identifiable steps in scheduling a project:

- planning, which involves establishing the logical sequence of activities, including restraints and interfaces;
- scheduling, which involves the process of adding durations and resources (if appropriate) to activities and adjusting the timing for optimum results;
- monitoring, which involves the process of regularly evaluating progress against the approved schedule;
- control, which covers the positive action necessary to correct schedule variance in order to achieve the schedule objectives.

In establishing the schedule, the engineer would select the most appropriate scheduling technique in relation to the size, complexity and risk of the project and would identify key dates. If appropriate, different levels of schedule detail could be established for different end users. The schedule would be prepared with input from all responsible personnel on the project and it would cover all phases from start to finish; if necessary, later phases of the project could be amplified later, but the framework would be established when the schedule is initially made.

When initially complete, the schedule requires the approval of the client, so that basis for schedule monitoring and variance reporting can be established.

In discussing the initial schedule, the client would be made fully aware of any specific schedule contingency, added either immediately prior to the project completion or for specific external parties. Also, the contractual obligations of the schedule on both the client and the engineer should be understood, including the effect of any slippages caused by contract extensions, changes and delays by any party.

10.0 BUDGETING AND ESTIMATING

Budgeting is the process of establishing, at an early stage, an estimated project cost (budget) that is acceptable to the client for a specific project scope of work to be performed in a specified time and quality framework, and against which the project can be continuously monitored.

At certain points in the life of the project, the engineer would prepare updated cost estimates for submission to the client. In general, the accuracy of the project cost estimate would be expected to improve as the project proceeds. It is important, therefore, that the degree of accuracy and the information on which the cost estimate was based be included in estimate submissions to the client. The layout of the estimate should be in an appropriate format (work breakdown structure, code of accounts, contract package, etc.) for use by the client.

Other items that need to be clarified and defined, as necessary, in finalizing an estimate include escalation, contingency, interest during construction and other financing costs. The amounts for these items would be clearly indicated together with the basis on which they were calculated.

In order that the client has a full appreciation and understanding of the estimate, the engineer would normally advise the client of value engineering comparisons, union renewal dates, management and engineering costs, direct and indirect costs, specific inclusions and exclusions, such as client-supplied items, hidden costs to the client, and overheads.

In the conceptual stage, the client may review the engineer's estimate in order to decide on the viability of the project. At this stage, alternatives and trade-offs may be discussed in defining the exact scope of the project; a life-cycle costing exercise may also be carried out, if appropriate. If and when the client approves this initial cost estimate, this then becomes the approved project budget from which all subsequent costs and forecasts can be monitored and controlled. As necessary, estimates of cost and cash flow would be prepared for subsequent monitoring and for assisting in arranging project financing.

As the project proceeds, any changes in scope would be referenced to the approved project budget and, in order to enable the client to be aware of the implications of changes in scope, approved scope changes would be fully documented in regard to definition, cost and schedule.

11.0 MANAGEMENT OF DESIGN AND OTHER CONSULTANTS

Design management is the process of monitoring and controlling the design function to determine whether the design is being carried out within the constraints of the project's scope, schedule and budget, to initiate any corrective action required and to advise the client accordingly. It is important to monitor closely the output of design to determine whether the design budget and overall project budget are being adhered to.

In providing design management services, the engineer would normally carry out the following in the area of consultant selection:

- work with the client to prepare a design brief outlining the client's requirements and forming a basis for selection of consultants, including prequalification requirements and consultants' staffing requirements;
- select consultants, either alone or in conjunction with the client;
- negotiate fee structures, terms of reference and responsibilities for the consultant with respect to the project team;
- recommend to the client an award of contract to the consultant;
- brief the selected consultants on the client's requirements and the project scope of work.

The engineer would determine whether the consultant is obtaining the necessary input from regulatory bodies, insurers, municipalities, etc., as well as reviewing and assessing user requirements to ensure that such requirements adhere to the project budget and performance standards, would initiate any corrective action required, and would advise the client accordingly. The engineer would further determine whether the design process includes the following items as appropriate:

- the project organizational structure and methods of operation of the consultants;
- the generation and evaluation of various alternatives to meet the project intent and the translation of the best alternative into technical documents for tender;
- due consideration to value engineering and life cycle costing to the appropriate degree as required by the client;
- assistance in the prequalification of bidders for construction and supply of materials and equipment;
- the evaluation of bids once received;
- the co-ordination of design between the various disciplines of the design process;
- due consideration to the constructability of any design;
- the review of samples and shop drawings submitted by successful bidders as normally undertaken by the various consultants;
- inspections during construction as appropriate;
- adequate means of ensuring prompt resolution of and response to site conditions, design and production problems, co-ordination and clarification questions;
- the review of operating and maintenance manuals;
- the preparation of as-built drawings at the end of the project.

In order to promote the meeting of the overall project schedule, the design function itself would be scheduled and monitored with consideration paid to the following:

- preparation of a schedule by contract package with due allowance to sequential tendering, if appropriate;

- identification of materials, services and equipment requiring long lead time and pre-ordering;
- allowance for time for appropriate approvals by the client and the regulatory authorities as required;
- control of design manpower and production to allow the design schedule to be met.

The management of the design process would also include the following items:

- implementation of a system of quality assurance in the design process to determine whether the design is adhering to the specified design standards, (as opposed to the project standards which define the intent, scope and budget of the project);
- the obtaining of client concurrence at various stages of the design process of the project to avoid the recycling of design;
- interpreting the design for the client so that the client understands the design before approving it;
- the implementation of an effective system of management controls on the design change process to promote adherence to the project intent, scope and budget;
- the retention of other consultants as required from time to time on various phases of the project to provide specialist technical advice, inspections, expertise or assistance;
- the coordination of the efforts of other consultants as required with the rest of the project team.

12.0 COST CONTROL

Cost control is the process of reporting, monitoring, analyzing and controlling commitments and resulting expenditures (costs) together with the initiation of the necessary present and future action to achieve the budget objectives on a project. In order for cost control to be effective it should commence at the inception of a project and should proceed through the various phases of the project.

The engineer would generally be responsible for overall control of costs against the approved budget and would establish the necessary procedures to permit the utilization of appropriate business management methods to control expenditures and to provide the client with accurate and timely cost information on the project. The extent and degree of cost control that can be achieved will vary with the type of contract that applies in a particular situation and the stage to which the project has progressed. However, the engineer would normally make the client aware of any limitations that may exist in this regard.

Cost control would normally include the following functions:

- analysis of commitments prior to award and comparison with budget allocations;
- establishment and monitoring of commitment authorization limits and procedures, including commitments against budgeted contingencies;
- coding of commitments and expenditures to budget codes for comparison and record purposes;
- initiation of the action necessary (including monitoring of design) to determine whether future costs will be kept within budget allocations;
- progressive monitoring of changes in scope and the preparation of required budget variation authorizations for the client's approval;
- continuous time and material quantity control on unit rate contracts;
- regular progressive assessment of future commitments and/or costs required to complete the project together with the determination of commitments and/or costs to date and their relationship to the approved budget. This would include the assessment of adequate provision for current and future variations to contracts as well as required contingencies;
- regular updating of cash flow forecasts;
- establishment and implementation of appropriate cost reporting systems which will provide the client with timely information on the cost status of the project including variations against approved budget.

13.0 PAYMENT CERTIFICATION

Payment certification is the process of verifying interim and final payment entitlement for any contractor, supplier, consultant, etc., engaged on the project. The engineer would perform this function on behalf of the client. The engineer while engaged as a project manager is placed in a position of trust and must pay due regard to the legal and ethical considerations of that position. At the same time, the engineer would advise the client of the requirements placed upon the client in the payment certification process, such as adherence to requirements of applicable construction lien legislation.

In the act of certifying payments, the engineer would assemble all the necessary documentation that certifies that the quantity and quality provided are in accordance with the terms of the applicable contract or purchase order and that the payments are in accordance with the terms of payment of the contract or purchase order and are in proper relationship with the value of work completed and remaining to be completed, Although often responsible for only parts of the back-up documentation the engineer would normally seek sufficient back-up documentation to accompany each certificate as required to document all aspects of the payment.

The engineer would establish a detailed procedure for performing this function that is in accordance with the client's requirements. The certification would be done in a timely fashion to take advantage of discounts where appropriate to optimize the client's financial resources. The coding of invoices to codes of accounts may be necessary to suit the client's purposes and this would become part of the payment certification process. As appropriate, the engineer would undertake to verify liens, recommend suitable deductions for the clearance of deficiencies, process the release of holdbacks and determine whether all other documentation such as letters of good standing from the Workers' Compensation Board and required Statutory Declarations, etc. are provided by those engaged on the project.

14.0 PROJECT ACCOUNTING

Accounting in the project management sense is the process of identifying, recording and controlling of actual payments of consultants, contractors, suppliers and others for services provided to the project. In comparison to the function of cost control (forecasting and controlling future project costs), accounting tends to deal with historical costs, or more precisely, cash information.

In order that the accounting function works smoothly, it is essential that appropriate accounting procedures are established which will fully satisfy the client's requirements and at the same time meet the needs of an effective project accounting system. The process of payment certification and authorization is an important part of an overall accounting system and is covered in the preceding section. The actual method of payment, such as payment from a project trust account controlled by the engineer, in conjunction with the client, or direct payment by the client, would be established early in the project.

The accounting system and procedures would normally be established in accordance with generally accepted accounting standards that can be audited by an appropriately qualified third party.

Accounting reports would be issued to the client and to other required parties on a regular and timely basis. These reports would normally include all project costs, including the client's own costs, and be in an appropriate format to satisfy the recipients. Cash flows, both short and long term, may be another requirement so that the client can plan more accurately the financial aspects of the project. The data in the accounting system would be in an easily retrievable form.

15.0 REPORTING

In order that the client, and others as appropriate, can be kept informed of the status of a project, the engineer would implement a program of regular reporting. Reports would be prepared on a regular, scheduled basis and would provide timely up-to-date information on all critical aspects of the project such that all necessary decisions or actions can be taken promptly.

The type, content and format of reports would be established to suit the nature of the project and the client's requirements and would normally include information on the following topic to the extent that they are applicable to the particular project:

- general project status;
- progress compared with schedule, including variances, explanations and possible schedule adjustments;
- costs and commitments compared with budget including estimated cost at completion, variances, explanations and possible corrective action where required;
- status of activities of consultants, including status of design and design changes;
- procurement activity, including materials/equipment delivery status;
- permits, agreements and contract status;
- construction status;
- commission status.

Consideration would also be given to the preparation of a postproject completion report.

16.0 PROCUREMENT

Procurement is the systematic execution of the procedure for purchasing all materials, equipment and services needed for the project, in good time, and in a manner which is cost-effective. These would generally include (but may not be limited to) those provided by consultants, testing services, suppliers, construction managers, and contractors.

The engineer would normally address the following aspects:

- procurement criteria and procedures based on good commercial practice and on agreement with the client;
- interaction between the project schedule and procurement activities;
- agreement with the client on signing authority, including requisitioning;
- prequalification of suppliers of goods and services including sourcing, availability and market climate;
- implementation of an appropriate materials management and control system:
- appropriate documents for calling for tenders or proposals including input on such aspects as packaging, shipping methods, currency and terms of payment, treatment of taxes, freight, duties, customs clearance, insurance, responsibility for changes in taxes, exchange rates, etc., spare parts and after-sales service and guarantees;
- issuance, receipt and assessment of tenders or proposals including negotiation and comparison of bids/proposals with each other and with the budget;
- appropriate documentation for purchase orders and contracts;
- verification of materials and equipment received.

17.0 EXPEDITING

Expediting consists of the actions necessary to determine whether schedule objectives will be met, to initiate corrective action when necessary and to protect against unexpected developments with regard to the delivery of goods and services. It applies to all materials, equipment and services needed for the project, either procured externally, or provided by the client or engineer, and may include the following:

- approvals;
- decisions;

- drawings and specifications;
- tender documents;
- shop drawings;
- off-site transportation;
- on-site construction/installation;
- question-answering and problem-solving;
- inspection and testing;
- operating and maintenance manuals;
- payment.

18.0 QUALITY CONTROL

Quality control is the establishment of quality standards for all materials, equipment and services necessary for the successful execution of the project, followed by systematic measurement of quality actually achieved, comparison with the standards, and corrective action where called for.

Quality standards would be established jointly and be mutually agreed upon by the client and the engineer with input from the consultants as appropriate. The client may choose to set standards for some aspects and incorporate them in the statement of requirements, or may choose to seek the advice of the engineer. Standards for some aspects may be regarded as options which can be decided during the project, when the client may be better informed to make trade-offs.

Procedures and responsibility for handling quality control would be specifically addressed and consideration would be given to the independence of the quality control function from other project functions. In particular, in relation to construction projects, the engineer would establish the necessary arrangements for required technical review of construction for conformance with design. The quality control of the project management function itself would also be considered.

An overall quality control program would normally include design checks, the quality control of the design management and construction management functions, materials testing and test certificates, inspection, deficiency lists and audits.

19.0 MANAGEMENT OF CONSTRUCTION

Construction management is the setting of a strategy, and its implementation, for the procurement of construction work. The engineer may perform the construction management function as part of the broader project management function, or the client or engineer may retain a separate person or firm to perform this function.

Depending upon the particular project, the engineer would make arrangements with the construction manager for the following to be performed and would monitor and control the activities of the construction manager to determine whether such activities are being carried out:

- provide input to the design and review the contract documents regarding constructability and cost;
- provide input to the project schedule regarding construction activities;
- recommend tendering strategies and procedures and the selection of tenderers, including tenders for pre-purchased equipment;
- call, receive, review, evaluate and compare tenders, recommend contract awards, and (if so authorized) award contracts for construction;
- mobilize and manage the construction site; arrange for the provision of temporary facilities; organize site logistics, including materials storage and storage off-site for pre-purchased materials and

equipment, site safety and security and statutory requirements; arrange for site clean-up;

- mobilize contractors and review their schedules, proposed personnel, equipment selection and methodology;
- provide day-to-day coordination, scheduling, and superintendence of construction;
- expedite the submission and review of shop drawings and samples;
- administer contracts with contractors, issue field instructions and field work authorizations as necessary, request quotations for changes, and issue change orders as necessary. Take reasonable measures to control situations that could lead to claims and maintain sufficient records to protect the client from unjustified claims and to permit recovery on client claims against others;
- promote satisfactory labour relations and assist in resolving disputes;
- monitor progress and cost, take reasonable measures to control progress and cost, and report to the engineer;
- call for inspection and correction of defective work;
- certify contractor's requests for payment, including progress certifications, substantial completion, and final completion. Monitor compliance with applicable construction lien legislation;
- arrange for the client to receive items such as as-built drawings, operating manuals, and operating instructions, as specified and legal surveys of the completed project;
- administer the correction of faults during the warranty period.

The client and engineer may decide that some or all of the above items should be the responsibility of the contractor, or one of the contractors, on the project. The allocation of responsibility for the above items between engineer, construction manager and contractor is dependent on the particular conditions existing on the project and is often determined by who agrees to take the risk of cost variances, quality variances, schedule variances, and the responsibility that the finished project conforms to the planned project. The selection, terms of reference and fee structure for the construction manager would be reviewed after due consideration by the client as to who will be assuming these risks and liabilities.

20.0 COMMISSIONING

Commissioning is the process of systematically bringing the various components of the project into an operational mode prior to start-up and formal handover to the client. Commissioning and start-up are normally carried out by the client's staff who will operate the completed project.

The engineer would assist the client in this process by organizing and managing the transition from the installation/construction phase to the operation phase in an orderly manner. To achieve this, a set of procedures covering the responsibilities, organization and requirements would normally be prepared and issued by the engineer in conjunction with the client. The procedures could include the following items:

- detailed equipment and systems commissioning and start-up sequence, such as check out, operational tests, static tests, performance tests, etc;
- client handover, including tagging procedures for equipment, systems, facilities and/or areas and arrangements for client's operating staff to become familiar with equipment and systems, etc;
- deficiency lists, and monitoring the rectification thereof;
- occupancy permits for buildings;
- listing and acquisition of operation and maintenance manuals to be prepared and handed over to the client.

A commissioning schedule would normally be a requirement in order to monitor the progress of commissioning. This is usually interfaced with the construction schedule and would indicate the sequences,

responsibilities, other major interfaces and time frame, in which the work has to be carried out.

Occasionally, the engineer has the responsibility for arranging for the training of the client's operating staff. In this case, adequate time would be allowed for arranging the necessary training in manufacturer's plants and/or similar completed facilities elsewhere.

As soon as the project becomes operational, the engineer would initiate and submit to the client a project final certificate for acceptance. This certificate would normally record the formal handover of the completed project and identify all the documentation (including operational and maintenance manuals, as-built drawings, equipment warranties, contract completion reports) that the client requires for on-going operation.

APPENDIX. BENEFITS OF GOOD PROJECT MANAGEMENT

Project management is not new. Projects (and most other human endeavours have always been managed, for better or for worse, depending to a large extent on the skill, intuition and luck of the manager

In recent years, there has been a growing awareness that management is a special skill which can be codified and learned. It is quite different and distinct from the technical design, engineering or construction skills most readily associated with many projects; indeed, there are usually aspects of a project which are outside the scope of these technical areas but which have to be managed as well, if the project objectives are to be met. This has resulted in the evolution of project management as a separate and distinct discipline. Some engineering firms choose to offer project management as a separate function within the engineering firm. Still other firms offer project management without engineering. In addition, some clients have their own inhouse project management staff. All of these are legitimate vehicles for achieving the management of a project.

This guideline does not promote one vehicle over another. Rather, it is intended to focus attention on those aspects of a project which are management-oriented rather than technical-oriented, It is intended as a guide to engineers who perform the project management function, whatever the organizational framework in which they happen to operate. It is also intended to assist clients in determining how their project should be managed and whether or not they should utilize the project management approach on their particular project.

As projects become larger and more complex, the effective, management of them becomes proportionately more significant. For these projects, the consequences of decisions on, essentially, how well the project is to be managed will generally generally far outweigh the consequences of how well a specific technical role is performed. It is suggested that on these projects a client should consider putting in place the appropriate project management capability before putting in place the appropriate design, engineering or construction capabilities.

Not all projects need a specialized project management function. However, where project management is warranted it can offer a client significant advantages. It can offer expertise over and above that which a client would otherwise have, allowing the use of more qualified human resources, with continuity of experience in this field, to be dedicated to the project for its life. This continuity of management of the project from concept to commissioning can provide the client with better control, accountability and end results. It can resolve conflicts that the client might otherwise be burdened with, and those decisions that have to be referred to the client can be presented in an uncluttered and timely fashion. It can provide for better information flow on the project and the use of an outside project manager can provide a degree of objectivity not otherwise available to the project. In addition, for those clients unused to large projects, the project manager can assist them or the users in fulfilling the role required of them.

A specialized project management function can also provide the client with much more control over the project. The organization remains under a single responsibility and provides a concerted and organized co-ordination, planning and control function. The client has more flexibility in determining the outcome of the project, and can adopt fast tracking or sequential tendering along with the direct selection of consultants, contractors and suppliers. In the case of a construction project carried out under the project management approach, it should be noted that this can result in different legal responsibilities to those applying under a client-consultant-general contractor relationship and these differences should be recognized.

Professional Engineers
Ontario

25 Sheppard Avenue West
Suite 1000
Toronto, Ontario
M2N 6S9

Tel: 416 224-1100 or 1-800-339-3716
Fax: 416 224-8168 or 1-800-268-0496

Enforcement Hotline: 416 224-9528 Ext.

Website: www.peo.on.ca