

MANUAL OF PROFESSIONAL PRACTICE



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of
Nova Scotia*

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This Manual is subject to periodical amendments and modifications. Use of this manual is at the sole discretion of the user. It is the user's responsibility to ensure that the referenced document is current. Current versions are available either through the Association or on the Web Site.

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Professional Engineers make an essential contribution to the society and economy of Nova Scotia working in areas crucial to the present and future of the province. We contribute to the safety and enjoyment of all citizens. Consequently, the practice of engineering must meet the highest standards of competence and ethical conduct. Engineering is also a dynamic field. As some engineering disciplines are becoming increasingly specialized, professional practice generally is becoming more diverse under the influence of sociology, ecology, economics, politics and the evolution of our laws. Engineers take seriously their obligation to improve constantly, but maintaining the highest of standards in a changing environment can be difficult.

The *Manual of Professional Practice* has been prepared by the Association of Professional Engineers of Nova Scotia (Engineers Nova Scotia) to assist engineers in maintaining these standards. The *Manual* aims to educate and to provide a reference document on the fundamental values of the Association, the Professional Engineer, and the practical application of these values in the many functions in which engineers practice today.

The *Manual* describes goals, not minimum standards. Nonetheless, Professional Engineers must continue to discipline fellow practitioners who do not meet standards considered appropriate by their peers. High goals, combined with strongly enforced professional standards, will make engineering an ever stronger profession, inspired by a contemporary, innovative and effective philosophy of practice. The *Manual* applies to all members of Engineers Nova Scotia. Consequently, its content is broad. The critical elements of the *Manual* are as follows:

Part A, the *Introduction*, outlines the characteristics that distinguish engineering as a profession and describes the legal responsibilities and obligations of the Association. This introduction also reviews the establishment of the engineering profession in Nova Scotia.

In **Part B**, the *Manual* discusses some of the more difficult and interrelated components of both the *Engineering Profession Act* and the *Engineers Nova Scotia Code of Ethics*.

There are a number of significant issues addressed in **Part C**, *Guidelines to Professional Practice*. These include commitment to society, use of the professional seal, liability issues and intellectual property.

Part D, *Engineering Job Functions and the Act*, provides guidance on standards of professional practice for fifteen job functions in which Nova Scotia engineers are involved. For each job function, direction is provided on the practical application of general themes of ethical and professional conduct introduced in earlier sections.

Finally, **Part E** includes the *Appendices*, which provides all the documents relevant to professional practice distributed by the Association to its members. These include guidelines on technical matters, policy statements and employment related material.

In order that this *Manual* will continue to be relevant and current as the engineering profession in Nova Scotia grows and changes, it is produced in this updateable binder format. It is the members' duty to maintain the *Manual* in current form. This updateable format allows the document to achieve the following goals:

- to continue to be relevant to all Engineers Nova Scotia members and those licensed to practice
- to continue to be current with the contemporary engineering practice and demands, and
- to include and appropriately reference all formal Engineers Nova Scotia publications related to professional practice issues.

By achieving these goals, the *Manual* should continue to meet its fundamental purpose: to provide a key educational and reference tool to assist engineers in maintaining high professional standards.

Any comments regarding the *Manual* are welcome, including identification of additional job functions for incorporation in **Part D**, and should be directed to the Association's Executive Director.

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INTRODUCTION

(1) CHARACTERISTICS OF A PROFESSION

A profession is a learned calling requiring advanced knowledge, understanding and abilities gained from intensive and specialized education, training and practical experience. Professions tend to be highly organized and regulated, yet members participate in varied activities that typically require the exercise of discretion and judgement. Members of a profession limit their work to their areas of expertise for the benefit of the public. Professional practitioners also maintain their competence throughout their careers.

Professions adopt distinctive Code of Ethics that deal with relationships between their members and the public, as well as with colleagues, employers, employees and clients. Adherence to a canon of ethics ensures an adequate standard of competence and conduct. It establishes a relationship of responsibility and trust between the profession and the public, while maintaining respect, integrity and confidentiality among practitioners, employers and clients.

The highest obligation of a profession is to the society it serves. This obligation rises above all others when responsibilities conflict. As part of this “social contract”, provincial and territorial legislation in Canada has normally acknowledged the privilege of recognized professions to regulate themselves and license qualified practitioners.

Engineering qualifies as a profession because:

- 1) it satisfies an indispensable and beneficial social need;
- 2) its work resists “standardization” and requires the exercise of trust, discretion and judgement;
- 3) its knowledge and skills are not common possessions of the public: they are the result of tested research and experience gained through education and practice;
- 4) it has a well developed group consciousness for the promotion of knowledge and professional ideals and for rendering a service to society;
- 5) it has legal status and well formulated standards of admission;
- 6) it has an ethical code that ensures an appropriate level of conduct, and
- 7) the primary responsibility of the engineer is to a third party, the “public”, which ultimately overrides responsibility to his/her client (the second party).

The *Constitution Act of 1867* gave the provinces jurisdiction over professions. The provinces, therefore, legislate the creation of professional bodies and procedures for operation of their associations, including the authority to admit members and regulate their conduct. This provincial legislation grants licensed Professional Engineers a monopoly within their areas of practice. The rights of monopoly and self-regulation are granted as the best protection for the public interest.

This focus on protection of the public was articulated in a study paper prepared by the Ministry of Attorney General of Ontario entitled “The Report of the Professional Organizations Committee” (1980):

“In the government of the professionals, both public and professional authorities have important roles to play. When the legislature decrees, by statute, that only licensed practitioners may carry on certain functions, it creates valuable rights. As the ultimate source

of those rights, the legislature must remain ultimately responsible for the way in which they are conferred and exercised. Furthermore, the very decision to restrict the right to practice in a professional area implies that such a restriction is necessary to protect affected clients or third parties. The regulation of professional practice through the creation and operation of a licensing system, then, is a matter of public policy; it emanates from the legislature; it involves the creation of valuable rights; and it is directed toward the protection of vulnerable interests. “[*Perlman v. Manitoba Law Society Judicial Committee*]

(2) THE ENGINEERING PROFESSION IN NOVA SCOTIA

The Association of Professional Engineers of Nova Scotia (Engineers Nova Scotia) is responsible for regulating Professional Engineering in the Province of Nova Scotia. Engineers Nova Scotia is a member of the Canadian Council of Professional Engineers (Engineers Canada). Engineers Canada is a national co-ordinating body consisting of ten provincial and two territorial associations, encompassing more than 170,000 Canadian Professional Engineers.

The *Engineering Profession Act*, which was promulgated on May 22, 1920, along with the By-Laws and Code of Ethics, define the duty of Engineers Nova Scotia to safeguard the public. The *Act*, By-Laws, and Code of Ethics define the responsibilities of individual members to the public as well as their relations with clients, employees and the profession itself.

A NOVA SCOTIA ENGINEERING PROFESSION ACT & THE CODE OF ETHICS

Part B addresses the formal standards of behaviour that apply to all engineers in the province, regardless of the nature or specialty of their practice. These general practices are established in several critical codes: the *Nova Scotia Engineering Profession Act*, the Bylaws of the Association of Professional Engineers of Nova Scotia, and the Code of Ethics of the Association. These documents establish the fundamental objectives of standards of ethical and professional conduct and provide the legal foundation for enforcement of these standards. Subsequent parts of this *Manual* are all aimed at providing interpretation and direction for the practical and day-to-day application of the standards of these documents.

The *Engineering Profession Act* establishes and regulates the practice of Professional Engineering in Nova Scotia. The *Act* addresses the establishment of Engineers Nova Scotia, the definition of Professional Engineering, requirements for membership, grounds for discipline and unauthorized practice offences. Pursuant to the *Act*, Engineers Nova Scotia may make By-Laws consistent with the *Act* that relate to its objects and powers. These Bylaws are subject to approval by the membership and the Governor-in-Council (Provincial Cabinet). The Code of Ethics for Engineers is an Appendix to the By-Laws. It consists of general statements of ethical and practice standards adopted by Engineers Nova Scotia for the guidance of its members. The By-Laws deems any breach of the Code to be unprofessional conduct. This type of transgression is subject to discipline by the Association as identified and defined in the *Act*.

(1) INTERPRETATION OF THE CODE OF ETHICS

The interpretative articles that follow expand on key components of the Code of Ethics. This review provides practical rather than legal interpretations of their implications. Professional ethics are an integrated whole that cannot be reduced to fixed “rules”. The more common issues and questions arising from the Code are therefore discussed in a general framework, drawing on all portions of the Codes to show their interrelationship and to expand on their basic intent.

(1.1) Protection of the Public and the Environment

The leading concerns of Professional Engineers are the safety, health and welfare of the public, and protection of the environment. All other requirements are subordinate to these overriding tenets of the profession. Satisfying these obligations, which extend to the work environment of engineers, often depends on individual engineering judgements and assessments of risk. Professional Engineers must therefore ensure that their works conform to accepted engineering practices, standards, and applicable Code, and would be judged “safe” by their peers. This responsibility extends to all situations that a Professional Engineer encounters. It includes an obligation to advise the appropriate authority of any concern with engineering activities, or their processes or products.

(1.2) Faithful Agent of Clients and Employers

Professional Engineers must serve their clients and employers as faithful agents or trustees providing objectivity, fairness and justice to all parties. They must handle confidential or proprietary information as the “property” of their clients and employers. They should not reveal facts, data or information obtained in a professional capacity without the prior consent of its owner, unless the public interest or the environment is at risk. Even in these instances, the Professional Engineer should encourage his/her client and/or employer to redress the situation

or, at least, should make every effort to contact them in writing before informing the appropriate authority.

Professional Engineers should avoid conflicts of interest with employers and clients. If conflicts arise, the Professional Engineer must disclose fully, without delay, the nature of the conflict to the affected parties. Where full disclosure may not protect the interest of all concerned, the Professional Engineer should withdraw from the issue or use extraordinary means, involving independent parties if possible, to monitor the situation.

As a faithful agent or trustee, the Professional Engineer must engage or advise to engage experts or specialists when such services are deemed to be in the best interest of the client or employer. This also means speaking accurately, objectively and truthfully for the client or employer, while respecting their rights of confidentiality and proprietary information.

Being a faithful agent also precludes using privileged or proprietary information and trade practices, or process information owned by a previous employer or client without their consent. General technical knowledge, experience and expertise gained by the Professional Engineer through involvement with the previous work may, however, be freely used without consent in subsequent undertakings.

(1.3) Competence and Knowledge

Professional Engineers should only offer services and advise on, or undertake, engineering assignments in areas in which they are competent to practice by virtue of their training and experience. This includes exercising care and communicating clearly when accepting or interpreting assignments and when setting expected outcomes. It also requires that the services of a specialist or expert be secured whenever necessary. Where the required knowledge is not available, the engineer must inform all parties involved that the activity will be experimental.

The Code requires that opinions on engineering issues are expressed honestly and only in areas in which the engineer is competent. This applies equally to reporting or advising on professional matters and to issuing public statements. This requires the self-awareness to present issues fairly and accurately with appropriate disclaimers and to avoid personal, political and other non-technical biases. Avoidance of bias is particularly important for public statements or when involved in a non-technical forum.

Professionals must remain abreast of developments and knowledge in their areas of practice through participation in ongoing professional development and continuing education. Besides maintaining their own competence, Professional Engineers are obliged to contribute to engineering knowledge and continued competence in their areas of practice.

(1.4) Fairness and Integrity

Honesty, integrity, competence, devotion to service and dedication to enhancing the quality of life are cornerstones of professional responsibility. Within this framework, Professional Engineers should be objective and truthful and include all pertinent information in professional reports, statements and testimony. They should accurately and objectively represent their clients, employers, associates and themselves consistent with their qualifications and professional experience. This tenet means more than avoidance of misrepresentation: it implies disclosure of all relevant information and issues, especially when giving advice or working as an

expert witness. Similarly, fairness, honesty and accuracy in professional advertising are expected.

Professional Engineers should prevent their personal or political involvement from influencing or compromising their professional role or responsibility.

As noted above, Professional Engineers should attempt to redress any impropriety within any organization or project in which they are involved. Failing this, they must report illegal or unethical engineering decisions or practices to the Association or another appropriate agency. They should avoid legal arrangements that compromise this obligation.

(1.5) Professional Accountability and Leadership

Professional Engineers have a duty to practice carefully and diligently. They must also be accountable for their actions. This duty is not limited to design or its supervision and management, but includes all areas of practice. For example, it includes construction supervision and management, preparation of shop drawings, engineering reports, feasibility studies, environmental impact assessments, engineering development work and related activities.

When an engineer signs and seals engineering documents, the engineer takes responsibility for the work. All types of engineering endeavours require this practice, regardless of where or for whom the work is done. This includes, but is not limited to, privately and publicly owned firms, crown corporations and government agencies/departments. Without exception, documents must be signed and sealed whenever engineering principles have been applied and public welfare may be at risk.

Taking responsibility for engineering activity includes accountability for one's own work. For the senior Professional Engineer this includes accepting responsibility for the work of an engineering team. This implies responsible supervision where the Professional Engineer is authorized to review, modify and direct all of the engineering work. This requires reasonable limits on the extent of activities and the staff that the responsible Professional Engineer can supervise.

“Symbolic” supervision is contrary to the intent of “taking professional responsibility.” For example, a Professional Engineer should not take full responsibility for all engineering for a large corporation, utility or government agency as, say, the “Chief Engineer” of the organization if he/she cannot be aware of these engineering activities or decisions. Such an arrangement makes the firm responsible by default, whatever the application of engineering supervision and direction.

Rapidly advancing technology and increasing recognition of the potential effect of engineering on the environment require Professional Engineers to account for the effect of their decisions on the environment and the well being of society. They should report any concerns of this nature within their organization and/or to Engineers Nova Scotia. More than ever before, the societal impacts of rapidly advancing technology require Professional Engineers to foster public understanding of technical issues.

(1.6) Conflict of Interest

Professional Engineers have a duty to advise their employer and, if necessary, their clients or even their professional association, if the overruling of an engineering decision may breach their duty to safeguard the public. Initially, the problem should be discussed with the supervisor/employer. If the supervisor/employer responds inadequately to the concern, the Professional Engineer must advise the client. Failing this, the Professional Engineer must present his/her concerns to the Association, even at the risk of loss of employment.

(1.7) Part-Time Entrepreneurship

A full-time employee who offers or undertakes Professional Engineering services for a different and separate employer or client outside his or her regular hours of employment is “permitted”. Engineers Nova Scotia does not formally restrict this practice.

The relevant clauses from the Code of Ethics are as follows:

A Professional Engineer shall act as a faithful agent of their clients or employers, maintain confidentiality and avoid conflicts of interest.

A Professional Engineer shall not use the advantages of a salaried position to compete unfairly with another Professional Engineer.

The Professional Engineer should ensure that this work does not conflict with their duty to their employer.

The Professional Engineer must inform the client who has engaged them to do the work of any limitations on his/her ability to provide services to that client, such as availability during working hours.

The Professional Engineer must not provide these services at a reduced fee because they have a salaried position that provides most of their required income.

Professional Engineers employed in the Federal or Provincial civil service should be aware of Section 110 of the Criminal Code of Canada:

110. (1) Everyone commits an offence whom (c) being an official or employee of the government, demands, accepts or offers or agrees to accept from a person who has dealings with the government a commission, reward, advantage or benefit of any kind directly or indirectly, by himself/herself or through a member of his/her family or through anyone for his benefit, unless he/she has the consent in writing of the head of the branch of government that employs him/her or of which he/she is an official, the proof of which lies upon him/her;

Section 107 of the Criminal Code defines an employee of the government to be anyone employed by Federal or Provincial Government. Under Section 110, it is an offence for a government employee to accept remuneration from anyone who has dealings with the government unless they obtain the written consent of the appropriate government department head. Anyone found guilty of such an offence may be imprisoned for up to five years.

Finally, clients often retain Professional Engineers to act as their agents. The duty of good faith that arises from the trust between agents and their principals is a very important one. Section 383 of the Criminal Code deals with violations of the principal-agent relationship. Professional Engineers should ensure that moonlighting activities do not affect the trust between them and any of their clients.

Various tort and contractual considerations may also come into play depending upon the nature of the moonlighting and the manner of its execution.

(1.8) Confidential Information

A Professional Engineer must not divulge confidential information to third parties without the express or implicit authorization of their client or employer, unless required to do so by law. Unreserved communication between the practitioner and the client or employer is essential to effective delivery of professional services. The client or employer is entitled to assume that this confidentiality will be maintained without request. The duty of confidentiality survives the professional commission that required it, continuing indefinitely after contracts or relationships end.

Also, Professional Engineers must not disclose confidential information for their own benefit or the benefit of a third party or to the disadvantage of their employer or client. They should decline employment or commissions that require such disclosures.

Professional Engineers may be concerned with their obligation of confidentiality when changing employers within their field. It is generally considered that Professional Engineers may apply any information or expertise gained in previous positions that has become general knowledge or the “state of the art”. They should not, however, apply information gained in former employment that is considered propriety or regarded as “trade secrets”.

A Professional Engineer preparing material for technical publications must be careful not to disclose confidential information inadvertently and should obtain the consent of all affected parties before publication.

(1.9) Duty to Report

Professional Engineers have obligations to their clients/employers and the public. Sometimes these obligations will conflict. On the one hand, the Professional Engineer must hold client/employer information confidential and must avoid its use to the disadvantage of the client/employer. On the other, they are obliged to protect the public welfare.

There is no doubt, however, as to the choice of the Professional Engineer. Their first responsibility is to the public welfare. The office of the Engineers Nova Scotia’s Registrar will cooperate with any member who reports a situation that the Professional Engineer believes may endanger the safety or welfare of the public. A Professional Engineer must also report unethical engineering activity undertaken by other Professional Engineers or by non-engineers. This includes, for example, “executive” decisions by senior officials of a firm that clearly and substantively alter the engineering aspects of a work, or the protection of the public welfare or environment arising from a work.

(2) DISCIPLINE

The *Nova Scotia Engineering Profession Act* authorizes Engineers Nova Scotia to regulate the conduct of its members. Several sections of the *Act* define the system under which complaints to the Association are subjected to a thorough investigation and passed on, if appropriate for a Hearing. Please refer to the Guideline on Discipline of Members for further information.

(3) ACT ENFORCEMENT

(3.1) General

Act enforcement is used to describe the activities undertaken by the Association so as to ensure that only individuals registered with, or licensed by, Engineers Nova Scotia are permitted to practice engineering or to use any designation that infers that they are an engineer or can practice engineering.

All engineering work performed in Nova Scotia must be in compliance with the *Nova Scotia Engineering Profession Act*. The *Act* requires that all engineering work must be done by registered or licensed Professional Engineers.

A registered Professional Engineer in Nova Scotia is an engineer who has met the education and experience requirements identified in the *Act*.

A non-resident Professional Engineer in Nova Scotia is an engineer who is a registered member in good standing with an Association of Professional Engineers, other than Engineers Nova Scotia, that is recognized by the Association's Council.

Examples of contraventions of the *Act*, under the *Act's* enforcement provisions, include the following:

- 1) Using the title of "Engineer" when not qualified to do so in accordance with Provincial or Federal legislation (i.e. Power Engineers are authorized to use the designation "Engineer" under the *Power Engineers Act* [the old *Stationary Engineer's Act*]; Marine Engineers are authorized to use the designation "Engineer" under Federal legislation)
- 2) Practicing engineering, as defined in *Section 1(g)* of the *Act*, when not qualified to do so. Please refer to *Section 21* of the *Act* for an overview of this specific authority.
- 3) A corporate entity carrying out the application of engineering without having an engineer as a partner or permanent employee. Please refer to *Section 21* of the *Act* for an overview of this specific authority.
- 4) An individual or corporate entity directing or permitting the practice of professional engineering by those not qualified to do so.

Following are the respective aspects of the *Nova Scotia Engineering Profession Act* which address the contraventions identified above.

Section 20 authorizes Engineers Nova Scotia to take legal action under the *Act* against any individual who does not have a certificate of registration or license to practice engineering but practices Professional Engineering. This provision also prohibits individuals who are not registered or licensed with Engineers Nova Scotia to use the title of Professional Engineer verbally, or any abbreviation of such title, which may cause any person to believe such a person is a Professional Engineer. Finally, this clause also prevents an individual from advertising, or in any way implying, that he/she is a Professional Engineer when he/she is not qualified to do so.

Section 21 confirms that a company cannot undertake or carry out the application of engineering without having a Professional Engineer as a partner or permanent employee. In addition, this *Section* prohibits a firm from using a title, description or designation which may lead a person to believe that the company is qualified to undertake or carry out the application of engineering, unless they have a Professional Engineer as a partner or on permanent staff. Finally, this *Section* also precludes such a company from advertising or conducting itself in any way that would imply that they are qualified to undertake or carry out the application of engineering.

Section 22 empowers Engineers Nova Scotia to prosecute any person or corporation whom directs or permits any member or employee of the firm, who is not a qualified Professional Engineer, to apply engineering.

The definition of engineering, as contained in the *Act*, states as follows:

“ ‘engineering’ means the science and art of designing, investigating, supervising the construction, maintenance or operation of, making specifications, inventories or appraisals of, and consultations or reports on machinery, structures, works, plants, mines, mineral deposits, processes, transportation systems, transmission systems and communication systems or any other part thereof; “

This definition has been tested in the Courts of Nova Scotia, and successful prosecutions have resulted in both the misuse of the designation “engineer” and the unauthorized practice of engineering.

Every Association of Professional Engineers in Canada also has an additional tool in working to prevent the misuse of the designation “engineer”. The Canadian Council of Professional Engineers (Engineers Canada) is also now recognized at the owner of (9) “official marks” under Section 9 of the Trade Marks Act, as listed below:

Trade Marks Office File #Official Mark

903673	Engineer
903680	Professional Engineer
903681	PEng
903678	Consulting Engineer
903677	Engineering
903674	Ingenieur
903675	ing.
903679	ingenieur conseil
903676	ingenieurie

Legal advisors for Engineers Canada state that any person or corporate entity using these marks, or any similar marks which can easily be mistaken for the official marks of Engineers Canada, is subject to penalties under the *Federal Trade Mark’s Act* which can include a Court injunction preventing any such unauthorized use.

The Engineers Nova Scotia Act Enforcement Committee plays a major role in Act enforcement and, based on information brought to their attention, determines what action should be taken, if any, on a particular Act enforcement concern. Any Act enforcement case under review must be substantiated by the facts as known to the Committee.

Before legal proceedings begin, engineering reports, if required, are prepared by those who could become expert witnesses in the Court proceedings. For flagrant contraventions of the *Act*, civil action may be taken after approval by the Act Enforcement Committee, Engineers Nova Scotia legal counsel and the Association's Council. In less serious contraventions, a Letter of Caution may be forwarded to the person(s) or firm(s) involved. The Association's Director of Professional Practice is responsible for ensuring the appropriate action is taken based on the recommendations of the Act Enforcement Committee and Council.

(3.2) Registration of Companies

Amendments to the By-Laws of the Association relating to Partnerships, Associations of Persons and Bodies Corporate providing engineering services to the public were approved by the Governor-In-Council and became effective as of July 1, 1990.

The following is a brief summary of the points respecting the requirements of By-Law Section 13(B):

- 1) The By-Law applies only to Partnerships, Association of Persons and bodies corporate that are engaged in providing engineering services to the public. The By-Law regarding the registration of companies providing engineering services to the public is not applicable to sole proprietorships.
- 2) Every such organization currently engaged in providing engineering services to the public is to file, with the Association's office, an Information Return, duly completed an prescribed form. (A copy of the Information Return is available from Engineers Nova Scotia.)
- 3) Organizations engaged in providing engineering services to the public on an ongoing basis must file an Information Return on, or before, January 1st of each year.
- 4) A certificate indicating compliance with the requirements of By-Lay 13(B) shall be issued upon filing the Information Return which contains the required information and which is accompanied by the administrative fee. The certificate of compliance is valid for the calendar year in respect of which it is issued.
- 5) Non-compliance with this provision is considered an offence under the above referenced By-Law.

B GUIDELINES TO PROFESSIONAL PRACTICE

Practicing within one's competence and adhering to the regulations and by-laws that dictate engineering practice are fundamental responsibilities of engineers. Both legal and ethical requirements limit engineers to practice within their competence. Failure to meet these requirements leaves them open to informal or formal professional scrutiny by their peers and Engineers Nova Scotia, pursuant to the *Engineering Profession Act*. Professional Engineers, therefore, should only undertake assignments if they honestly believe they are competent to proceed effectively or can become competent without undue delay, risk or expense to the client or employer. Failing this, they must engage a suitable "expert" in the areas in question.

Part B of this *Manual* introduced the *Engineering Profession Act*, the By-laws, and the Code of Ethics as fundamental to the concepts of professional standards. Users of this *Manual* should be familiar with those documents. In addition, Engineers Nova Scotia has developed a number of guidelines to encourage consistent engineering methods and practices that will enhance the quality of engineering practice in Nova Scotia. (Engineers Nova Scotia Guidelines and similar documents are listed in *Part E* of this *Manual*, and are available on request.)

These Guidelines describe the characteristics of a reasonable and prudent engineer, standards that all members must strive to achieve. They advise on matters of practice and procedure rather than substantive engineering. They are not legal documents. They do not supersede or replace contractual arrangements designed to satisfy specific situations where good engineering practice might, in certain circumstances, dictate departure from their provisions. They are meant to reflect the intent of the *Engineering Profession Act* and be a reference document when adjudicating allegations of unskilled practice in disciplinary cases.

Besides these items, there are many other documents that are important to the Professional Engineer, depending on his/her discipline and professional activity. Professional Engineers must also comply with external regulations, sometimes called “demand side legislation”, both in the rendering of technical service and in the operation of their practice. The following legal jurisdictions generate “demand side” requirements:

- Federal Codes and Statutes
- Provincial Codes and Statutes
- Municipal Codes and By-Laws.

Professional Engineers should also be familiar with industrial and trade standards recognized by the relevant authorities.

The following sections provide guidelines for professional practice in several key areas and issues:

- Commitment to Society
- Certificates of Compliance
- Reviewing the Work of Another Professional Engineer
- Selection of a Consulting Engineer
- Use of the Seal
- Liability Issues
- Advertising
- Intellectual Property
- Professional Development
- Communications
- Safety Issues

(1) COMMITMENT TO SOCIETY

Professional Engineers should recognize that professional ethics are founded on integrity, competence, devotion to service, and enhancement of the public welfare. This concept should always guide their conduct. In this way, the actions of each professional will enhance the dignity and status of the profession.

The Code of Ethics require engineers to be consistently honest, impartial and fair in their relationships with clients, associates, the public and others affected by their actions. They should diligently complete their undertakings in good conscience, putting aside self-interest while demonstrating concern for the expectations and welfare of the public.

With specialized training in the application of engineering principles, they should conscientiously apply their skills to benefit the safety, health and welfare of the public. They should respect the privilege of professionalism by adhering to legislation governing their profession and avoid

associating with specialists who do not conform to recognized ethical practices or others of questionable integrity. Good stewardship to ensure well-planned and cost effective use of resources is also a priority. In other words, they should do the best possible job, maintain and improve standards, and attempt to make the world a better place. This, in turn, will give visible credibility and dignity to their profession.

Professional Engineers, through their practice, should advance public knowledge of the profession and should serve in public affairs when their professional knowledge may be of benefit. They should promote and present their profession clearly and positively to the public. They should extend public knowledge and appreciation of the profession and their achievements. They should serve on public boards, boards of directors and other organizations. They should endeavour to participate in society at all levels, from community affairs to public office, with integrity, tact and decorum.

(2) CERTIFICATES OF COMPLIANCE

Amendments to Engineers Nova Scotia By-laws provided for the issuance for Certificates of Compliance to corporations, partnerships or other legal entities that provide engineering services to the public. Every organization that currently provides Professional Engineering services directly to the public is to submit an Information Return that is available through the Association's office. Those business entities that practice Professional Engineering for their own use, such as Nova Scotia Power Incorporated and Aliant, are not required to obtain a Certificate of Compliance. Organizations engaged in providing Professional Engineering services to the public must file an Information Return on or before January 1 of each year. Engineers Nova Scotia will issue a Certificate of Compliance indicating adherence to the requirements of By-Law 13(B) upon filing of the necessary information.

(3) REVIEWING THE WORK OF ANOTHER PROFESSIONAL ENGINEER

To begin a review of engineering work, the reviewer should assemble the original instructions, basic data, amendments, clarifying instructions, specific design assumptions and other relevant information on the project. The reviewer should understand the mandate and conditions applying to the review. To assist this, it may be desirable to have written instructions that specify the mandate.

The reviewer must carry out the review on factual and technical grounds, strictly within the mandate but mindful of the overriding public interest. Reviewers must be temperate in their judgement and must assume responsibility for their opinions, while giving appropriate credit to the work of other Professional Engineers.

The Code of Ethics permit a Professional Engineer to review the work of another Professional Engineer whether or not that engineer is still connected to the project. If the original engineer has ended his/her connection with the project, the reviewer, before undertaking the review, should understand how the results of the review are to be used. Even when satisfied that the parties have ended their connection, the reviewer should, with the agreement of the client, inform the other Professional Engineer of the contemplated review. The client has the right to withhold permission to inform the other Professional Engineer; however, the reviewer should only proceed with the review when he/she is satisfied that the reasons for the owner's decision are valid.

If the review is of the work of another Professional Engineer who is still working on the project (either through an employment contract or an agreement to provide professional services), he/she must be informed of the review. The reviewer should only undertake the assignment when he/she has confirmed that the original engineer is aware of the review. This obligation is restricted to the provision of an engineering review. If a second Professional Engineer were engaged by another person to provide Professional Engineering services on the same project, he/she would have no obligation to advise the original engineer of their commission.

The reviewer must administer the review contract and evaluate Professional Engineering work at arm's-length so that the Professional Engineer of record remains fully responsible for the design. The acceptance of mutually agreed upon changes does not relieve the original design engineer of responsibility for the work under review. The employment agreement or contractual arrangement at the time of the review does not affect the responsibilities of the reviewer discussed above.

Once the review is complete, the reviewer has no further right or obligation to disclose the findings to the Professional Engineer whose work has been reviewed. Generally, the client would not permit disclosure of the findings and the contractual obligation of the reviewer is to the client. The reviewer should, however, seek approval of the client to inform the other Professional Engineer of the general nature of the findings and, if appropriate, should try to resolve any technical differences.

Senior Professional Engineers often review designs prepared by other Professional Engineers. Most Professional Engineers expect their work to be routinely reviewed as part of ongoing quality control and professional development. If the reviewer finds design changes are necessary, he/she should inform the Professional Engineer who executed the design of these findings and the reasons for the recommended changes. During the design stage, the Professional Engineer and the reviewer may agree to change the proposal. The design engineer must not, however, agree to any change suggested by the reviewer that could result in an unworkable installation, would conflict with the relevant Code or would create a risk of damage or injury.

(4) SELECTION OF A CONSULTING ENGINEER

A detailed procedure for selection of consulting engineers is set out in the publication, "Guidelines for Selection of a Consulting Engineer," included in *Part E* of this *Manual*. Professional Engineers and others selecting a consultant should be made aware of this recommended approach.

Individuals or firms selected to provide Professional Engineering services must be registered with Engineers Nova Scotia. When engaging a Professional Engineer, the client should describe the work to be done to ensure that the Professional Engineer understands the requirements. For his/her part, the consulting Professional Engineer assumes responsibility for performing the task competently in keeping with agreed upon project objectives, technical requirements and regulations. In the interests of both the Professional Engineer and the client, the details of the services to be rendered should be set out in a formal agreement. A Recommended Form of Agreement is available from Engineers Nova Scotia.

Some clients seek professional services through competitive bidding. This is legal and ethical, and Engineers Nova Scotia permits its members to engage in competitive bidding. However, if contracts are bid at unrealistically low prices, it is likely that less skilled Professional Engineers

will be used and/or time devoted to the assignment will be inadequate. In either case, the project purpose may not be well served. The “Guidelines for Selection of a Consulting Engineer” are intended to avoid this situation and to serve the interests of both the client and the Professional Engineer.

(5) USE OF THE SEAL

The *Engineering Profession Act* gives authority to regulate the use of the Professional Engineers’ seal. The “Guidelines on the Use of the Seal” provide specific direction in this respect.

A Professional Engineer does not avoid potential civil liability for negligent engineering work by omitting to affix his/her seal to plans and documents related to their work. Neither do Professional Engineers incur additional liability by placing their seal on such plans and documents. Of course, if a Professional Engineer improperly seals plans and documents when they have not done or directly supervised the associated work, they may be found guilty of negligence on that account as well as unprofessional conduct. In short, apart from improper use of the seal, its use does not affect the liability of a Professional Engineer.

In addition to its intended project-specific purposes, use of the seal publicizes the role of the Professional Engineer in the community. It also provides recognition of the work of individual Professional Engineers. However, neither of these indirect benefits justifies overuse or misuse of the seal.

(6) LIABILITY ISSUES

(6.1) Liability in Contract

Engineering service contracts commonly contain provisions requiring the engineer to perform services competently and professionally. Even if there is no formal written contract, or the written contract itself does not expressly provide such a requirement, the courts ordinarily hold that this is an implied term.

The failure of an engineer or engineering firm to provide the level of service required by the express or implied terms of a contract is a breach of contract for which the engineer will be liable should the client suffer loss or damage as a result.

Under contract law, a person can be liable for breach of contract only if the person is a party to the contract. Consequently, an employee-engineer is not liable *for breach of contract* where the contract is between the client and the engineering company for which the employee-engineer works. The employee-engineer may still, however, be personally liable to the client, their employer or a third party if the employee-engineer has been negligent in the performance of his/her duties.

Engineers or groups of engineers frequently practice through an incorporated company and enter contracts in the name of the company. This arrangement may protect the individual engineer from personal liability *for breach of contract*; however, the individual engineer will remain personally liable for negligent performance.

(6.2) Negligence

Negligence is a branch of the law of torts. Liability in negligence arises independently of liability in contract, although the same negligent act could give rise to claims both for breach of contract and in negligence. This means that even if the engineer performs services gratuitously (i.e., without a contract) they may still be liable for negligent performance of those services.

A claim of negligence involves three fundamental elements:

- 1) a duty of care owed by the defendant to the plaintiff to avoid foreseeable harm
- 2) a breach of the duty of care (i.e., a negligent act or omission by the defendant), and
- 3) a loss or damage suffered by the plaintiff caused by the negligent act or omission.

All professionals, including engineers, are considered to owe a duty of care to their clients to perform their services with skill and competence. Failure to do so will result in liability for negligence if the client suffers loss or damage as a result. The duty of care may also extend to third parties potentially at risk if the engineer is negligent in the performance of his/her duties.

(6.3) Professional Liability Insurance

Professional liability insurance provides protection to the insured Professional Engineer or engineering firm against claims arising from the provision of engineering services. Many practising Professional Engineers use this type of insurance.

Liability insurance provides the Professional Engineer with protection from insured claims, for which the insured engineer is found liable, and for investigation and defence costs associated with claims asserted against the insured engineer regardless of whether any claim is valid. Professional liability insurers usually underwrite “claims made.” A “claims made” policy provides coverage only if the policy is in force when the claim is made against the engineer. It is important, therefore, to maintain coverage without gaps. Otherwise, there is a risk that uninsured claims will be made between the lapsing of one policy and its renewal or replacement.

All insurance policies exclude coverage of certain types of claims. Although these “exclusions” may vary depending on the wording of the insurance contract, there are several standard exclusions. These include: failure to advise on insurance; failure to complete drawings or specifications on time; liability of others under contracts; liability under warranties or guarantees; liability for duties not customary to the Professional Engineer; liability relating to estimates for return on investments or capital; and liability resulting from participation in joint ventures or other partnerships that are not the subject of any special endorsement.

A Professional Engineer who is found liable for negligence or breach of contract will be liable personally for any damages or losses suffered over his/her coverage limits. The Professional Engineer will also be liable for the full amount of any claims for which there are exclusions in the policy of insurance.

(7) ADVERTISING

Professional Engineers using advertising to promote their services should not mislead the public. The following principles apply:

- 1) All advertising and promotional activities relating to Professional Engineering services should comply with basic rules of acceptable engineering practice and the Code of Ethics.
- 2) The dignity and status of the profession and its members should be preserved.
- 3) Statements made or implied should be truthful, factual and precise, without exaggeration or misrepresentation.
- 4) Comparison with, or criticism of, services offered by other engineers, either directly or indirectly, is inappropriate.
- 5) Claims of greater responsibility for a specified project than is actually the case are inappropriate.
- 6) Words that suggest or pictures that illustrate, without a proper disclaimer, portions of a project for which the advertiser has no responsibility, thus implying greater responsibility than the advertiser incurred, are inappropriate.
- 7) Appropriate indications of co-operation by associated firms or individuals in specified projects should be included.
- 8) Engineering responsibility for proprietary product or equipment design should not be implied in, nor should an engineer's name be linked to, an advertisement by those interested in the sale of such projects or equipment.
- 9) The Seal of a Professional Engineer or the Seal of the Association of Professional Engineers of Nova Scotia should not be used for advertising or commercial purposes.

These general principles should apply to all forms of advertising including, but not limited, to professional cards, telephone directories, newspapers, magazines, radio, television, vehicle identification, letterheads, brochures, pamphlets, web sites, office and job site signs and facsimile transmissions.

(8) INTELLECTUAL PROPERTY

(8.1) Copyright Act

Copyright means the right to copy. Only the copyright owner can produce or reproduce the work in question or allow others to do so. Copyright applies, among other things, to any book, table, letter, scientific presentation, speech, course, geographical map, plan or computer program. The rights protected under the *Act* include the right to perform the work or any substantial part of it, to deliver it in a lecture, to publish it, to translate it, to convert it, or to transmit it by telecommunication, as well as certain other rights including the right to authorize the preceding acts.

Subject to three categories of exceptions (photographs, cinematographs and sound recordings; works of Crown copyright; anonymous and posthumous works), copyright exists for the life of the author, the remainder of the calendar year in which the author dies, and for 50 years following the end of that calendar year. Copyright automatically protects all works; however, registration with the Copyright Office provides better and additional security. To register, a person must complete an application form and send it to the Copyright Office along with the appropriate fee. The Office does not require a copy of the work as it will not be reviewed or assessed in any way.

Normally a Professional Engineer who prepares engineering plans holds their copyright. Professional Engineers may wish to protect these copyrights. They may, for example, wish to ensure that a client cannot reproduce documents produced for them to benefit another person or company without compensation to the Professional Engineer who created them.

Unless otherwise agreed, a client cannot reproduce plans prepared for them by a Professional Engineer without the express or implied consent of the Professional Engineer. Contracts may include provisions

stipulating that an author must assign all copyrights to the client. The author may also assign only specific or limited rights in exchange for compensation. Under the *Copyright Act*, the definition of artistic works includes drawings, charts, plans, and architectural works.

The Government of Canada recently amended the *Copyright Act* to remove any uncertainty about the ability to obtain copyright protection for computer programs. It has modified the definition of a “literary work” to include computer programs. In addition, the definition of a “computer program” was added to codify principles already established in case law. Under the *Act*, a computer program is a set of instructions or statements expressed, fixed, embodied or stored in any manner to be used directly or indirectly in a computer to cause a specific result. Accordingly, copyright protection is available for all computer programs, whether in source code or object code, no matter how they are stored.

The amendment did not create a new category of copyright protection. The courts protected computer programs before the amendments; however, the Government used the occasion to reduce the protection afforded to computer programs by creating two exceptions to copyright. The first exception provides that it shall not be an infringement for a person who owns a copy of a computer program authorized by the owner of the copyright to make a single reproduction of the copy by adapting, modifying or converting the computer program or translating it into another computer language, if that person proves that:

- 1) the reproduction is essential for the compatibility of the computer program with a particular computer;
- 2) the reproduction is solely for the person’s own use; and
- 3) the reproduction is destroyed forthwith when the person ceases to be the owner of the authorized copy of the computer program.

The second exception allows the owner of an authorized copy of a computer program to make a single back-up copy, provided the person proves that the reproduction for back-up purposes is destroyed forthwith when they cease to own the authorized copy.

These two exceptions give the authorized software user a limited right to change the software to ensure compatibility with their computer system and allow for the protection and security of the original computer program.

8.2) Patent Act

A patent protects the rights of anyone who invents a new and useful process, structure, function, machine, manufacture or composition of matter, or a new and useful improvement on any of these. The *Patent Act* stipulates the conditions for obtaining a patent. Preparing and prosecuting a patent application is a complex task. It requires broad knowledge of patent law and Patent Office practice. Use of a registered patent agent is, therefore, recommended.

The patent grants the patentee and his/her legal representative the exclusive right, privilege and liberty of making, using or selling the invention to others from the day the patent is granted. The patent applies for up to 20 years from the day the patent application is filed. Work contracts and client contracts may stipulate that the inventor agrees to assign his/her rights to inventions and

to any patents for such inventions. The *Patent Act* does not require that patented items be marked as “patented”; however, marking an article as patented when it is not is against the law.

Under certain circumstances, inventors must grant a license on their invention. The Commissioner of Patent has the power to order an inventor to grant compulsory licenses for the manufacture of new foods or pharmaceutical products. This permits one or more companies to import or produce the patented invention subject to payment of royalties.

(8.3) Industrial Design

The *Industrial Design Act* protects creator of industrial designs. An industrial design is the shape, pattern or ornamentation applied to a mass-produced article. The design number have features intended for visual appeal and must serve a useful purpose. Registration of an industrial design with the Industrial Design Office will secure exclusive right to the design. As of January 1, 1994, registration is for a ten-year term. A maintenance fee is required within five years of registration. Once the term has expired, anyone is free to make, use, rent or sell the design in Canada.

(8.4) Trade Marks

A trademark is a word, symbol, design or combination of these used to distinguish the goods or services of a person or company in the marketplace. There are three categories of trademarks: ordinary marks, certification marks (i.e. those that identify goods and services meeting to defined standard), and distinguishing guises (i.e., a unique shape of a products or its package).

The *Trade Mark's Act* stipulates the conditions and restrictions for registration of trademarks. It also sets out the rights and remedies available to a trademark owner in Canada. Registration of a trademark with the Trade Mark's Office gives the registrant the exclusive right to apply it in association with the goods and services with which it is used in the marketplace.

Generally, no one but the owner of a registered trademark or trade name may sell, distribute or advertise goods or services using the trademark or trade name. Others may not use the trademark or any name or device that is suggestive or confusingly similar. Registration is valid for 15 years. The owner may renew it every 15 years upon payment of a renewal fee.

(9) PROFESSIONAL DEVELOPMENT

Engineers Nova Scotia has in place a Continuing Professional Development Program as a requirement of the Act. For more information, or to receive the Program Guidelines, please contact the office on web site.

(9.1) Continuing Competence of the Professional Engineer

The Code of Ethics requires Professional Engineers to maintain and improve their competence in the profession. This is an essential element of a rapidly evolving profession. Only an active program of professional development can satisfy this requirement. Professional experience must be gained on the job as well as through continuing education. The employer and the Professional Engineer should co-operatively facilitate learning on the job. Continuing education typically supplements this effort outside the workplace.

(9.2) Responsibility

The Professional Engineer has primary responsibility for his/her continuing professional development. Engineers are obliged to participate in their own development and to assist other Professional Engineers to maintain and enhance their competence.

Engineers Canada shares this responsibility with Engineers Nova Scotia and the other constituent associations, employers of Professional Engineers, learned societies and education institutions. Professional Engineering associations should act as facilitators and promoters, and recognize the activities undertaken by their membership to achieve this goal. Employers should also encourage Professional Engineers to participate in activities that maintain their competence. Learned societies offer a wide range of services that can be used by Professional Engineers to maintain and improve their competence. Similarly, educational institutions provide many opportunities to enhance professional competence.

(9.3) Continuing Education

There are three classes of continuing education: technical, managerial, or professional.

Technical continuing education covers a wide range of disciplinary and sub-disciplinary content and may even be tailored to a particular application. It may include any engineering course taken at a recognized education institution after graduation. They may deal with a chosen specialty or training in another branch of engineering or engineering-related field. This type of training generally interests Professional Engineers beginning their careers but mid-career and senior Professional Engineers may also benefit from participation.

Managerial continuing education may embrace a wide range of topics, such as:

- arbitration and other forms of dispute resolution
- budgeting and control
- communication skills
- computer applications
- economics
- environmental and social issues
- financial management
- health and safety
- labour relations
- law (contract, industrial, commercial)
- management principles
- marketing
- negotiation skills
- organizational development
- project management
- psychology/behavioural science
- quality assurance.

Courses in these fields are usually of greatest interest to mid-career and senior professionals looking to upgrade or refine their skills, although junior engineers may also benefit. Participants may be motivated by the desire to advance their careers as well as to improve their practice.

Continuing education focused on professional issues may address a similarly wide range of topics, including:

- concepts of professionalism
- ethics in the workplace
- whistle blowing
- professionalism and unionism
- impact of engineering on society
- conflicts of interest.

These areas are of interest to engineers in all phases of their careers. They help engineers to better understand their roles and responsibilities as professionals, which is beneficial in both subordinate and managerial positions.

(9.4) Forms of Continuing Education

Continuing education may be formal or informal.

Formal activities are those provided as a structured course or program which includes an assessment of the student's learning. Although formal activity is not mandatory, all members should strive to include some formal activities within their continuing professional development program. Delivery methods might include traditional classroom settings, and remote techniques such as written correspondence, video, or interactive electronic exchange. Formal activities include, but are not limited to:

- courses provided through universities, technical institutes, and colleges
- industry sponsored courses, programs, and seminars
- employer training programs and structured on-the-job training
- short courses provided by technical societies, industry, or education institutions.

Informal training may not be structured or offered by an educational institution, but does expand your knowledge, skills, and judgement. They include such activities as:

- self-directed study;
- attendance at conferences, technical sessions, talks, seminars, workshops, and industry trade shows;
- attendance at meetings of technical, professional, managerial associations or societies;
- structured discussion of technical or professional issues with one's peers.

(10) COMMUNICATIONS

Effective and responsible communication is an integral part of engineering practice. Professional Engineers may be involved in a broad range of communications activities in the course of their careers. Some of these activities are daily events such as updating colleagues, supervisors or clients on project status. Other activities such as speaking to high school students about careers in engineering, being interviewed by the media or delivering a technical paper to peers may only occur once in a professional lifetime.

The discussion of the characteristics of a profession in the introduction to this *Manual* also serves as guidelines for the Professional Engineer engaged in any communications activity:

Professions adopt distinctive Code of Ethics that deal with relationships between their members and the public, as well as with colleagues, employers, employees, and clients. Adherence to a canon of ethics ensures an adequate standard of competence and conduct. It establishes a relationship of responsibility and trust between the profession and the public, while maintaining respect, integrity, and confidentiality among practitioners, employers, and clients.

In addition, the Code of Ethics states that every Professional Engineer is responsible “to enhance public regard for the profession” by educating the public about engineering. They also state that “a Professional Engineer shall co-operate in extending the effectiveness of the engineering profession by interchanging information and experience with other engineers and students and by contributing to the work of engineering societies, schools and the engineering scientific press.”

Furthermore, as stated in the section on Commitment to Society in this *Manual*:

Professional Engineers, through their practice, should extend public understanding of the profession and should serve in public affairs when their professional knowledge may be of benefit. They should promote and present their profession clearly and positively to the public. They should extend public knowledge and appreciation of the profession, and their achievements. Where possible they should serve on public boards, boards of directors, and other organizations but in so doing should not use their position to exert inappropriate influence to secure professional assignments. In other words, they should endeavour to participate in society at all levels, from community affairs to public office, with integrity, tact, and decorum.

Each Professional Engineer is an ambassador for the profession. A simple contribution each Professional Engineer can make is to use the P. Eng. designation in all business correspondence, documentation and advertising, regardless of whether the content is related to engineering. This carries through to volunteer, community and political work. The image created by each engineer through his or her professional, social, community and political activities contributes to an impression of their profession.

It is, therefore, important for Professional Engineers to develop effective and responsible communications skills and take every opportunity to create a better understanding of the profession.

(11) SAFETY ISSUES

Workplace safety concerns involve both the employer and employee. The employer has control over the workplace and is responsible for the health and safety of employees. The employee is responsible for tasks performed. Each employee must follow safety precautions and procedures in the performance of tasks so as not to create health or safety problems. The two parties must co-operate to identify and eliminate all safety and health hazards in the workplace. Following are some responsibilities of which Professional Engineers should be aware depending on their position within a corporate framework:

Corporate Directors and Officers

- Ensure the company complies with the *Occupational Health and Safety Act* and the relevant regulations.

- Create a safety program for all staff.
- Provide information, training, supervision, and proper facilities to all employees.
- Provide and maintain personal protective equipment as required.

Managers

- Comply with the *Occupational Health and Safety Act* and the relevant regulations.
- Co-operate with the health and safety committee and officers.
- Ensure employees are not exposed to harassment in the workplace.
- Make all appropriate health and safety information available to all employees.
- Notify the employees of any hazards in the workplace or job site.

Supervisors

- Ensure the employees comply with the *Occupational Health and Safety Act* and all relevant regulations.
- Ensure that protective equipment and devices are used.
- Ensure all employees for whom they have responsibility and are able to control are aware of safety hazards in the workplace or job site.

Employees

- Ensure that their own actions do not adversely affect the health and safety of others. Wear or use protective equipment when necessary.
- Co-operate with the workplace parties and the officers.
- Ensure protective devices are not removed unless specific procedures are followed.
- Report all hazards observed in the workplace or job site for which they have responsibility and are able to control.
- Refrain from horseplay or pranks in the workplace or job site
- Comply with the provisions of the *Occupational Health and Safety Act* and the relevant regulations.
- Refrain from causing or participating in harassing behaviour at the workplace.

Depending on the job, a Professional Engineer may be employed in any of the following functions and, therefore, their duties will differ. It is the individual engineer's responsibility to be aware of their role and to act accordingly. If a Professional Engineer is not aware of their specific role, they should seek clarification from management.

Project Manager (individuals or corporations that control a project)

- Comply with the *Occupational Health and Safety Act* and the relevant regulations.
- Ensure that other parties, such as sub-consultants, suppliers and sub-contractors comply with the *Act* and regulations.
- Document safety requirements of other parties.
- Encourage co-operation between committees and officers of other parties.

Consultants

- Comply with the *Occupational Health and Safety Act* and its relevant regulations.
- Responsible for identifying, documenting and attempting to rectify any safety hazards in a workplace or job site for which they are responsible and who they have authority to control.
- Follow all safety guidelines of the client.

Suppliers

- Ensure services are carried out safely.
- Ensure that advice or certification of results provided to clients is not negligent so as to present a safety hazard.

The *Nova Scotia Occupational Health and Safety Advisory Council* publication “*Taking Responsibility*” recommends that Professional Engineers pay special attention to their role on construction sites. Several models are used to organize construction sites with new models under development. Construction project models may include project managers; construction managers; consulting engineers; general contractors; sub-contractors; and owners, with or without employees or agents of the owners on-site. The actual responsibilities of each party depend on the contracts and practices applied for each project.

Responsibility for workplace health and safety does *not* depend on whether a person happens to be a professional such as an engineer, or whether they, as an owner, will eventually receive the finished product. Sometimes either one of these people *might* be a “constructor” under the *Occupational Health and Safety Act*. The real question is: Does the party *direct* activities at a project?

A party who directs the work processes for a project is accountable for the protection of health and safety on the project, to the extent of their authority. Authority may be set out in a written contract or may emerge from the practices in effect between the parties. A party who assumes responsibility only for assessing and communicating whether a project has met a specified standard is not directing work at a project. If the quality control function goes beyond this, it will be a matter of fact that this function was expanded to include directing the work process.

It is very important that an engineer properly communicate his/her role and responsibilities to those in the workplace or on the job site. For example, engineers inspecting for compliance with specified standards must communicate their requirements carefully. The engineer should not, for instance, directly instruct a contractor to correct a deficiency in a product on a construction site. This would put the engineer in the position of directing the contractor’s forces. Unless contractual or employment responsibilities dictate otherwise, the engineer should report the deficiency to the owner or employer. The owner or employer would then request that the contractor take appropriate corrective action.

The Nova Scotia Department of Labour and Workforce Development has requested that all engineers involved in preparing contract documents for engineered structures ensure that such documents contain a clause that requires the construction contractor to comply with the *Occupational Health and Safety Act*. The Occupational Health and Safety Division of the Nova Scotia Department of Labour and Workforce Development has clearly identified that ignorance of the requirements of the *Act* is no defence. If an engineer has any questions regarding these matters, they should call the Department for clarification.

Engineers Nova Scotia has assisted in the development of a Safety Certification Program for Professional Engineers practicing in the field of engineering design and inspection. This Safety Certification Program has been endorsed by the Department of Labour and was developed in response to a demand from consumers of engineering services (i.e. the Nova Scotia Department of Transportation and Infrastructure Renewal that engineering firms be safety certified. Information on this Program can be obtained through Engineers Nova Scotia.

C ENGINEERING JOB FUNCTIONS & THE ACT

Engineering requires that Professional Engineers be involved in a wide variety of job functions. This Part of the *Manual* provides direction on the practical application of general themes of ethical and professional conduct introduced in earlier Parts. However, in this Part, they are developed for specific job functions. This Part of the *Manual*, and the number of job functions addressed, will evolve as engineers find themselves in an increasing variety of job functions. Please contact Engineers Nova Scotia with any comments you may have regarding job functions engineers are filling which involve the practice of engineering but are not listed in the Table of Contents under Part D. It is intended that Guidelines for all the job functions identified in Part D of Contents will be completed over time. Members will be issued these updates as they become available.

(1) DESIGN

A Professional Engineer whose practice includes the field of engineering design should take several steps to ensure the design is properly executed. To begin with, he/she should meet with the client or a representative of the client to specify the client's requirements. This discussion should address functional and aesthetic issues, as well as cost and scheduling objectives, contract requirements, and scope of work.

Based on this consultation, the engineer should establish the basic parameters of the design including space and systems requirements. A preliminary design concept can then be prepared within the framework provided by these considerations. This idea should also take into account economy, performance, capital costs and compatibility with other design elements. This consideration should include assessing the cost and suitability of other reasonable approaches in relation to client priorities.

The design must meet the requirements of relevant codes and authorities. This includes ensuring that a Professional Engineer inspects the construction work as stipulated by the *Nova Scotia Engineering Profession Act*, the National Building Code, and provincial and municipal regulations. It is the responsibility of the engineer to be familiar with these requirements.

Involving other professionals in the design process may be necessary in light of other relevant legislation or the limits of the design engineer's specialties. The engineer should inform the client when this need arises. Where always required he/she should prepare terms of reference for these supporting professionals. The engineer is responsible afterwards to work harmoniously with the resulting team. He/she should take into account the needs of fellow professionals and provide information to them as they may require. The engineer should also work with other team members throughout the design process to ensure they have input to all relevant aspects of the design process.

(1.1) Final Drawings and Specifications

With the approval of the client and relevant authorities, the engineer should refine the preliminary design into its final form. He/she should document the final design in plans and specifications suitable to guide construction of the design. The engineer must co-ordinate his/her efforts with other designers involved. He/she should prepare calculations and specify systems as appropriate to meet the specifications for the design. The design should be presented in clear, complete contract drawings. If the contractor is responsible for any aspect

of the engineering design. The contractor must engage an appropriate Professional Engineer to design these components of the project.

All design drawings should indicate the purpose of the drawing (Preliminary, For Construction, Feasibility, etc.), the issue date, and, for those considered final, be stamped and signed by the design engineer. As the purpose of drawings is to represent the design clearly and unequivocally, it is important that they be prepared at an appropriate scale. Where the selected scale or the complexity of the design makes drawings difficult to read and interpret, separate detail drawings should be provided.

Drawings should incorporate schematics and diagrams for all major systems. They should likewise provide layouts for all systems where necessary for clarity, with large-scale details, elevations and sections properly cross-referenced. Drawings should include symbol lists and typical details for all equipment, accessories and systems. They should also include schedules where necessary to define special features of construction or finishes. The Design Engineer should initial all drawings as they are revised.

In preparing the final drawings and specifications, the engineer should analyze and design all systems to meet or exceed applicable regulations. This generally requires the engineer to liaise with a wide range of government bodies. Examples are municipal planning and building inspection departments, fire protection officials, public and private utilities, and federal and provincial officials in the fields of environment and transportation. This is not, however, a complete list. Requirements for review will vary with each project and may change over time.

Review does not however diminish the responsibility of the engineer. Regulatory reviews are not checks or appraisals. Liability for design work remains with the design engineer who must ensure that all aspects of work meet engineering as well as regulatory standards.

The engineer should prepare a specification for all work for which he/she is responsible. Specifications should be complete, clear and concise. They should also follow a standard format as closely as possible. The document should start by outlining the general scope of work. Subsequent sections should describe the various classes of work under well-organized, appropriate headings. Individual sections and headings should be set apart graphically with bold type, underlining or similar devices. A table of contents should be included to provide easy reference.

The specification should use standard terms for materials and processes that are consistent with the plans. If requested, the engineer should supply final tender drawings and specifications according to the requirements of the contract between the client and the engineer. In addition, and if requested by the client, the engineer should estimate the probable cost of the work or comment on the separate work of independent cost consultants.

(1.2) Tender Documents

If requested by the client, the engineer may prepare or assist in the preparation of tender documents. This can imply several duties at the discretion of the client. They may ask that the engineer provide conditions covering unit prices, alternative prices and separate prices required from the contractor. He/she may help the client to call tenders and analyze the submitted bids. During the tendering process, the engineer may also help the client to answer questions raised by bidding contractors. Based on his/her involvement in analyzing bids, the engineer may award the most suitable contractor or contractors to the client, and the desired materials or systems.

(1.3) General Review during Construction

The client may ask that the design engineer or another qualified engineer provide general review services during construction. This is done so as to ensure that the constructed works are in general compliance with the design documents.

(1.4) Special Services

The engineer may supplement the services described under the preceding headings with additional services, provided these services are within the scope of his/her experience and ability. These include the following services:

Advisory Services: Testimony, consultation and advice, appraisals, valuations, research or other services leading to specialized conclusions and recommendations.

Feasibility Studies: Preliminary engineering studies and the collation and processing of information to select one of several alternative systems or courses of action relative to the project. This may include gathering data on site conditions affecting design; analysis of systems or of several alternative plans, economic study of capital, operating costs and other financial considerations; and similar matters leading to conclusions based on which recommendations for the project will be made.

Surveys of Existing Systems: Detailed surveys of measurements and evaluation of existing systems. This may include securing information on special existing equipment such as unusual loadings and safety systems.

Provision of Record Drawings: Revised or new drawings necessary to show “as built” or “record” conditions.

Translations, Conversion, Reduction: Translation of contractual documents into a second language, conversion of measurements to metric or imperial units, and preparation of drawings for reduction of scale.

Fast Track Construction: Where several bid packages are prepared either to divide a large project into manageable components or to facilitate rapid construction start-up, the engineer may be required to perform additional work to prepare the extra bid packages.

(2) REVIEW DURING CONSTRUCTION & COMMISSIONING

(2.1) In General

The review during construction of engineering projects requires the appropriate engagement of a qualified Professional Engineer. To do otherwise would risk violation of the *Engineering Profession Act*.

The reviewing engineer is responsible for the interpretation of engineering design plans and documents as well as the review of other relevant documents and specifications so as to ensure that the contracted works are in general compliance with the engineering design. This engineer must also inspect work as it proceeds to ensure that it conforms to design work and his/her direction.

As a reviewer, the responsibility of the Professional Engineer is primarily to the public. The engineer must interpret documents and review work on-site to ensure that the project is carried out as intended by the designer for the benefit of the owner. In this respect it differs from construction supervision, in which the primary relationship is between the engineer and the contractor, notwithstanding that effective construction supervision is also in the best interest of the owner. In this respect, the owner and other participants in the construction process must understand that the reviewing engineer cannot certify the work of the contractor. Certification by the engineer must be limited to the requirement that the constructed works are in general compliance with the design documents.

Without exception, only a qualified Professional Engineer should conduct the review during construction of engineered works. In this context, the responsibilities of the reviewing engineer are limited to those of a quality control nature. If a construction site is involved, the reviewing engineer's responsibility on the construction site, in terms of safety, are identified under Section C of this *Manual*.

As Professional Engineers, reviewing engineers must naturally adhere to the *Engineering Profession Act* and the Code of Ethics, as well as with all applicable laws and regulations. Examples of the latter include the National Building Code, the Nova Scotia Building Code Regulations, and all applicable local regulations such as Land Use By-Laws and Subdivision By-Laws. As with all engineering activities, the reviewing engineer must give foremost consideration to public safety and environmental protection.

Ideally, the engineer engaged to carry out a construction review is the design engineer. When this is not the case, and if it is feasible, the selected Professional Engineer carrying out the review should contact the design engineer with the approval of the owner. This will allow the reviewing engineer to familiarize him/herself with all plans and specifications in the presence of the design engineer. The reviewing engineer should subsequently liaise with the design engineer, if available, to ensure that on-going interpretation is correct. In particular, the reviewing engineering should notify the owner and the design engineer of any changes to the design prompted by conditions encountered during construction. If the design engineer is not available for such consultations, notification of such changes to the owner is sufficient.

(2.2) Review Process

The engineer engaged to conduct review during construction has various responsibilities including, but not limited to, one or more of the following depending upon the nature of the project:

- Interpreting drawings and specifications for the project.
- Reviewing vendor documents, equipment and material specifications, supplier qualifications and manufacturers' manuals for conformance with specifications.
- Visiting the site to review construction on a frequency commensurate with the size and complexity of the project to see if the construction is occurring in general compliance with the design document.
- Initiating quality control and materials testing programs, when relevant, to determine conformance to the specifications and interpreting the test results.

If the reviewing engineer is not also the design engineer, he/she must also communicate with the design engineer, when possible, concerning any contemplated changes to the design, as noted above.

Construction review should follow a rigorous methodology. After initial discussions with the owner or designated representative(s) of the owner, the reviewing engineer should begin the process by calling a meeting with the contractor. At this meeting the engineer and contractor should discuss any relevant matters to ensure that the intent of the design is clear and this would include any special conditions or procedures to be applied during construction. They should also review the procedures for construction review and its frequency.

Also at the outset of construction work, the engineer should adopt or develop a format for “Construction Review Reports” to be prepared at specified intervals during construction. Sample formats are available but essential elements include clear identification of the project, the date of the report, status of construction on the review date, a summary of review work and documentation of approved changes and other relevant matters. Regardless of whether the reviewing engineer and the design engineer are the same people, it is essential that all changes be clearly described with reasons for any alterations to the design. This provides the best protection from disputes with other parties involved in the construction process and for defence against future claims that may arise.

The reviewing engineer normally reports to the owner or a designated representative of the owner. At the beginning of construction the engineer should consult with the owner concerning the appropriate level of inspection. They should give consideration to the requirements of all regulatory authorities such as municipal planning and engineering departments, provincial government departments, and any relevant federal departments which may relate to their responsibilities as the reviewing engineer.

The relevant agencies will vary with the project and its location. The engineer should determine the regulations applicable to the subject project at the outset. Where any confusion may exist, the engineer should contact the appropriate agency’s representatives for clarification.

Where warranted, he/she should advise on the need for specialist testing and should ensure that qualified specialists carry out all necessary tests. If also providing the role of monitoring construction progress for the owner, the reviewing engineer can also be responsible for the release of progress payments during construction work.

On completion of construction, the reviewing engineer should prepare a “Construction Review Summary Report.” As with Construction Review Reports, this report should include appropriate filing information such as the project name and number, and report author and date. It should identify all preceding Construction Review Reports with a brief description of the purpose of each review. It should also summarize all approved changes to the design with applicable payment changes. The report provides a final record of the review process and changes made during construction.

(2.3) Review for General Design Compliance & the Nova Scotia Building Code Regulations

Buildings, as described in the Nova Scotia Building Code Regulations, must comply with the requirement for professional design and review, as stipulated in the Nova Scotia Building Code Regulations. The Engineers Nova Scotia Guideline, “Engineering Review During Building

Construction for General Compliance To The Design”, identifies the role of the engineer as specified in the Nova Scotia Building Code Regulations.

(2.4) Commissioning

When construction involves engineered systems, these systems should be commissioned upon the completion of construction. Commissioning involves “turning on” and testing these systems. Testing must confirm that these systems can operate as specified by the design engineer.

The commissioning engineer is often a different person from the reviewing engineer, given the required specialization in various engineering systems. This position may be filled by one of the sub-consultants to the prime engineering consultant, by a separate commissioning sub-consultant engaged by the prime consultant, or by a commissioning sub-consultant engaged by the owner. The first approach ensures familiarity with the design of the relevant systems and their objectives. The second and third models require the prime consultant and the owner to coordinate and manage the commissioning function in relation to design and construction services.

Although commissioning is associated with completion of construction, the commissioning engineer should ideally be involved from the conceptual design stage, whatever organization is selected. Where the commissioning engineer is not the design engineer, he/she should review the concept design as well as the design drawings and specifications. This involvement will familiarize the commissioning engineer with the design and its objectives.

Testing, however, takes place when systems are completed during construction. The commissioning engineer will normally have to test a variety of systems. He/she should adopt or create suitable forms for each separate system to be commissioned. These forms should incorporate normal filing information such as the project name and number, and report author and date, as well as the system and components tested. The primary content of the form should be a list of all relevant design specifications along with the results of tests against these parameters. These test results are submitted to the client — whether the prime consultant or the owner. If requested by the client, the commissioning engineer may also participate in the preparation and/or review of operating and maintenance manuals when relevant.

On completion of testing, the commissioning engineer prepares a Final Commissioning Report. The report should incorporate a Facility Commissioning Statement and a Performance Test Summary Report. The Facility Commissioning Statement describes the findings of the commission process. In some circumstances it may give conditional acceptance with a description of the conditions to be met or deficiencies to be corrected. The Performance Test Summary Report is similar to the Construction Review Summary Report in that it provides a concise list of all systems tested and the status of each (i.e., whether satisfactory or deficient).

(2.5) Final Review

When construction is substantially completed and commissioned in accordance with design drawings and specifications, the reviewing engineer must conduct a final review. Final review should take place in the presence of the contractor and owner. The purpose of the review is to identify any remaining deficiencies that the contractor must deal with before the engineer confirms that the constructed works are in general compliance with the design documents.

On completion of the final inspection, the engineer should prepare a list of all observed deficiencies with necessary corrections. He/she should submit this list to the contractor for action with a copy to the owner.

Assuming all deficiencies have been corrected to the satisfaction of the engineer and the owner, the engineer will submit a Construction Completion Certificate to the owner. The Construction Completion Certificate confirms that all work has been completed in general compliance with the design drawings and specifications based on the review process carried out during construction subject to changes approved in that process. It should incorporate a declaration by the contractor or their representative certifying that construction has so complied.

The work of the reviewing engineer may overlap with the commissioning engineer at this stage. The responsibility of the commissioning engineer, however, is restricted to the testing of specific engineered systems.

(2.6) Inspection during the Warranty Period

One further engineering inspection may be requested by the owner or the owner's representative after completion of construction but before expiration of the warranty period. This inspection determines if any deficiencies have arisen in the interim. As with Final Review, the reviewing engineer should conduct this inspection in the presence of the contractor and owner.

The result of the warranty inspection is a list of identified deficiencies, which should be submitted to the contractor and copied to the owner. It should incorporate the results of any relevant on-going testing of the engineered systems by the commissioning engineer, who should monitor changes through the full range of seasonal and operating conditions to confirm the proper functioning of all components. The commissioning engineer should provide the results of these tests to the owner or the owner's representative in a Warranty Inspection Report, which lists all deficiencies in these systems.

If requested, the engineer carrying out the warranty inspection can identify when all deficiencies have been adhered to his or her satisfaction.

(3) PROJECT MANAGEMENT

(3.1) Introduction

Projects are a specific class of work with a specific beginning and end. They can be distinguished from process-oriented work or the day to day functions of an office or organization. Projects are usually undertaken to create a specific product, such as studies/reports, designs, or innovations. The important distinction in relation to the day-to-day operations of a company or government department is that a project will have a clear result that will usually be scheduled to occur at a specific date. Generally also, specific resources will be allocated to a project and limits placed on the costs or resource inputs devoted to it.

This section is not a manual on project management. There are many texts procedures and system devoted to the on the subject that readers may wish to consult. This section basic project management practice are outlined in order to identify professional and ethical issues associated with specific steps. For consulting engineers, project management may be the dominant activity in their daily routine. The responsibilities of engineers in many branches of government and industry, by contrast, may focus on the conduct and management of daily processes. Even in these situations, it is often necessary to define and carry out projects to deal

with specific issues. The following outlines some considerations for process-oriented offices that undertake projects.

It is also important to distinguish project management from construction supervision, which is the subject of a separate section in this manual. There are many common elements, however. Project management techniques are applied by construction managers. Inasmuch as construction processes invariably have defined beginnings and endings within budget constraints they are a category of project management. The primary distinction is the unique practices and controls that are inherent to construction, notably the adherence to design and the process of construction inspection.

(3.2) Project Management Practice

Project management involves detailed steps from project scoping through project team selection to production and post-project evaluation. Good project management involves while not all encompassing the following components:

- accurate project scoping
- sound project team selection
- comprehensive project planning
- clear definition of project deliverables
- careful project monitoring
- adherence to project schedule and budget
- through project review and evaluation.

Communication between the managing engineer or project manager, and his/her client enhances the effectiveness of project management and execution at each step. Regular communication between the project manager and other members also smoothes conduct of the project team.

(3.3) Project Specification

Before submitting a proposal and beginning a project it is important to scope project requirements, staffing and skill needs, project timing, and budget constraints. Depending on the situation, some or all these tasks will fall to the project manager, the individual charged with responsibility for administering and executing the project. Sometimes Terms of Reference will at least partly define these tasks.

It is important under all conditions for the engineer designated as project manager to establish a clear mutual understanding with his/her client, whether they are internal or external to the manager's organization. Internal clients are members of the same organization for whom projects are conducted. They are equivalent to external clients with whom the engineer has a contractual obligation. The term "client" is used below in reference to both types of relationships.

When the engineer is responding to an external Terms of Reference, the proposal process normally addresses the need for mutual understanding. The Terms of Reference usually require the engineer to prepare a proposal to outline project tasks, budget, and schedule. Even though the proposal may be well received and suited to client needs, the engineer can assume that all issues are mutually understood. It is good practice for the project manager to meet with their client early in the project to discuss the work plan and its proposed execution. Both parties

should firmly establish decisions concerning project staffing, deliverables, and method of payment at this point, if the proposal or organization practice has not already set these parameters. Whatever the understanding, it is always best to review these arrangements to avoid conflict later in the project.

The project manager should also delineate the role of the client in project execution. This may include client involvement in meetings, budget management, or in specific project tasks. The obligations of the client to facilitate project execution should be understood as clearly as the responsibilities of the project manager and his/her team.

(3.4) Project Team

An important component of the project scoping process is to identify an appropriate team. Each project requires specific skills. However a project is assigned, professionalism requires the managing engineer to ensure that all team members have the training and experience to accomplish the tasks assigned to them.

When assigning work to staff, the project manager should be conscious of Canon 4 of the Code of Ethics for Engineers, which states that “[a] Professional Engineer shall undertake only such work as he is competent to perform by virtue of his training and experience.” Work assignments, therefore, should take into account the specialties of individual engineers, their years as professionals, and their familiarity with the task(s) they will perform. The same considerations apply to non-engineers whom the project manager may include on their team. The manager should be especially careful to ensure engineers do engineering work and that assignments to engineers are appropriate to their specializations. In other words, civil engineers should do civil engineering work, mechanical engineers should do mechanical engineering, and so on.

The project manager should also recognize his or her limitations in reviewing the work of different specialists. Although managers may be perfectly capable of supervising individuals drawn from many disciplines, they must be careful not to take control over work outside their own discipline.

When dealing with other Professional Engineers the project manager should recognize the responsibility placed on all engineers by Canon 4, as noted above. The project manager and his or her engineering subordinates must recognize limitations where they occur. If it is not possible to secure the services of an ideally qualified engineer or to provide appropriate supervision within the project team, external peer review has been arranged. Without such an arrangement ethics require refusal of the assignment.

Involving individuals outside the project manager’s organization may be necessary to satisfy professional requirements for certain projects. Consultants typically engage sub-consultants for this purpose. A sub-consultant is an individual or firm that is contractually obliged to the primary or prime consultant to contribute work to a specific project. The prime consultant normally describes the background, skills, and responsibilities of the sub-consultant in their proposal, if one is prepared. Except in very unusual circumstances, the project manager will be a member of the prime-consulting firm. He or she is responsible for ensuring that the sub-consultant performs the functions assigned to them.

(3.5) Project Contracts

The client and consultant project manager often treat a selected proposal as an implied contract to deliver specified work. Entering a formal contract is, never the less, better. Often consultants and/or clients will have standard contract documents for this purpose. Usually, language in the contract incorporates the proposal as the specification of the work program and deliverables. Once entered into, an agreement to undertake a project should receive the full commitment of all parties involved. Engineers are not only bound by implied or explicit contractual arrangements but by the Code of Ethics. All parties to a contract engaging a Professional Engineer should be aware that the standards of ethical professional conduct would prevail.

Whatever the form of agreement between the manager and his/her client, it is advisable to document any changes from an initial memorandum or proposal in writing. Any subsequent changes from this documented understanding should also be confirmed in writing at the time they arise. If such changes result in altered budget requirements, related documentation should address the impacts. Throughout project execution, the manager should conscientiously observe the original commitments. Any decision to deliver less, more, or a different product from that originally presented should be mutually acceptable to all parties under specified conditions.

Once entered into, an implied or written contract binds the engineer. He or she must complete the project to the specifications of the contract unless the client agrees to modifications or termination, or if there is justified cause for termination by the engineer. The engineer may justifiably end a contract where the contract provides for such termination or where client direction would violate the law or the Code of Ethics. Among possible reasons for such termination are the emergence of a conflict of interest that could cast doubt on the independence of the engineer's judgement, instigation by the client to commit an illegal act or acts, and failure of the client to follow engineering advice.

A key aspect of nearly all contracts will be an anticipated budget. The budget should cover all project demands as nearly as possible. There are many methods for calculating budget and recovering fees. It is often beneficial to outline the basis for budget estimations in proposal documents. The anticipated basis of payment should definitely be specified in contract documents. In particular, it is important to specify the circumstances under which the client will cover budget overruns.

The project manager should identify the role of the sub-consultant, their expected compensation, and the deliverables for which they are specifically responsible. Arrangements between prime consultants and their sub-consultants have traditionally been even less formal than between consultants and clients. It is beneficial, however, to meet the same standards of documentation with sub-consultants as with the client. Direct communication is advisable to ensure that the prime consultants and their sub-consultants understand their respective responsibilities. As always, documenting these obligations in a contract is desirable.

In situations where the client obtains services internally without direct payment, such as when employees of one government department contribute to a project carried out by another department, documenting responsibilities is also important. It is particularly important to ensure that all team participants are available to work on the project as necessary. When a project manager calls on staff in other departments or from other companies to contribute and does not have the leverage provided by a contract, he or she should ensure the commitment of the individual's superiors. Preparing a memo outlining the likely time requirements in relation to project objectives can accomplish this.

(3.6) Project Control

In the course of project execution, the project manager must ensure that their team carries out work to all agreed on specifications. The manager, therefore, is responsible for ensuring that they provide all specified outputs on schedule and within budget. They should inform the client or superior for who work is being executed of any changes from these specifications as they may occur.

A variety of changes are possible. The most common issues are meeting schedule and budget. It is very important that the manager communicates changes in these areas as quickly as possible. Sometimes the client may not be concerned with reasonable delays or can cover the need for additional budget. It is always, however, most comfortable when the client is informed beforehand when difficulties arise. The earlier the client knows about budget or schedule concerns the better the opportunity to take corrective action.

Changing staff or work procedures may also be necessary. When replacing staff, substitutes should meet the same professional standards as for the original team formation. The manager should replace departing team members, wherever possible, with individuals with similar qualifications and experience. Using professionals with less or more experience may be unavoidable at times. In such conditions, the project manager must be aware of the implications and take compensating action as necessary. This may include increasing supervision where the substitute team member has less experience, adjusting budget for a more experienced and expensive worker, or a variety of other measures. Whatever action the project manager takes, he or she should inform the client of changes in key personnel and any possible implications for project execution.

One means to keep the client informed of changes as a project proceeds is to organize the project into phases. Phases can be fixed in relation to interim deliverables so that the client can review progress. Meetings to conclude each phase, and present and discuss these deliverables also provide the opportunity to introduce potential changes and check progress against the proposed schedule. Preparation of minutes is advisable to document these discussions and agreed on changes.

The project plan should organize phases to build toward the final deliverable to avoid unnecessary duplication and backtracking. Determination of appropriate phasing is an important component of project planning. Deadlines for deliverables and dates for individual meetings should be set in advance as part of the project proposal or plan.

If the progress of work shows that the team should not or cannot carry out a particular task as proposed, the project manager must adjust the work program. Once again, the project manager should ensure that they inform the client of changes and that the client agrees before the particular task begins. This type of change often has implications for personnel and budget. It may also influence the project schedule. The manager ought to make the client aware of the full scope of such changes to the work plan.

As noted, keeping other team members informed as the project progresses is equally important for the project manager. The project manager should inform members of his/her own office as well as external employees and sub-consultants of changes relevant to them.

Project phasing is also useful to the project manager for cost control. Phasing helps the project manager to track expenditures in relation to work completed. Alternatively or in conjunction with tracking against particular tasks, the manager may wish to monitor expenditures by individuals or groups comprising the team. Most consulting firms record expenditures regularly in computerized project management databases. These systems provide budget tracking information on-line and/or through regular reports. The project manager should regularly consult this information to ensure that project expenditures are appropriate and on target.

(3.7) Special Considerations

For project control systems to be effective, managers must structure projects to facilitate tracking. They should separately identify phases and individual responsibilities according to the demands of the project and preferences of the manager. Many organizations have systems for coding projects and their components for exactly this purpose usually carrying over to filing and computerized budget tracking systems. Maintaining links between these systems and computer files (i.e., word processing documents, spreadsheets, and graphics) is usually very beneficial. For organizations certified under ISO 9000, project management procedures of this type will usually be defined and documented. Managers in ISO 9000-certified organizations must follow these procedures as set down.

In organizations where day-to-day operations are more process-oriented, standard filing systems may not be well suited to project organization. Such organizations may also lack employee time sheets and other recording systems by which consultants and other project-oriented operations track resource use. Process-oriented organizations should consider how projects could be tracked within these systems. They may find it useful to set up separate filing systems for project as opposed to process work and may find benefits in instituting systems to record the use of resources. Project managers in these situations may find it beneficial to establish their own procedures, with approval of their superiors, to record and track project activities.

Besides resource allocation and project monitoring, the project manager must be aware of requirements for external permission, approval, and permitting. All engineers must ensure they are familiar with regulations pertaining to their discipline. It is often important to obtain permission or prepare applications for permits before proceeding with specific project tasks. The project plan should consider these requirements. The project manager should ensure that they submit applications with sufficient lead-time to avoid disrupting project execution.

The complexity of some projects may demand more than simple phasing and resource allocation. In large, complex projects tasks overlap, and stop and start. Resource requirements may also vary widely from one stage to another during a project. It may, consequently, be important to co-ordinate resources with other projects to ensure that sufficient staff is available at critical points in the project.

The Project Evaluation and Review Technique (PERT) and Critical Path Method (CPM) were developed for computer application to help in the management of this type of project. Both techniques involve mapping the tasks that comprise a project in a network to delineate relationships among them. PERT is focused on estimating the duration of a project and monitoring progress as the project proceeds. CPM is an optimizing technique to determine the most efficient means of completing a project.

Computer programs based on these techniques are now available that allow managers not only to track overall progress but also monitor the availability and commitments of potential staff. Some provide graphics and day-to-day calendars to portray the allocation of staff and equipment. Users can also easily adjust contemporary programs if project tasks change.

(3.8) Project Completion and Evaluation

Maintaining good documentation throughout a project is important. The proposal or project plan usually specifies documentation to be submitted in the course of the project or on its completion. This normally includes interim and final reports, plans, and specifications. It may also include data and, occasionally, software developed for the project or other computer-related material. Many clients, for example, want to receive a word processor file of the final report, and/or spreadsheet, CAD, and other electronic files.

Placing conditions on written and electronic data is advisable. The proposal and/or contract, or a covering letter accompanying the transferred material may state such limitations. The project manager should protect his/her organization against the exposure of trade secrets or sensitive information. He or she should limit liability in case a recipient copies or modifies material without authorization. This is particularly important with electronic files that subsequent users can change and/or copy to others.

The project manager's organization should also maintain files on the project during its execution and as a historical record. Such files should include records of meetings; progress reports; project-related correspondence, including fax and E-mail documents; and relevant data and calculations. Team members should also file reports, plans, and specifications, although physical limitations may require separate storage of this type of material. Different organizations will develop their own practices for recording and storing materials but careful project coding is beneficial in all circumstances to facilitate cross-referencing.

Organizations are legally required to maintain project documentation for a minimum of seven years. Some may maintain original documents for longer periods. Microfilming is sometimes used to limit the space requirements for a long-term record. Taking measures to protect key project documents from fire and other hazards is also advisable.

The evaluator should be unbiased and their evaluation method should maintain their independence from the project manager and team. The evaluation process will invariably involve technical review of project outputs, whether they are reports, designs, or a completed product such as a building or a manufactured item. It should also include consideration of procedures, adherence to schedule and budget, and client satisfaction. Investigations may include consultation of project staff and/or the client. Questionnaires administered by mail or through interviewing may be useful for this purpose, provided they are properly designed and applied.

(4) MANUFACTURING

(4.1) Introduction

Manufacturing engineers organize and manage the processing and production of goods. The book *Manufacturing Engineering* by John P. Tanner (1985) cites the following description of manufacturing developed by Society of Manufacturing Engineers:

“That speciality of Professional Engineering which requires such education and experience as is necessary to understand, apply, and control engineering procedures in manufacturing processes and methods of production of industrial commodities and products, and requires the ability to plan the practices of manufacturing, to research and develop the tools, processes, machines and equipment, and integrate the facilities and systems for producing quality with optimal expenditure.”

Notwithstanding that the root for the word manufacturing means “by hand”, contemporary manufacturing, as the foregoing definition implies, involves extensive use of machinery and the application of computers.

Manufacturing also involves organizing people. Modern manufacturing processes normally require carefully planned division of labour and extensive specialization of functions. Manufacturing engineers specify machinery, equipment, and human resources in combination to create quality products as efficiently as possible. They seek to minimize production costs, maximize productive, meet or exceed quality standards and ensure that processes are safe and reliable.

(4.2) Work Environments

Manufacturing engineers are usually permanent full-time employees. Some manufacturing engineers work on contract or as consultants, generally in design, planning, and organizing roles as opposed to day-to day operations. In either situation, the manufacturing employers of engineers are usually large organizations.

Manufacturing processes are normally housed in plants built specifically for manufacturing activities. Within manufacturing plants are specialized machinery and equipment, usually arranged to minimize the energy and human effort required to produce specified outputs. A great deal of the effort of manufacturing engineers is devoted to finding opportunities to reduce further the resource, capital, and labour inputs required for production.

Manufacturing engineers do not normally have direct contact with the end customer for their products. The first responsibility of the manufacturing engineer is to his or her employer. The priorities of the manufacturing company are primarily to produce goods that can be sold at competitive prices. This puts a heavy emphasis on cost reduction through every facet of the manufacturing process.

In addition to producing products at minimum cost, manufacturers must ensure that both the production process and the resulting product are reliable and safe. The manufacturing engineer has a key role in addressing these goals as the frequent designer of both products and production processes. He or she must eliminate process arrangements that might compromise employee or public safety. He or she must also guard against design defects in manufactured products that could reduce the utility of such products for consumers. In addition to liability concerns, these issues have economic relevance. Work time accidents cost time and money, and sub-par products will influence their competitiveness in the market.

Manufacturing organizations usually have many employees filling specialized, complementary roles. Manufacturing engineers must organize these employees. Frequently, also, the manufacturing engineer will supervise and/or lead teams within the manufacturing operation. In this capacity the manufacturing engineer is responsible for the Occupational Health, Safety and Security (OHS&S) of subordinates. Additionally, the manufacturing engineer must ensure that

concerns for public welfare are accounted for throughout the product design and manufacturing processes.

With respect to OHS&S, the manufacturing engineer should account for any possible or known hazards inherent in the manufacturing process. Manufacturing can involve the operation of heavy machinery and handling of heavy and/or awkwardly shaped materials. Assembly line manufacturing, in particular, can expose workers to repetitive strain injuries. Furthermore, machinery may operate loudly or may generate effluents that can affect exposed employees. The manufacturing engineer must seek methods to reduce or eliminate these situations. In the case of repetitive strain injuries it may be possible to replace human input partially or completely with specialized machinery or robotics. Alternatively, the manufacturing engineer may alter the process so that intensive labour is shared among workers or varied in a way that will reduce its impact. With respect to noise and effluent impacts, the first step is probably to reduce levels of both. Further steps may involve reducing impacts through adaptations of machinery (e.g., muffling noise) or by equipping workers with protective equipment. This must, of course, be done while maintaining a level of sensory input that will allow workers to identify dangers indicated by noise, smell, and vibration.

Within manufacturing work teams the manufacturing engineer must often work with individuals of diverse backgrounds and skill sets, many of whom are not engineers. This may include people from areas such as product development, sales and marketing, senior management, production supervision, maintenance and production. The manufacturing engineer may be required to co-ordinate and motivate the varied contributions of people and resources from these functional areas.

(4.3) Manufacturing Engineering Practice

The practice of manufacturing engineering covers the following major tasks:

- design of manufactured products
- design and installation of production equipment
- design and implementation of manufacturing processes
- control and refinement of manufacturing processes
- maintenance of production equipment.

Accredited Manufacturing Engineering programs are offered by a number of Universities and Colleges in Canada. Manufacturing engineers, can also be drawn from a variety of other engineering disciplines. Unless specifically trained through an accredited institution, most often, they come from the ranks of industrial and mechanical engineers, although electrical, civil, and software engineering all provides background relevant to manufacturing design and management. For the most part, Canadian engineers refine their knowledge of manufacturing engineering on the job. There are certain advantages to the Canadian approach, particularly the level of general expertise and knowledge that engineers can bring from their specialties to the manufacturing workplace.

The need for designation of manufacturing engineers has, also, been addressed in North America through certification programs offered by the Society of Manufacturing Engineers (SME). The Society reports on its Web site that the following accreditations are available:

- Certified Manufacturing Technologist (CMfgT), which recognizes competence in the fundamentals of manufacturing;
- Certified Manufacturing Engineer (CMfgE), recognizing a more comprehensive knowledge of manufacturing processes and practices;
- Certified Enterprise Integrator (CEI), which recognizes a proficiency in leading the implementation of complex business changes using information technology to enhance products, processes, and services.

The CMfgE designation is clearly of most relevance to Professional Engineers interested in manufacturing, although there may also be interest in CEI accreditation among engineers interested in the application of computer systems to manufacturing.

On the job, manufacturing engineers are designers, implementers, and managers. As designers their priorities are to design products that function reliably in their intended purpose, are as safe as possible in intended and unintended applications, are marketable, and cost-efficient. Because most manufacturers produce goods for competitive markets it is very important that designs are cost-effective. Since markets generally dictate price, the benefit to the manufacturer is proportionate to their ability to reduce cost. The challenge to the designer of manufactured products is to design goods that satisfy criteria of marketability, functionality, and safety, while minimizing cost. This same challenge extends to the design and management of production processes.

As definers of manufacturing processes, manufacturing engineers usually develop policies and procedures for operations within the context of company policies and procedures. They are responsible for developing procedures that allow sufficient flexibility to address unanticipated problems in the project/process.

Production planning to co-ordinate production with market demand provides significant value in this regard. A long-range production plan has clear benefits for financial management by improving budgeting and reducing inventories of both inputs and outputs. It also has distinct advantages as a tool for communicating within a company and to staff. A well-presented plan conveys the goals and objectives of the manufacturing operation throughout the organization.

Good communication is the foundation of effective labour management in the contemporary workplace. Manufacturing plants have historically been regarded as difficult work environments in which management and labour are widely separated. In modern manufacturing plants considerable effort has been devoted to remedying these conditions. Modern plant managers strive to maintain a clean and safe work environment. Attainment of these goals has proven to be beneficial not only to workers but also to the profitability of manufacturing operations.

Organizational innovations over the last 30 years have tended to focus on greater involvement of employees in product design and production, and plant management. More participatory approaches to plant management allow workers to contribute their ideas to improving production processes and the resulting output. These more democratic arrangements have been found to enhance product quality and lower production costs.

(4.4) Ethical Considerations

The priorities of the manufacturing engineer include minimization of production costs, maintenance of a reliable and safe manufacturing environment, and production of good quality, reliable, and safe goods. These objectives can at times conflict. Government guidelines and

laws govern many of these facets of safety and environmental protection for manufacturing operations, and manufacturing engineers must be familiar with these requirements. As professionals they must also be conscious of the requirements of The Code of Ethics.

Whatever category of engineering a manufacturing engineer may be trained in and regardless of whether or not they possess a specific manufacturing engineering designation, engineers involved in manufacturing must be conscious of the scope of their expertise. Manufacturing engineering can be very specialized. For example, engineers involved in the manufacture of steel may share very little practice knowledge with engineers working in the production of computer components. Consequently, manufacturing Engineers must be aware of their knowledge and experience, and the limits on transferring this to different manufacturing processes.

The first responsibility of all engineers is to the public welfare. All engineers -- whatever the activities in that they may engage -- must consider potential hazards to the public. Manufacturing processes imply inherent dangers to people and the environment. Many manufacturing processes, for example, require the handling of dangerous chemicals, some involve use of large machines, often-heavy loads must be moved, and frequently large volumes of energy are consumed. All of these aspects of manufacturing can imperil workers or the public if managed improperly. These events are fortunately rare but disasters do occur. An explosion in a chemical plant or a refinery, for example, will endanger both workers and members of the public in the vicinity of the facility. There have been instances of this type in which on site workers and nearby citizens have been seriously injured or killed.

Without question, manufacturing establishments typically present a higher level of both human and environmental dangers than most other business properties. The manufacturing engineer has a duty to be aware of potential hazards within his or her workplace. As noted, the character of many manufacturing environments can expose workers to greater risks than are found in most other workplaces. A Professional Engineer shall guard against conditions that are dangerous or threatening to life, limb or property on work for which he/she is responsible, or if he/she is not responsible, will promptly call such conditions to the attention of those who are responsible”.

The Nova Scotia *Occupational Health and Safety Act* places substantial responsibility on engineers and other employees. Employees must protect their personal safety and that all of fellow workers. They must report any possible safety hazards to their supervisor or employer immediately when such safety hazards become apparent. They must assist in alleviating these hazards to the greatest degree feasible. If deficiencies are not satisfactorily addressed the employee is obliged to report to an internal Occupational Health and Safety Committee (OHS&S) where one exists or, if this proves unsatisfactory, to Occupational Health and Safety Division of the Nova Scotia Department of Labour and Workplace Development.

The obligations of Professional Engineers are reinforced by their professional standing and the assumption of greater knowledge that it implies. This is especially important where the engineer stamps designs. The *Occupational Health and Safety Act* states clearly that a Professional Engineer who negligently or incompetently gives advice or stamps documents resulting in endangerment of workers at a workplace is in contravention of the act.

Likewise, manufacturing engineers must be familiar with environmental legislation, as applicable for all manufacturing processes being considered. Environmental requirements apply to effluents streams discharged to air, ground and water. In Canada, the Federal and all Provincial

Governments continue to develop increasingly strict legislation pertaining to effluent streams, waste management and the recycling of waste materials. Here in Nova Scotia, these regulations have been largely developed pursuant to the Nova Scotia *Environment Act*. The Manufacturing Engineer should at least be aware of any and all environmental regulations that may pertain to his or her areas of responsibility, and be prepared to notify his or her employer of any incidents or infractions.

Manufacturing engineers are usually employees of companies. Although their first responsibility is to the public welfare, their primary contractual responsibility is to their employer. A Professional Engineer shall act for his client or employer as a faithful agent or trustee and shall act with fairness and justice between his client or employer and the contractor when contracts are involved. In this respect an engineer should not criticize the actions of his or her employer without first trying to resolve the conflict internally.

If the employer is not willing to accept the advice of the engineer, the engineer is obliged to explain and document his or her professional judgement. A Professional Engineer shall present clearly to his clients or employers the consequences to be expected if his professional judgement is overruled by other authorities pertaining to work for which he is professionally responsible. This includes outlining the consequences of ignoring the specific engineering advice. If it proves impossible to convince an employer and/or senior managers to accept his or her engineering judgement, the manufacturing engineer should consider resignation. In the extreme, if the public welfare is threatened, the engineer may be obliged to communicate concerns to Engineers Nova Scotia and/or government authorities.

As an employee working within an organization, the responsibilities of the manufacturing engineer also flow to fellow workers. The contractual obligation of the engineer to his or her employer usually implies a responsibility to facilitate the effective performance of superiors and subordinates. When dealing with subordinates, however, an engineer must observe the right of a subordinate to adhere to the same professional standards, whether or not the subordinate is an engineer. A Professional Engineer shall not expect or direct an employee or subordinate to act in a manner that he/she or the employee or subordinate considers to be unprofessional or contrary to the public good.

The duty of the manufacturing engineer to his or her employer extends to specialized information held by the employer or produced by them while under contract to their employer. Specialized information can be key to gaining competitive advantages in the marketplace. It is important, therefore, that manufacturing engineers know what information is confidential and ensures that it remains the private and confidential property of their employer.

Document control policies can aid in meeting these goals. If a document is clearly marked "*Confidential*" the engineer and other employees are obliged to ensure that it remains confidential. When dealing with external suppliers or contractors, an understanding of confidentiality agreements and their application is required. Appropriate use of copyrights and patents is also important to protect the advantages of design and production advances.

Nevertheless, it may be possible to exchange technical information without breaching confidentiality directives. The manufacturing engineer must obtain a written release from his/her employer prior to any confidential information being released for public consumption. Venues for such exchange include seminars, conferences, journals, and societies devoted to engineering advancement.

Engineers Nova Scotia has an important role to play in support in this type of technical information exchange. Of particular relevance for manufacturing engineers are such associations such as the Society of Manufacturing Engineers (SME), the American Institute of Plant Engineers, the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), and the American Society for Quality Assurance (ASQA). There are also associations for engineers involved in the production of specific products (e.g. the National Electrical Manufacturers Association, the Rubber Manufacturers Association; the Valve Manufacturers Association of America. Because most manufacturing engineers are employees, it is important that their companies see the value of these associations and support the participation of their engineering staff.

(5) OPERATIONS & MAINTENANCE

(5.1) Introduction

Most engineering creations have a substantial life after they are made or constructed. Buildings, roads, bridges, municipal infrastructure components, and similar products are usually designed to last for 50 years or more. With upgrading and replacement of ageing components, some products of engineering design have literally lasted for centuries.

The safe and effective attainment of the design life of an engineered product relies on good operations and maintenance (O&M) practice. As products, structures, and infrastructure age, they must be managed, inspected, and when necessary, replaced in part or completely. O&M engineers are involved in this process of monitoring and managing engineering creations. They must monitor and maintain equipment and facilities to ensure their safe and effective operation.

(5.2) Work Environments

O&M engineers normally work for a single customer. Common employers of O&M engineers are industrial plants, large facilities, and government departments responsible for management of buildings and/or infrastructure. In Nova Scotia, engineers with O&M responsibilities are employed in pulp and paper mills, food processing plants, and by other various manufacturers. All three levels of government also employ O&M engineers, most often in departments responsible for roads, water, sewer, and storm-water infrastructure, and other public works.

Like most engineers and other workers, O&M engineers are directly responsible to their employer. The effective O&M engineer ensure that buildings, facilities, or machinery in their care are maintained in good working order at all times, and are capable of performing the functions for which they are intended. This role is important to the safe, effective and reliable operation of such facilities or systems in general, and as such, the O&M engineer serves the direct interest of his/her employer as well as addressing the basic ethics of the engineering profession.

Responsibility for operations and maintenance usually requires day-to-day attention. The O&M engineer, therefore, is usually an employee as opposed to a consultant or contract employee. O&M organizations usually include employees whom are not engineers to carry out functions such as inspection maintenance and cleaning. The engineer, in these cases, may fill the role(s) of technical advisor supervisor or manager.

O&M engineers may also rely on consultants or contract engineers to provide specialized expertise or additional manpower. In some instances where inspection and maintenance can be done at defined intervals it may be sufficient to engage engineering consultants. This is

especially appropriate for buildings and public infrastructure components that deteriorate slowly. In these cases, non-engineering staff within the organization may carry out an on-going maintenance program as directed by a consultant.

It is very important for the engineer working with non-engineering staff to recognize their overall ethical responsibility. Whether working as supervisor or advisor, the engineer is responsible to ensure that staff taking his or her direction executes their work in a technically proper and ethical manner. One way of ensuring this is through the provision of complete and up-to-date O&M manuals. Manuals are beneficial to professional as well as non-engineering staff. Typical manuals describe the following:

- *Operational and management responsibility* - the goals and objectives of the O&M program.
- *Staffing* - personnel requirements including lines of responsibility and job descriptions.
- *Regulatory requirements and/or operating standards, including testing procedures* - government standards that must be met for such factors as pollutant output, and operational minimums and maximums set by the employer.
- *Normal, alternate, and emergency operations* - typical operating levels and settings
- and, if applicable, levels and settings for other conditions, including emergency conditions.
- *Reporting requirements* - daily, monthly and/or quarterly, and annual records of operation.
- *Safety considerations* - on-site hazards, protection measures, and appropriate response to typical and emergency events.

A comprehensive O&M manual will inform all members of the O&M team of their responsibilities and interrelationships. Adherence to the procedures established should ensure the highest level of performance and safety for employees and users. Some O&M organizations may have several manuals applying to different machinery and infrastructure components.

(5.3) O&M Practice

It is considered advisable to plan O&M activities. Preventive maintenance is very important to reduce costs and improve reliability. Effective preventive maintenance requires scheduled inspection and record keeping. It is the objective of preventive maintenance programs to maximize “planned maintenance.” Need for emergency action is an indicator of failure to anticipate or properly monitor operations.

As opposed to project work, on which many engineers, particularly consultants, concentrate, O&M is process-oriented. Whereas engineers involved in project work generally distinguish between work by individual projects, engineers responsible for O&M usually organize records on the basis of time. Records are typically organized in five classifications:

- *Operation and performance records* - records of operations, production, and problems/repairs, usually in the form of a daily log or similar record prepared at specified time intervals.
- *Descriptive and inventory records* - records of machinery/infrastructure for which the O&M engineer and his/her organization are responsible, including date of acquisition, source of acquisition, key features, location, and function.
- *Maintenance records* - records of scheduled and unscheduled maintenance, including problems addressed; actions taken, including time and monetary costs; and current status.

- Financial or cost records - accounts documenting cost of equipment and parts acquisition, and operations (e.g., fuel and operating personnel), and maintenance actions.
- Personnel records - records of staff employed in the O&M organization, including position, job description, compensation, and evaluations of performance.

Each record type must be diligently maintained. For most complex machinery a daily log is maintained. This is normally supplemented by reports prepared at less frequent intervals such as monthly or quarterly. These records are intended to record performance and, particularly the nature and frequency of problems. In a program of preventive maintenance, problems are identified early and resolved before they evolve into major concerns.

This requires rigorous documentation. Maintenance requirements whether routine, identified as a result of inspection, or arising from component failure specified in a work order. Work orders should describe the work required and its priority. O&M staff assigned to the task should record the status of their work at specified times to its ultimate completion. On completion, performance should be documented through scheduled inspection and subsequent maintenance. Collected work orders, therefore, provide a historical database on the performance, repair, and status of all components.

The extent of a preventive maintenance program will depend on its costs in relation to the potential losses resulting from equipment breakdowns. The cost and characteristics of some machinery components, for example, may be such that it is more cost-effective to wait for them to fail than to monitor their day-to-day condition (e.g., light bulbs). Effective O&M procedure requires, of course, stocking appropriate parts and training staff in their efficient replacement.

An effective O&M program will, in any case, monitor the occurrence of failures to improve processes. If particular components fail regularly, the engineer should strive to find better components and/or more effective approaches. Recording and investigating problems will not only identify unreliable components, it will allow maintenance staff to isolate causes. This provides the soundest basis for devising improvements that will increase reliability.

The five component records listed above provide the management of an O&M organization with the necessary information to track the O&M process. They should be integrated to the greatest degree possible. Work orders provide the most frequently used common source of data input for most categories of maintenance records. Code numbers for specific machines and their components can also tie together inventory and maintenance records.

The attributes of good record keeping are the same for manual and computerized record systems. Records should be kept rigorously up to date and thoroughly cross-referenced. Computers do however allow greater flexibility in presenting data. Properly normalized databases (i.e., systems with common data entry and updating) will allow data to be shared and updated in all five categories. For example, inventory information on machinery characteristics can be presented with historical maintenance records compiled from work orders and daily log entries. This type of record integration allows managers to monitor the performance of both machinery/infrastructure and staff, including measures of their cost-effectiveness.

(5.4) Ethical Considerations

The O&M engineer must, of course, be mindful of his or her ethical responsibilities in their daily practice. Like all engineers, the paramount responsibility of O&M engineers under the Code of

Ethics is for the welfare of society. Society in this sense includes workers who operate or maintain facilities and machinery, and may also include members of the public who use facilities and infrastructure. Poorly maintained or operated machinery may injure workers. Similarly, improper maintenance of public buildings or infrastructure may have the same consequences for citizen users. In the extreme, improper management of key infrastructure components such as dams or specialized plants handling hazardous materials can cause damage, injury, or death to members of the public who are neither employees nor users. The consequences in these cases, of course, can be vast.

From this perspective, the responsibilities of the O&M engineer are imposing. The engineer and his/her employer may be legally responsible for any harm to persons or property from negligent O&M practice. Liability in tort Law can lie with the employer with respect to employees, with the employee with respect to his or her employer, and with the full range of potentially affected parties whether or not a contractual arrangement has been struck. In short, the engineer and any organization for which the engineer may work may be liable for damages suffered by any individual affected by negligent practice.

Negligence is defined in law, as a failure to meet a “reasonable standard of care.” In everyday situations this means a person must take actions that correspond to normal prudent practice. For engineers and other professionals, the standard is more stringent, as professionals must satisfy the standards of their profession. The actions of engineers must conform to normal prudent practice of engineers in their speciality. In this context, it must also conform to the standards established by the Code of Ethics.

An engineer must ensure that their actions are consistent with both the Code of Ethics and the typical practice of other engineers engaged in similar roles. The penalties for negligence proven in court can be substantial. Financial compensation is normally required. In severe cases, the courts may impose fines and/or imprisonment.

The responsibility for reasonable care and prudence is immediate and ongoing for the O&M engineer. Orderly inspection and recording procedures are not only vital to effective maintenance; they are the best defence against claims of negligence. It is also important for the O&M engineer to ensure his or her familiarity with common practice in his or her area of practice. In addition to having the appropriate educational foundation -- particularly the appropriate engineering specialty -- O&M engineers should be familiar with all manuals relating to machinery and infrastructure for which they are responsible, including updates. They should also consult with manufacturers, suppliers, and other professionals in their field, and attend seminars and training programs as necessary. These initiatives ensure that the engineer’s knowledge and practice is in keeping with the best current approaches in their field.

As noted, O&M engineers often advise or supervise non-engineers. In this role the engineer should be aware of both the limitations and experience of staff who are not trained engineers. They should be particularly mindful of Canon 16, which states that a Professional Engineer:

“ shall not expect or direct an employee or subordinate to act in a manner that he or the employee or subordinate considers to be unprofessional or contrary to the public good.”

Two considerations follow from this Canon. First, the engineer should not assign responsibilities beyond the capabilities of staff. Second, he or she should respect the knowledge that many staff may have from firsthand experience dealing with machinery and infrastructure.

Substantive disagreements should be discussed and, when feasible and necessary, taken to a third party. Preferably, the third party will be a Professional Engineer with similar or superior knowledge and experience. A consensus agreeable to all parties should then be sought. Under all circumstances, such considerations should be recorded but particularly when disagreement persists and one course of action must be chosen. If the selected approach is not that considered best by the O&M engineer, Canon 14 instructs that he or she must “present clearly to his clients or employers the consequences to be expected if his professional judgement is overruled.”

In the extreme, an O&M engineer may find him or herself pressured to relax maintenance programs or overlook shortcomings by a client or employer. This may result from budget, personnel, or time constraints; economic motives; or other factors. If the engineer finds him or herself forced to do so, he or she should recall Canon 15 stating that a Professional Engineer:

“ shall refrain from unprofessional conduct or from actions which he considers to be contrary to the public good, even if expected or directed by his employer or client, to act in such a manner.”

An engineer should not depart from a maintenance schedule or prescribed operations procedures, under any circumstance, unless such modification is clearly justified and documented.

(6) EDUCATION

(6.1) Introduction

Whereas most active engineers carry out the daily practice of the engineering, engineering educators practice their profession by continuing and improving the profession itself. This section is a guide for Professional Engineers teaching engineering subjects to current and future engineers. It is equally applicable to tenured professors and occasional continuing education instructors.

The section focuses on the professional and ethical considerations of engineering educators rather than trends in education theory, although it briefly addresses good teaching techniques and practices. Engineering research is also discussed, particularly as it relates to the learning environment for students. Educators working in a university setting are the most obvious target audience but other teachers of technical subjects may benefit from these guidelines as well.

Engineering educators can influence thousands of other engineers in a lifetime of teaching, and thereby affect all of their works as well. More than most of their peers, engineering educators can leave their mark on the profession, and on society as a whole. With this influence, however, comes the responsibility to teach well, to engender enthusiasm and respect for the calling of engineering, and to develop a sense of professionalism in students at all levels.

(6.2) Typical Education Settings

(6.2.1) Undergraduate

Nova Scotia has one institution that grants engineering degrees, Dalhousie University. It was known until recently as the Technical University of Nova Scotia and, before that, as the Nova Scotia Technical College. Dalhousie normally confers Bachelor of Engineering degrees in co-

operation with several associated universities. Currently, associated universities are Acadia University, University College of Cape Breton, Nova Scotia Agricultural College, St. Francis Xavier University, Saint Mary's University, and the University of Prince Edward Island (PEI). Students attending one of these schools typically take the first two years of their engineering education at one of these schools before proceeding to Dalhousie to complete their degrees.

Dalhousie offers programs in Civil, Electrical (including Computer Engineering), Mechanical, Mining, Chemical, Metallurgical, Industrial, and Agricultural Engineering (including Environmental Engineering). All programs have a co-operative education format supported by related work periods recognized as part of the degree.

(6.2.2) Graduate

Dalhousie grants several graduate-level degrees. The Master of Engineering (M.Eng.) degree requires a minimum one year of study and is not research based, although candidates must complete a project report. The Master of Applied Science (M.A.Sc.) and Master of Science (M.Sc.) degrees both typically require two years of study and a thesis. The Doctor of Philosophy (Ph.D.) degree normally requires a preparation period of three years and includes a thesis component.

(6.2.3) Research

Research is a vital component of the professional lives of engineering educators in a university setting. Engineering research advances the state of engineering practice, provides valuable learning and experience to graduate students, and generates needed revenue for teaching institutions. Besides the traditional government-supported research foundations and councils, the recent trend toward partnerships with industry and government has provided additional sources of research funding.

(6.3) Considerations of Engineering Educators

(6.3.1) Qualifications

Educators should examine their motives for following the vocation of teaching, and consciously commit to serve the needs of the students as well as their own career objectives. To provide a quality engineering education to students, educators should possess an appropriate balance between technical proficiency and teaching effectiveness. Most professors have earned the academic credentials required to cover the subject matter competently. Practical technical experience in non-academic settings is also a valuable asset for potential educators. Market forces and the needs of the teaching institutions often drive current educational and experiential requirements for professorship. These guidelines, therefore, do not cover such requirements.

Effective communication, however, is a critical qualification for successful teaching. Educators should ensure they are comfortable presenting before groups. To this end, they may wish to upgrade linguistic or communication skills. Under all circumstances, they should organize their lectures around definite objectives clearly stated for students. Career professors should also consider membership in the American Society for Engineering Education. Engineering educators should devote time and study to education theory besides improving their technical knowledge, and take courses and other measures to improve their teaching skills continuously. They should also consider spending at least some sabbatical time gaining current, practical experience in private consulting, industry, or other frontline engineering setting. An alternative

method of gaining practical non-academic experience is to maintain a part-time connection with other groups or companies outside the university environment.

(6.3.2) Student-Centred Teaching

Educators can measure the success of their approach to engineering education by ensuring that graduates have:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyse and interpret data
- an ability to design a system, component, or process to meet desired needs
- an ability to function on multi-disciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global and societal context
- a recognition of the need for, and an ability to engage in, life-long learning
- a knowledge of contemporary issues, and
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Several schools of thought exist about the most effective approach to teaching technical subject matter. These approaches may be broadly classified as content-centred, teacher-centred, or student-centred. Although the first two have merit in many circumstances, experts generally acknowledge that student-centred teaching suits the widest range of situations. It is not only effective in transferring engineering knowledge, but also in engendering enthusiasm for engineering practice, instilling professionalism, and establishing a pattern of subsequent lifelong learning.

Educators who employ student-centred teaching may create both an intellectual engagement and establish an interpersonal rapport with their students. Building this rapport can be as simple as allowing ready accessibility; being and appearing prepared for class; frequently soliciting and acting on feedback; arriving early and staying after classes to talk to students; and showing respect for and empathy toward students. Effective professors show not only intellect but also dedication and enthusiasm for their field. By moving beyond the mere presentation of scientific and technical material, they encourage their students not only to learn the course material but also to think independently as engineers. This approach need not preclude the educator from maintaining firm control over the classroom. It does, however, establish a learning environment where the student is an interactive participant in the process.

Barriers to the student-centred approach do exist. Large class sizes leave less time for individual contact with students. Some professors are not comfortable dealing directly with students. Greater demands are being placed on educators from all sides, particularly with respect to research. Typically teaching effectiveness is not as well rewarded or acknowledged as research success. However, the criteria for the Engineers Canada Medal, which “recognizes an exemplary contribution to teaching and learning of the engineering profession in Canadian universities,” illustrate the merit of the student-centred approach for Distinction in Engineering Education. The criteria for the award include “personal teaching effectiveness, contributions to the learning environment, leadership beyond one’s own courses, and continuing education

activity directed to the improvement of engineering education.” Though Engineers Canada offers this award to only one recipient per year, the criteria may help to set a personal standard that any educator should attempt to achieve.

(6.3.3) Professionalism

A key role of Engineers Nova Scotia is to maintain the highest standards for the admission of practising engineers. Engineering educators are largely responsible for ensuring that graduates can meet these high standards. As stated in the academic calendars, “Engineering is one of the most important of professions. Virtually all aspects of modern life are involved with the subject. The education of an engineer is demanding, but it provides great rewards for the future. In particular, there is the personal satisfaction in following a career where one’s personal expertise can benefit society and contribute to a better world.”

Under the *Engineering Profession Act*, teaching engineering is considered a form of professional practice. Any professor who has the qualification to be designated a P.Eng. and is teaching in Nova Scotia must register with Engineers Nova Scotia. Experienced professors should also take it upon themselves to mentor not only their students but also new faculty members.

Educators must guide students into becoming professionals not simply by educating competently. They must also explain and demonstrate to students, particularly at the undergraduate level, that engineers must be professional in every sense of the word. Engineering professors should be active in, or at least knowledgeable about, the affairs of their professional association. They should be role models in this respect. Professors should serve on committees, attend annual meetings and other events, read professional publications, and contribute to the debate on issues of the day. Though the nature and intensity of this involvement will naturally vary over time, engineering educators should always maintain a vital and visible connection to their professional association.

(6.3.4) Ethical Behaviour

Engineering educators should realize, as with all Professional Engineers, their primary duty is to assure and promote the welfare of the public. An intimate familiarity with the Code of Ethics can help educators to maintain the highest ethical standard and allow them to act as role models for students. As important, integration of the Code of Ethics into course work, where appropriate, will help inculcate ethical thinking in students.

Engineers’ Code of Ethics states that a Professional Engineer shall “keep themselves informed in order to maintain their competence, strive to advance the body of knowledge within which they practise and provide opportunities for the professional development of their subordinates.” This not only obligates the Professional Engineer to participate broadly in other aspects of his/her profession, it suggests that lay professionals should also participate in engineering education. Engineering educators should actively solicit the assistance of their peers in the non-academic community to contribute to their students’ learning environment, perhaps by arranging field trips, tours, work terms, guest lectures, career days, or other types of involvement

A Professional Engineer shall co-operate in extending the effectiveness of the engineering profession by interchanging information and experience with other engineers and students and by contributing to the work of engineering societies, schools and the scientific engineering press. This not only obligates the Professional Engineer to participate broadly in other aspects

of his/her profession, it suggests that lay professionals should also participate in engineering education. Engineering educators should actively solicit the assistance of their peers in the non-academic community to contribute to their students' learning environment, perhaps by arranging field trips, tours, work terms, guest lectures, career days, or other types of involvement.

(6.3.5) The Role of Education Managers

Department heads, division leaders, deans, and other academic managers can and should create and foster a positive environment for learning and practice. These managers develop plans, set policies, hire and organize staff, direct resources, and control the direction of the department or faculty. In fact, in the Canadian accreditation system, these managers must be registered with the P.Eng. designation. They must also balance academic freedoms, protect the pursuit of less popular research, make recommendations concerning promotions and tenure, fairly distribute workloads and rewards, evaluate teaching ability, and maintain harmony among staff, usually in an era of diminishing resources and increased demands. Administrators often do all these activities as well as teaching and/or research duties. Clearly these roles are challenging, but they are also crucial to the success of the faculty and the teaching facility. Perhaps key is the ability to recruit talented and enthusiastic faculty members, and to create a setting where both faculty and students can fully develop. Further, these managers have a duty to learn and apply proven management techniques to perform their role properly.

(6.3.6) Outside Consulting

Engineering professors who maintain external business interests may have unique access to a university's physical, intellectual, and personnel. The use of laboratory facilities, supplies, computer support, graduate students, researchers, and other university assets is unfair competition with private consulting firms and laboratories and must not be practiced. A Professional Engineer shall "act as faithful agents of their clients or employers, maintain confidentiality and avoid conflicts of interest. Consulting professors must exercise care and good judgement in their dealings with their employers, clients and other consultants to avoid this potential conflict.

(6.4) Research

Research activity is generally considered science and not engineering and, therefore, exempt from the *Engineering Profession Act*. The Code of Ethics does still apply to the engineer engaged in research however. High standards of research conduct are necessary to guarantee equitable treatment of educators, students, and the institution. The responsibility for educating and training future professionals, and using grants/contracts to work towards finding better solutions carries with it the duty to adhere to the highest standards and principles. Research in this context is all creative or academic work "claimed to be of scholarly significance." In particular, persons in authority such as deans, department heads, and principal investigators have a special duty to foster an environment that permits only ethical research. Formal complaint and investigation procedures generally exist for suspected breaches of research conduct and generally may be initiated in confidence.

Breaches in appropriate research conduct can include such concerns as:

- academic dishonesty
- falsification of data and documents
- plagiarism

- theft of intellectual property
- mistreatment of students assistants
- breach of confidentiality, and
- misdirection of research funding.

Engineering faculty mentoring graduate students should always be aware that, for the graduate student, research should present a positive learning experience, with a clearly understood period of service. The needs of the student should rank as highly as the other requirements of the research being undertaken. Research professors must draft agreements respecting commercial property rights and other obligations of graduate students fairly and explain the implications before signing.

(7) REGULATORY FUNCTIONS

(7.1) Introduction

Regulators enforce legislation created by governments for the public good. Engineers working as regulators and permittees, therefore, should find a clear parallel to the Code of Ethics that regulate and guide their practice. This section assists Professional Engineers who work for government regulatory bodies in various roles. It applies equally to all levels of government. The focus of this section is on the professional and ethical considerations of engineer regulators, not on the day-to-day job functions or technical knowledge they require. The discussion emphasizes engineer regulators who review and approve the works of other engineers.

(7.2) Typical Regulatory Settings

Engineers work as regulators in all three levels of government. They may also take on regulatory functions for private organizations, particularly utility companies. Engineers employed in these capacities may have authority to issue permits or approvals of various types, with a level of scrutiny that will vary from cursory to extensive. Examples range from a permit to modify a dwelling, to evaluation of a controversial environmental impact study. Common regulatory roles are listed below by the three government levels and the private sector.

Municipal

Typical municipally regulated areas include:

- building permits
- community planning and development
- construction services
- fire codes
- septic fields
- residential and commercial development
- water and sewer services, and
- zoning.

Provincial

Typical provincially regulated areas include:

- agriculture
- boiler and pressure vessels
- construction health and safety
- environment
- servicing including water, sewer, treatment and septic systems
- fisheries
- highways
- industrial health and safety
- labour
- mines and energy
- natural resources
- offshore energy, and
- utilities.

Federal

Typical federally regulated areas include:

- agriculture
- environment
- fisheries and oceans
- mining
- natural resources, including forestry and mining
- public works
- transportation of dangerous goods, and
- vessels.

Private

Typical areas in which private companies and crown corporations become involved in regulation include:

- electricity,
- natural gas pipelines,
- CCTV,
- internet and,
- telephone and telecommunications.

The regulatory environment is complex. Regulation frequently involves two or more levels of government and/or the private sector. A good example is the municipal subdivision approval process. Although the municipality is responsible for managing the process and granting approval, input may be required from provincial, federal, and private agencies. Besides review by its own professionals in engineering, planning, recreation, fire, police, and water services, the municipality will usually need input from agencies in all three of the other sectors.

For example, if the developer intends to provide services on-site, the Nova Scotia Department of Health is responsible for conducting percolation tests. The municipality may also require opinion from the Nova Scotia Environment concerning environmental impacts and the Province could require an environmental assessment, if the project qualifies as a Class I or Class II

undertaking pursuant to Schedule “A” of the Environmental Assessment Regulations, which follow from the Environment Act (e.g., if the subdivision affects 2 hectares or more of a wetland). The municipality may also request the opinion of the Nova Scotia Department of Transportation and Infrastructure Renewal if traffic from the subdivision is likely to affect a provincial roadway (i.e., an arterial highway). They could require input from the Department of Fisheries and Oceans, if a navigable waterway is likely to be altered, and they would certainly need the advice of Canada Post to locate community mailboxes. Finally, they would consult local utility companies concerning installation of communications and power services, and any possible impacts on services already existing in the area (e.g., a transmission line easement passing through the proposed subdivision). In some regions of Nova Scotia it is necessary to consult a natural gas company to avoid interference with gas line easements and /or to provide for natural gas hook-ups.

There is a trend to privatize aspects of public service provision. The private sector role seems especially likely to expand in the provision of water and sewer systems, and roads. With this evolution, the input of private stakeholders to the regulatory process will probably expand. The involvement of some government agencies may also increase as they alter their service delivery.

(7.3) General Practice Considerations

Consistent with their roles as public servants, engineers serving as regulators must put the public welfare before all other considerations. This interest includes protection of health, safety, the environment, wildlife, the economy, and society as a whole. Where these priorities appear to compete, the larger perspective of service for the public good may be instructive. For example, regulators whose primary duty is protecting the environment may view their responsibility as being in the public interest for future generations in addition to present considerations.

To aid in decisions related to ethical aspects of their work, engineer regulators should be very conversant with the Code of Ethics. One concern regulators must guard against is the existence or appearance of a conflict of interest, or the accusation of corruption. The autonomy to grant approvals and permits, carry out inspections, or assess fines requires extra vigilance to protect against charges of unethical behaviour by parties affected by regulatory decisions.

All participants in the regulatory process should contribute in identifying required changes to those regulations. Examples of needed changes could include gaps, overlapping or confusing legislation, outdated tests or standards, dangerous oversights, unreasonable impediments to development, insufficient protection, or cumbersome or unenforceable regulations. Engineers should report such observations to the appropriate level of the regulatory agency, which has a responsibility to provide all due consideration and act on valid suggestions.

Because regulators most often function in a governmental system, they must avoid influencing or being influenced by political considerations. They should not permit political interference to interrupt, accelerate, or deny the proper application of the regulations. On the other hand, some regulatory decisions ultimately lie with elected representatives, notably at the municipal level. Under such circumstances, engineers must continue to apply their professional judgement but must recognize their role as advisors as opposed to decision-makers.

Even in these circumstances, however, the engineer must continue to place greatest emphasis on the public welfare. If, for example, an engineer’s political masters are inclined to a decision that may jeopardize public safety or have even a lesser impact on the collective welfare, the engineer is obliged to point out these concerns. If the consequences of such a decision are

sufficiently severe, the engineer must in good conscience inform Engineers Nova Scotia. If this action has professional repercussions, the engineer may take consolation in avoiding legal liability and upholding the ethical standards of his/her profession. A Professional Engineer shall hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace.

All engineers working, as regulators, at whatever level, should exercise professional judgement within the bounds permitted by the regulations. Not only should this judgement be founded on sufficient knowledge, but also it should be consistently and equitably applied. A Professional Engineer shall offer services, advise on or undertake engineering assignments only in areas of their competence and practise in a careful and diligent manner.

This is not only important for ethical reasons. Regulatory decisions generally must be supported by documentation. At the municipal level many larger regulatory decisions require a report to Council. Such reports must provide a coherent rationale for the action recommend by staff.

Many regulatory decisions are also subject to appeal. Sometimes appeal is to government representatives (e.g., to Municipal Council or the responsible Provincial Minister) and sometimes to a tribunal such as the Nova Scotia Utilities and Review Board. The actions of regulators and their decisions may also be appealed to the courts. Indeed, appeals from the decision of the Utilities and Review Board and of Provincial Ministers are made to the Supreme Court of Nova Scotia. Regulators can expect to be called before these bodies to explain and justify their decisions. Professional Engineers working in these capacities should therefore be prepared to defend their recommendations in both informal and formal appeal situations.

(7.4) Regulatory Roles and Guidelines

(7.4.1) Policy

Engineers may be involved in setting policy and developing related regulations. These regulations should be reasonable, necessary, sufficient, and enforceable. Where possible, existing regulations should be streamlined and logically grouped to communicate their intent more clearly. Policy-makers should talk with inspectors and other front-line employees about changes. Where possible they should seek opinion from the public when developing new policies. Relevant legislation often requires public meetings or hearings, or other procedures for this purpose. Engineers should ensure that they are familiar with legislation and guidelines for policy-making and approval that apply to their areas of responsibility.

(7.4.2) Management

Engineering management is responsible for allocating resources efficiently for inspection and approval of projects falling under their jurisdiction. Once policy makers set regulations, the responsible authorities should clearly identify them and make their text readily available to the public. They should clearly delineate the regulations and support them with explanatory documentation as necessary.

Given the multi-disciplinary nature of many regulatory processes, engineers should recognize their role as team players. At times, an engineer may be responsible for the ultimate approval of an application. At other times, the engineer will be one of many players providing input to the review of an application. In either case, the engineer must recognize his/her role and participate as a co-operative team member. They should deal with the application thoroughly and promptly

in the best interest of the public. This means communicating clearly to others on the team and respecting the contributions of engineers and non-engineers alike.

(7.4.3) Approvals

Engineers who review submissions and issue approvals should ensure they are competent to perform these roles. Non-engineers and persons of limited technical experience or other qualifications should not review engineering drawings and specifications except to detect obvious deficiencies. As noted, however, the regulatory process is often complex and involves many actors. Engineers should recognize that they may provide their input, at times, to other professionals who do not understand particular issues to the same depth. They should be prepared to express their opinions in sufficiently simple terms to allow full comprehension by other regulators. On the other hand, when the engineer acts as the integrator of input from other experts, he/she should try to understand the priorities these individuals express and give them proper weight in the approval process. If there is any danger of misunderstanding, it is advisable to consult directly with other regulators through meetings, by telephone contact, or in writing.

Approvals are often time sensitive. Often, the cost to applicants is significantly affected by the time taken to obtain approval. Time frames established for review and approval should be reasonable and met within legislated periods without compromising the thoroughness of the review process. The regulator should understand that his/her role is not that of a technical checker or design critic, especially of details outside the regulatory scope. However, if the regulator notes potentially dangerous or destructive design feature that is outside regulations, they should relay this information to the designer.

When the regulating body refuses or withholds approval, regulators should give the proponent reasons for the denial with sufficient detail to guide revision. This will permit the proponent to carry out the required modifications efficiently and expedite the subsequent review. It will also curtail appeals and will protect the regulator in the event appeal is unavoidable. If the engineer regulator detects a pattern of routinely under-designed works, however, he/she should inform the designer of this trend and not be drawn into doing actual design. It may, in fact, be appropriate to report under-designed works to Engineers Nova Scotia, especially if they reflect a pattern on the part of the particular engineer.

The engineer recommending approvals to proceed with engineering works should consider himself/herself part of the project team. For projects carried out in the public interest, they may do so by encouraging communication with the other parties, being available for meetings during the design phase, and expediting the review process. When working with other regulators this means encouraging open communication and responding promptly to inquiries from others.

The regulator should be aware of the reputation and history of the proponent to evaluate better the accuracy of the information presented, and to assess the effort required to complete the review. Conversely, the regulator also has a duty to protect the reputations and trade secrets of all proponents. Finally, predictability and consistency in the application of the regulations are critical in establishing credibility with proponents and the public.

(7.4.4) Inspection

For engineers working as inspectors or directing inspectors for regulatory agencies, several key practice issues should be considered. Foremost is fair and uniform application of the rules and requirements of the permit. The inspector must ensure that the proponent, contractor, or owner

addresses concerns identified under the permit with due diligence. The inspector should also ensure that, where possible, the spirit of the regulation is enforced, in cases where the minimum standards required under the regulations may be inadequate for a particular situation.

Site visits should be random and unannounced to ensure representative site conditions within the standards set by legislation. Inspections should be as thorough as necessary to determine compliance. If inspectors note deficiencies, they should allocate reasonable time for redress. If they observe dangerous conditions outside their mandate, inspectors should immediately report these circumstances to the site supervisor or responsible authority.

Departments should apply policies consistently in cases of non-compliance. Responses should proceed as required from verbal to written warnings, and to enforcement proceedings if necessary. They should apply these policies equally from case to case and from inspector to inspector. Finally, where resources are limited, or inspectors have identified patterns of non-compliance, the inspector should focus on the most consistent offenders.

(7.4.5) Enforcement

Engineers charged to enforce regulations should do so judiciously, uniformly, and dispassionately. They should closely follow guidelines, where they exist, to eliminate bias. Defensible professional judgement is however always appropriate. The engineer should not enforce dangerous, outdated, or irrelevant regulations, and should be flexible where the regulations are clearly not meant to apply. They should carefully exercise the ability to issue summary offences; however, there should be no hesitation where the offence obviously requires such action.

The enforcing engineer should treat all parties equitably to avoid and speedily resolve conflict without recourse to official channels, if possible. They should treat the proponent, contractor, and the public fairly and equally. If after reasonable warnings, the offender is still out of compliance, the regulator may have to consider more drastic action. Legal advice should be sought before proceeding with such a course of action, if it is not routine.

Although not generally specified in the regulations or bylaws that engineers may be charged to enforce, all engineers in this role should beware of engineering work that has not been executed by a qualified Professional Engineer. If an application is received in which it appears that engineering work has not been carried out by a P.Eng., the regulating engineer has not been involved and corrective action is not undertaken, the regulating engineer should notify Engineers Nova Scotia at the earliest opportunity.

(8) EXPERT TESTIMONY

(8.1) Introduction

During their careers, many Professional Engineers will be called to give expert testimony in a legal context. This overview is a guide to engineers considering acting as expert witnesses and a reference for those professionals already practising in this area. It will help not only engineers who provide expert testimony in support of others, but also engineers who may be required to give testimony relating to their own works.

The expert witness serves an important role in the justice system by clearly explaining complex technical matters, and providing reasoned, defensible opinions and conclusions. Ultimately, the

decision to offer service as an expert is solely that of the individual engineer based on his/her education, experience, competence, reputation, and confidence. Given the increasing specialization in many areas of practice, it is likely that many more engineers could and will provide expert testimony than currently do. Highly qualified engineers may avoid the work because of the adversarial context and perceived pressure to advocate for the client no matter the conclusions reached by the engineer. Presenting an appropriate delivery without affecting the accuracy or completeness of the findings is, however, possible. In fact, it is in the interest of the profession that more Professional Engineers serve as experts. By doing so they increase the availability of informed opinion and reduce the risk of too few serving, or too many who may be of lesser competence.

Finally, the scope of this section is solely on the engineer as expert witness, not the broader but related field of forensic engineering.

(8.2) Typical Dispute Resolution Settings

A Professional Engineer may be asked to serve as an expert witness in several settings. This section describes the more common circumstances.

(8.2.1) Civil Litigation

Civil litigation is the most commonly known form of dispute resolution taking place in the public law court system. It is also often the most complex, and time-consuming and is commonly the least predictable as well, especially where juries of lay people are involved. A description of the civil litigation process could warrant its own text books, and in fact has. The client's legal representative, who generally contracts the services of the expert witness, is the best source for obtaining current additional information on the civil litigation process.

One important and common process of civil litigation is examination for discovery, during which the opposing counsel questions the witness to learn his/her perception of the facts. The opposing counsel will record expert statements. They will usually refer to these statements during the trial, often as part of an attempt to impeach the credibility of the witness. If the parties are unable to settle, as often happens, the case will go to trial. The difficulties and delays inherent in the current legal system have led to several Alternative Dispute Resolution (ADR) procedures, which are also described here.

(8.2.2.) Arbitration

Arbitration is, perhaps, the most common current alternative to the legal system. It relies on an arbitrator or panel of arbitrators, chosen by both sides and knowledgeable in the area under dispute, to render a fair and timely decision. Arbitration may be binding or non-binding, depending on the agreement signed by both parties. In the interest of expediency, the arbitration may limit or eliminate discovery and examination of documents, which consume most of the resources required for civil litigation. Some insurers, however, oppose the process precisely because of the limited access to the documents held by the opposition. Otherwise, the process is similar to a trial, inasmuch as both sides present evidence and arguments for decision. The expert witness generally needs to spend less time educating the parties and may focus on presenting and defending the conclusions reached.

(8.2.3) Mediation

Mediation is a non-binding technique requiring a knowledgeable and trusted mediator agreed upon by both parties to resolve the dispute. However, the focus is more on negotiation and compromise to arrive at a settlement agreeable to both parties, rather than a winner-take-all decision. The mediator accomplishes this by facilitating discussion and compromise. Each side meets privately with the mediator to explore potential outcomes of the dispute. The mediator points out the strengths and weaknesses in each party's case and provides an educated, independent perspective. They deliberately shorten the time frame for discussion. An expert witness who acts as an advocate in this setting may force his client into an entrenched position, practically guaranteeing the failure of the process.

(8.2.4) Binding Arbitration

This technique, also known as mediation/arbitration, is more commonly encountered in labour disputes, but has recently found favour in resolving certain construction disputes. Again, a mediator familiar with the issues and the arbitration process works swiftly to discover the facts of the situation, and then facilitate a negotiated settlement. If the negotiation should fail, the arbitrator can impose a solution, which is itself a powerful incentive to compromise. In this situation, the arbitrator may, in fact, employ a Professional Engineer to conduct an independent analysis. Alternatively, the arbitrator may direct the experts from both sides to submit a joint report and recommendation, perhaps under the direction of the arbitrator's expert.

(8.2.5) Private Litigation

Private litigation is a recent development in other jurisdictions rarely employed in Nova Scotia, although this may change. The process is very similar to civil litigation, but conducted by private parties, often before retired judges. The swiftness of the decision can yield significant savings on larger cases.

(8.2.6) Neutral Fact-Finding

Another trend in ADR becoming common in Nova Scotia is neutral fact-finding. Neutral fact-finding is an informal process in which the disputing parties ask a neutral third party to investigate a dispute, usually one involving complex or technical issues. This neutral party may in fact be the expert. The third party analyses the facts in the dispute and issues his or her findings in a non-binding report or recommendation. A variation of neutral fact-finding is early neutral evaluation, where the parties to a civil case have their attorneys present the core of the dispute to a neutral evaluator. This occurs after the case is filed in court but before discovery of facts. The neutral evaluator then gives a candid assessment of the strengths and weaknesses of the case. If the parties cannot settle, the neutral evaluator helps narrow the dispute and suggests guidelines for managing discovery. In both situations, the expert in essence becomes the judge, rendering an informed and impartial opinion on the facts presented.

(8.2.7) Hearings, Tribunals, Enquiries, Boards, and Royal Commissions

Public hearings, tribunals, enquiries, boards, and royal commissions are conducted under the laws and statutes, and at the direction, of municipalities, provinces and the federal government. Some have the power to compel testimony; some accept formal statements instead of testimony. The format permitted for presentation is typically more open than for legal

proceedings but must be used cautiously. The political and often highly visible nature of some of these proceedings points to extra caution for the expert witness.

(8.2.8) Other Appearances as an Expert

Engineers may also be called on to appear for expert testimony at professional disciplinary hearings, at appeal hearings, at coroners' inquests, or, rarely, as an *amicus curiae* (literally "friend of the court") to help a judge understand technical evidence.

(8.3) Considerations for Accepting Assignments

(8.3.1) Ethical

The individual engineer is the only person who can determine if serving as an expert in any given situation is appropriate. A careful review of the Engineers Nova Scotia Code of Ethics should provide guidance where doubt may exist. In general, though, the engineer should possess "current experience and ongoing knowledge" in the area in question. He/she should be willing to submit the transcripts of depositions and testimony to peer review.

The Professional Engineer should present the same conclusions, independent of who has employed his/her services, and avoid becoming an advocate of the client's position. While this may appear difficult, given the pressures of a legal or quasi-legal setting, a fair and unbiased evaluation of the facts will best serve the client. The witness should, of course, present reasonable and defensible conclusions with conviction and authority based on such evaluation. Assurance of the autonomy to arrive at whatever conclusion the evidence shows should be an important factor in the decision to accept any assignment. It is critical that the engineer fully understand the requirements of the assignment and the time frames involved, before agreeing to undertake the work.

A Professional Engineer serving as an expert witness should not provide expert testimony that is false, obviously questionable, unsubstantiated, or without scientific foundation. The key to this process is a thorough review of all available and appropriate facts concerning the case under examination. The expert's opinion after this process is completed should reflect the state of engineering knowledge at the time of the incident. The engineer should review the available facts thoroughly, fairly, and impartially. He/she should not exclude any relevant information to create a view favouring either party to the dispute.

Finally, the engineer should gauge the good faith of the parties involved. He/she should decide if the prospective client is seeking a real solution to a problem or if the purpose of the engineer's assistance may be other than described. Assignments that place the engineer between two hostile and manoeuvring parties may do more damage to the professional reputation of the witness than may be worthwhile.

(8.3.2) Competence

Distinguishing between an engineer's qualifications and his/her current competence is important. Qualifications, such as an advanced degree for example, or past service in a prominent position do not necessarily guarantee an up-to-date familiarity with the state of practice in a given field. Likewise, a wealth of practical experience, on-the-job training, and ongoing, lifelong learning may permit an engineer with an entry-level degree to speak credibly on the most complex issues. Do not, however, overestimate or overstate your expertise. Again,

the decision to offer service is that of the individual, but he/she should not overlook the importance of competence over credentials.

(8.3.3) Conflict of Interest

Foremost when accepting any assignment is the existence of, or the appearance of, a conflict of interest. The engineer must ensure he/she is aware of all parties to the action and identify any conflict to the client, whether it is real, potential, or perceived. This examination should be done with the awareness that opposing counsel will likely exploit any opportunity to cast doubt on the motive of the expert, thereby attacking the credibility of the witness.

If the engineer gives notice of conflict to the client and client's counsel, who then continue to request the engineer's services, he/she should obtain a written acknowledgement of the conflict. The expert should consider informing the other parties involved, with the consent of the supporting counsel. Another possibility is a conflict of self-interest, where the engineer may be opposing a potential client in the future. The engineer should consider this possibility when offered an assignment.

(8.3.4) Conditions and Restrictions

The time required for trial may be prolonged and demanding. One condition of acceptance by the engineer should be agreement from the client to give sufficient notice of deadlines and proceedings to allow the engineer to complete other assignments and commitments. The engineer should also consider his/her ability to remain available to the client for the likely length of required service. The engineer should also inform the client if they may require additional, specialized input from other experts. They should agree which party will pay for such specialized services before contracting for the engineer's service.

When considering the assignment, access to sufficient resources to complete the investigation should be a key consideration. These resources include time, fees, access to supporting counsel, documents, evidence, and direction from the client.

One condition that the client may require is absolute confidentiality. Alternatively, opposing counsel may probe the confidentiality of an engineer's past relationship with another client. The expert witness must be aware that, in most cases, the court may not recognize the confidentiality normally afforded a client. The relationship between a Professional Engineer and his/her client is not considered "privileged" in the legal sense.

(8.3.5) Fees

Engineers Nova Scotia can provide general guidance to the member engineer with respect to forms of agreement, and standards of performance for expert testimony. A written agreement is advisable where possible. Lacking a written agreement, however, the engineer should send a thorough letter confirming the terms of the commission as understood by the engineer to the client as quickly as possible after acceptance of the assignment. This will allow the client to address misconceptions and can serve as a written record of duties and responsibilities.

The expert witness cannot testify on a contingency basis, where the fee depends on the amount of the award. This is a breach of an engineer's professional ethics.

The engineer should obtain the likely level of effort, including court time, from the client or client's counsel. A contract outlining form of payment and an agreed-upon and detailed schedule of fees should be prepared. The contracting parties should identify and note all changes to the agreement and fees and agree to them in writing.

(8.4) Aspects of Investigating, Analysing and Reporting

Once the engineer accepts an assignment, the work of conducting the investigation, gathering information, doing the analysis, documenting the procedures, and reporting the results may begin.

(8.4.1) Investigating

It is the responsibility of the engineer to allocate adequate time and effort to ensure that they can reach an informed conclusion based on full knowledge of the facts. They should share matters involving undisputed facts with other investigators early in the proceedings. This allows subsequent discussions to focus on the qualitative conclusions reached and not on the quantitative inputs.

A site visit may be required, along with a photographic and/or video record of the visit and site. Samples, dimensions, witness accounts, and detailed notes should be collected as needed. With samples, photographs and video, the courts often require that a chain of custody render such documentation admissible and defensible. Tests should be done by an accredited laboratory, with duplicates, replicates, field blanks, and second-laboratory testing used as appropriate.

The expert should carefully document the source, date, nature, and location of all data gathered. Where possible, the expert should gather the data. Alternatively, qualified support staff under the direct supervision of the expert should collect the data.

The engineer has a duty to do a literature search to review current regulations, legislation, standards, specifications, and other technical literature, to ensure familiarity with current practice. This will not only provide more current and defensible conclusions to the client but also bolster the engineer's credibility as a witness. An understanding of the relevant points of law around which the case is based will also help the engineer in developing an appropriate report to strengthen the client's argument.

(8.4.2) Analysing

The engineer should do his/her own analyses of data and reach his/her own conclusions. One exception may be computer modelling, which more junior or specialized support staff often conducts. In this situation, the engineer should be thoroughly versed in the function, history, authorship, internal checking procedures, inputs, and outputs of the software. The engineer should also do an independent manual check where practical.

The engineer should try to obtain all required input for the analysis. They should carefully document any assumptions where made. He/she must not ignore or omit contradictory or unfavourable data from the analysis. Where relevant, they should address such data and its implications for their conclusions.

Broad disclaimers, though tempting, may reflect poorly on the knowledge of the expert. If the data do not support a firm conclusion, the reasons for this should be made clear, and the

relative degree of likelihood of various conclusions should be expressed. Where the expert reaches firm conclusions, they should follow a clear and logical progression of the analysis, with supporting evidence included and contrary data explained. Many experts concur that a conservative and defensible approach to the findings is the most successful in a court setting.

(8.4.3) Reporting

A written report is generally the most accepted means of presenting the conclusions of the investigation for legal purposes, rather than engineering drawings or a verbal presentation. Photographs, drawings, and graphs may support the report, but these should be simple, clear, and readily understandable to the lay person. The language and style of the report should also aim for the lay audience, and be concise and accurate. The report should build on and demonstrate a clear and direct relationship between the facts and the conclusions reached. A trusted second party should check the spelling, grammar, and layout of the report within the restrictions of confidentiality. At the very least, the engineer or his/her secretary should apply spelling and grammar-checking software to ensure a professional presentation.

A preliminary report of the evidence is often appropriate to inform the client of the data gathered to date. Conclusions are not generally presented at this stage. The final report follows, with the conclusions presented, references cited, and calculations shown. Counsel may require a draft of the final report to allow comment on the style, language, and presentation. Counsel will usually not comment on the procedures or conclusions given the status of the expert. The expert should destroy all draft copies, intermediate versions, and unsubstantiated conclusions or notes; otherwise, opposing counsel could subpoena or otherwise enter such records as evidence during trial. For a similar reason, the expert should report vulnerable points in the report or possible avenues of attack by the opposition verbally or separately, and not include them in the report itself.

Timeliness is also an important concern. The report should be prepared according to the contractual agreement, and as required by the review board, tribunal, or other agency. The engineer must provide sufficient lead-time to the client and supporting counsel for review and study.

(8.5) Conduct While Presenting in a Legal Setting

Many guides are available dealing with appropriate conduct during presentation at discovery, depositions, and in court settings. Supporting counsel is the best source of such information. The best preparation is to know the technical subject matter and the material of the case thoroughly. Supporting counsel should also have a good understanding of the facts and opinions of the expert's work. The following checklist is a compilation of several suggestions for the witness during discovery and trial:

- know where and when to go for the discovery and the trial. Arrive early.
- during discovery, do not attempt to hold a conversation; be polite, avoid small talk, and wait for the question.
- you cannot win the case at discovery. Give as little away as possible while remaining truthful.
- do not disclose any information given to you by supporting counsel.
- when present in court but not on the stand, pay attention to the proceedings, avoid whispering to others, and remain in your place until court recesses.

- be prepared with appropriate visual aids.
- dress conservatively.
- be prepared to state your qualifications as an expert for the court.
- ask your supporting counsel where to sit before and after your testimony.
- take the time to think before you answer.
- keep the answers short and direct.
- do not be overly modest or boastful.
- be cautious about your tone, facial expressions, and body language in court.
- never guess. If you don't know, or don't understand, say so.
- do not volunteer information.
- show respect to the judge and opposing counsel.
- do not get angry, emotional, or attempt to be humorous.
- make eye contact, speak clearly, and remain calm and cordial.
- if your supporting counsel objects, stop talking immediately and await direction.

Remember throughout the proceeding that the supporting counsel is responsible for the presentation and success of the case. The responsibility of the expert is to present specialized information clearly and truthfully. If the analysis is based on sound methods and current practice, the work of the expert will be successful, independent of the outcome of the case.

(9) RESEARCH

(9.1) Introduction

Research is generally defined as systematic investigation to acquire knowledge. It is a characteristic of all educational processes and a practice of all professionals. In the book *Engineers and Their Profession* (4th edition, p. 23), John D. Kemper defines research as “the process of learning about nature and codifying this knowledge into useable theories.” He notes (p. 23) that, notwithstanding the broad application of research in daily and professional life, there is a tendency to view research as the purview of scientists.

Such a view is, however, narrow. The Organization for Economic Co-operation and Development (OECD) distinguishes between three categories of research with varying relationships to pure science. The most closely tied to the practice of science, is “basic research,” which the OECD defines as:

“ Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts without any particular application or use in view.”

This is distinguished from “applied research”:

“Original investigation undertaken in order to acquire new knowledge directed primarily towards a specific practical area or objective.”

The OECD also defines “experimental development” as follows:

“ Systematic work drawing on existing knowledge gained from research or practical experience directed towards producing new materials, products and devices, to

installing new processes, systems and services and towards substantially improving those already produced and installed. ”

The latter two classes of research bear the most relevance to engineering, although engineering clearly rests on the foundation of pure science. There is, however, considerable overlap among the three as discussed below. It is not unusual for discoveries in the course of applied research and experimental development either to contribute to the stock of pure scientific knowledge or to stimulate basic research. The basic scientific training of all engineers as well as the stimulus provided by involvement in applied research and experimentation may also stimulate interest in basic research.

(9.2) Engineering Research

The Code of Ethics commits engineers to improve the competence, and thus the dignity and prestige of [their] profession. This implies that engineers confronted with problems beyond the scope of existing knowledge will investigate the full range of solutions. There are many examples of this in common engineering practice. An extreme example might be the goal of putting a human being in space. To reach this objective, engineers no doubt worked closely with pure scientists in a wide range of investigations to solve the engineering problem of propelling a vehicle beyond our atmosphere and then returning it safely to earth. The same kind of relationship can also be part of devising means to reduce or treat pollutants, to build safe structures in changing environments, to generate energy from non-traditional sources, or many other engineering challenges.

The primary distinction between scientists and engineers is the objectives to which their research is applied. Engineering research is normally undertaken to solve practical problems. Although pure science has many practical applications, scientists are not usually as directly motivated by real world problems. For the pure scientist research is worthy if it has the potential to yield knowledge about our environment and the universe around us. As the OECD states above, there need not be “any particular application or use in view.” It is one of the remarkable characteristics of human ingenuity and co-operation, however, that very few scientific discoveries do not ultimately have practical benefit through their application by engineers and others.

The research process is in fact so inherent to human nature and so fluid that it is very difficult to compartmentalize the participants in the research process. Some of the greatest researchers in history — Faraday, Edison, and the Wright brothers, for example — had limited education and no professional qualifications. They were motivated by a combination of curiosity and ambition. They were responsible for major accomplishments but established and maintained sound research standards.

Engineers who undertake research have similar motives. In addition to personal standards, however, they are also governed by the Code of Ethics and standards of professional conduct. Plagiarism, falsification of data, and misrepresentation of data are serious concerns in all branches of research. Pressures of competition for research money or the simple lure of fame have occasionally stimulated researchers to dishonest acts in the past.

One of the strengths of the engineer as a researcher is the regulation of conduct provided by professional associations such as Engineers Nova Scotia. Engineers Nova Scotia and equivalent bodies have the ability to levy serious sanctions on engineers guilty of misconduct in

research. This type of discipline does not apply to amateur researchers as well as to some research scientists, although institutional and legal sanctions can also be severe.

(9.3) Research Environments

Although amateur researchers have carried out and continue to conduct important research, most significant research is now done by professionals within organizations. Research organizations are funded from a variety of sources. Federal and provincial governments, crown and private corporations, universities, charities, and private individuals all contribute to research efforts with monetary and in kind contributions. There are many public sector research organizations and most substantial corporations have divisions or departments dedicated to research and development (R&D).

The Federal Government supports several research bodies. The Natural Sciences and Engineering Research Council (NSERC) is one that provides general assistance to researchers across the country. Its mission statement exemplifies the objectives of government in encouraging research:

“ The [NSERC] fosters the discovery and application of knowledge through the support of university research and the training of scientists and engineers. The Council promotes the use of this knowledge to build a strong national economy and improve the quality of life of all Canadians.”

Other government agencies are more directly involved in research. Probably the most prominent is the National Research Council (NRC), a federal Crown corporation. Some federal departments have research arms such as the Defence Research Establishment within the Department of National Defence. Defence Research Establishment Atlantic is in Dartmouth. Another important Nova Scotia research body of this type is the Bedford Institute of Oceanography, which is funded by Natural Resources Canada. Other federal organizations support research through grants, scholarships, and similar programs. As their mission statement indicates, NSERC is one of these as is NRC. Another example demonstrating the diversity of research support is Canada Mortgage and Housing Corporation, which funds social, scientific, and engineering research in residential construction through an annual program of scholarships and grants.

In Nova Scotia, the Provincial Government funds research through InNOVACorp. Like NRC, InNOVACorp is a Crown corporation. It replaced the Nova Scotia Research Foundation in 1996. InNOVACorp assists Nova Scotia industries to commercialize technological innovations. Among other services it provides engineering and scientific assistance. Engineering facilities include an environmental simulation lab, tensile and advanced materials test centres, a prototype shop, computer-aided design, and an instrumentation laboratory. InNOVACorp also provides scientific support services.

Most university professors undertake research as well as teaching. Often, this research is funded from private sources as well as through grants from the government agencies mentioned. Success in research and in securing funding for further research is a major factor in advancement in the academic community.

Some private corporations also maintain research facilities and/or fund research projects. Corporations like 3M and Bell Northern Research are examples of high profile companies that have developed many important innovations. The rewards from the discovery of commercially

useful innovations can, of course, be very substantial. These and other companies employ scientists and engineers to investigate areas that can improve production processes or lead to new products. Many of the larger industrial enterprises in Nova Scotia employ engineers in this type of role.

Few of the many research organizations in Canada work in isolation. One of the primary purposes of the various government agencies involved in research is to facilitate the communication of research results within the large research community. Journals, conferences, and other devices have also evolved to provide the avenues for sharing information. Grants and scholarships usually require recipients to report, publish, or otherwise communicate the results of supported research.

(9.4) Research Process

Research is founded on the scientific method. The scientific method in its most essential form consists of the declaration of a hypothesis and the conduct of an experiment or experiments to test the hypothesis. The generation of hypotheses normally results from observation of the surrounding world or from logical deduction connected to observation. Experiments are intended to recreate the conditions surmised so as to determine whether the hypothesis will hold.

Ideally, experiments should be set up in such a way that other researchers could duplicate them so that their results can be confirmed. It is very important, therefore, that experiments and their results are reported as clearly as possible. Canon 18, requires engineers to do this by commanding that they “interchange[s] information and experience with other engineers and students and [contribute] to the work of engineering societies, schools and the scientific engineering press.” Only through this sharing of knowledge in journals and other forums is it possible for advances to be verified and incorporated into the body of scientific and engineering knowledge.

There are many journals available to publicize research results. They range from the highly academic to practically oriented industry magazines. Nearly every branch of engineering support such publications. There are journals for most major nations in related languages. Familiarity with the literature in his or her field is an important responsibility for every researcher. Researchers need to track the progress of research in their selected field to help focus their investigations and eliminate “dead ends.” For certain types of research based primarily on deductive reasoning, this type of professional exchange may be more important to progress than observation of physical experiments.

Another important component of the research system is the research laboratory. In laboratories set up by institutes and corporations the scientific approach is applied to practical research problems. Most business corporations, as noted, have R&D arms to refine existing products and develop new commodities. The result has been an era of specialized R&D in which engineers have had a major role. They are called upon to resolve pressing questions on demand. The result has been numerous innovations that improve our lives.

Over the last few decades R&D specialization has evolved. Notwithstanding the achievements of separate R&D organizations, concern grew that products were not efficiently produced or well-suited to consumer needs. Contemporary management approaches call for closer working relationships between research, development, and application. Production staff is frequently involved in research processes today. Indeed, contemporary emphasis on consultation often involves users/consumers in problem definition and testing.

The result is an iterative rather than a sequential research process. It is also a process in which social science is playing an increasing role. Quality circles to identify and correct production problems with staff are now commonplace. Focus groups, sample surveys, and other consultative approaches are also used with production staff and consumers to identify areas for improvement and innovation. The goal of this augmentation of the research process is, ultimately, to increase its efficiency. Consultation should lead to processes and products that function better and are more relevant to user needs.

(9.5) Research Misconduct

Fraud is potentially a problem in research. It generally takes three forms. The first is plagiarism or the appropriation of the work of another. The standard notion of plagiarism involves copying the written work of another individual without attribution or acknowledgement. Plagiarism, however, also covers the piracy of another person's ideas.

The second common form of fraud is the falsification of evidence. This involves the reporting of experimental or observational data that did not occur in order to support a more stimulating or desirable conclusion.

The third source of fraud is deliberate misinterpretation of data. It is a variation of falsification that involves reaching conclusions that are not supported by the evidence. It generally has the same motives as falsely reporting data.

An engineer who is confident that research fraud has taken place should, in any case, report the fraud to Engineers Nova Scotia. It is the responsibility of the Disciplinary Committee to determine the extent of the fraud, if any, and to determine appropriate penalties. Such fraud is a very serious offence. Under many circumstances it may be subject to additional legal penalties.

(9.6) Industrial Property

Beyond the objectives of answering questions of intellectual interest or solving particular practical problems, research is often aimed at garnering fame and economic benefits. Legal recognition of inventions of the type developed by engineers is obtained through copyrights and patents. Along with trademarks and industrial designs, the rights associated with these certifications are known as "industrial property rights."

Copyright protects written materials and designs. Unless assigned to another, copyright resides with the author of a work. Except as otherwise specified by the federal *Copyright Act*, the author holds copyright for the course of his or her lifetime. Copyright persists with the heirs of its holder for 50 years after his or her death.

In the context of research, copyright is the fundamental protection against plagiarism. A copyright can be registered with the federal Copyright Office, although it is not essential, registration is advisable to protect licensees and assignees of copyrights from the claims of subsequent licensees and assignees.

Copyrights protect ideas or the particular expression of ideas. Patents are applicable only to the physical products of research. An idea cannot be patented. Only the tangible products of an idea or ideas are patentable. For example, although many of the components of the original aeroplane were patentable as was the plane itself, the principles of flying, such as Bernoulli's

principle or the Venturi effect, on which these items are based, are not. Indeed, it is vital to the process of invention that ideas are freely available for application by inventors.

Patents must be applied for and registered. Once registered a patent has a term of 17 years. Patents have dual importance. On the one hand, they are a form of recognition. Like publications, they are a measure of accomplishment for researchers. On the other hand, patents protect potential economic benefits. During the period of a patent, only the patent holder can produce or reproduce the patented item for sale.

Patents, like copyrights, may be assigned to others. Licensing of patents must be registered. Typically, licensees pay royalties on sales of the patented product. If a patent is infringed, the *Patent Act* entitles the holder to claim all damages, whether sustained by him or herself or patent licensees.

Where research or invention may yield economic benefit, employee engineers are normally responsible to their employers. Unless a contract between the individual engineer and his or her employer states otherwise, the fruits of the engineer's creativity on the job are the property of the employer. This includes any patents that may result from work.

Normally, however, the engineer will be able to patent or benefit from the results of research undertaken outside the confines of their workplace and beyond the realm of their work responsibilities.

10 STUDIES AND INVESTIGATIONS

(10.1) Introduction

The words "studies and investigations," in common language, refer to research to acquire knowledge. The noun "student," of course, is derived from the verb "to study" to mean a person actively engaged in the acquisition of knowledge. Investigation adds the concept of organized research to answer specific questions. Many commonly associate investigations with the processes of scientific and criminal investigation in which scientists, police detectives, or others attempt to determine how certain events transpired in relation to an unusual circumstance or suspected illegal act. The process is intended to answer questions for which there are no answers at the outset or for which the answers are initially unclear.

Engineers must undertake studies and investigations for the same reasons. As engineers explore the possibilities of techniques and materials, they often need to expand their knowledge and test their thinking beforehand. Also, at times, they need to determine the reasons for unforeseen failure in products or processes for which their expertise can provide the necessary insight.

(10.2) Work Environments

The processes of studying and investigating are essential to the practice of the prudent engineer. Studies and investigations are undertaken to reduce the chances of failures or problems and, in the event that failures and problems do occur, to either resolve them or avoid them in the future. Sometimes too, engineering studies and investigations are pursued to determine liability and assign responsibility in the context of the courts. This role is now frequently referred to as "Forensic Engineering."

There is little difference in the requirement for investigations and studies between the public and private sectors, or between consulting engineers and others. All types of engineers have to undertake special studies and investigations if and when circumstances demand. Inasmuch as consulting engineers are more often engaged to carry out discrete assignments, and the need for studies and investigations can interfere with the ongoing responsibilities of employee engineers in government or business, studies and investigations will tend to form a larger proportion of the consulting engineer's workload.

Regardless of this distinction, there is no branch of engineering in which studies and investigations do not play a role. On the other hand, there are disciplines and practices in which they are more central. Engineers in universities and research institutes, for example, generally focus on studies and investigations in the context of developing and advancing general engineering knowledge. Studies and investigations can also be integral to the design process as in the case of naval architects and aeronautical engineers who, respectively, use tank and wind tunnel tests to evaluate performance before committing their designs to construction. Structural engineers often use the same techniques to assess the influences of water and wind on their designs.

For some types of engineers, investigations and studies are the primary activity in which they engage. Many transportation engineers, for example, are almost exclusively involved in developing manual assessments and/or running models to evaluate the current and future impact of traffic. Their work provides a foundation for other engineers to design roads or undertake other improvements to address the deficiencies that modelling identifies.

The influence of human and natural impacts also gives rise to studies and investigations by many types of engineers. Structural engineers, for example, must frequently assess the integrity of buildings, bridges, and other structures that have been affected by the passage of time and exposure to the elements. As noted, this type of investigation can be undertaken in response to failure or, more often, as part of routine maintenance. In the latter role, studies and investigations are vital to prevent failures that could endanger public welfare.

(10.3) Practice of Investigations and Studies

Engineering investigations are typically undertaken to address practical objectives: to acquire information, to determine methods of addressing particular situations, and to test the feasibility of different approaches. As such, studies and investigations resemble scientific experiments. They must be properly set up and each step should be fully documented.

Studies and investigations take myriad forms. They can be undertaken to improve understanding of physical and behavioural phenomena. They can also be carried out to ascertain the feasibility or economic rationale for purely engineering initiatives or for other initiatives for which engineering knowledge is relevant. And, they can deal with flora, fauna, humans, or, in short, just about any subject of interest to engineers.

Methodology, therefore, varies greatly. Engineers undertaking studies can use secondary and primary sources. Secondary sources are written reports, audio and videotapes, and other records that may provide information on the subject of interest, including the Internet. It is always good practice for engineers undertaking investigations and studies to begin by determining what secondary source materials exist. Review will determine whether the issue has been addressed previously. Even if earlier documentation does not directly answer the question or questions under consideration, it will usually provide useful background information.

It may provide a partial answer, a basis for hypotheses, or eliminate unproductive lines of inquiry.

Assuming secondary sources do not provide a full answer, the engineer conducting a study or investigation must resort to primary research. Primary inquiry covers many options itself. Among common primary research techniques are interviewing and surveying of other people, including both the general public and other engineers, and various forms of physical inspection and data collection. The information acquired can be either qualitative or quantitative. Qualitative information is opinion and expert assessment expressed in words. Quantitative information is numeric data acquired by counting or measuring. Quantitative data are usually preferred because numbers can normally be more readily compared and, therefore, conclusively assessed.

Interviews and surveys are organized ways of collecting data from people. Interviews can be informal or structured (i.e., involving fixed questions). Surveys are often a form of structured interviewing. They involve asking many people questions either through direct interviewing or through questionnaires that individuals are asked to fill out based on oral or written instructions. Surveys are usually administered to samples drawn from a larger population. It is very important for engineers applying this technique to thoroughly understand sampling methodology. Understanding sampling will help to calculate the number of survey responses required to reliably answer their questions and interpret the results properly.

Investigations of physical phenomena generally require physical methods. The most basic method of physical investigation is inspection. An early task for engineers assessing physical questions is inspection of the object, site, or phenomenon in question. An engineer who does not visit a building site for a structural assessment, for example, is unlikely to be considered to have done a complete job. On the other hand, the nature of inspection will very much depend on the questions to be addressed.

Physical investigations can be roughly divided into non-destructive techniques and destructive methods. Destructive techniques which usually do not require total destruction of the object(s) under study, involves stressing, excavating, opening, and dismantling objects in order to better view their condition. Non-destructive approaches will suffice where superficial evaluation is adequate. Non-destructive techniques can also supplant destructive methods through application of advanced technology such as the use x-rays or television to assess the condition of objects that are not readily accessed or viewed by any other means.

Physical conditions can also be assessed by experimentation and re-creation. This approach is normally used when engineers are investigating transitory events like accidents. As there may not be witnesses to accidents or the information from witnesses can be distorted by their perspective or interest, re-creation can facilitate objective understanding. Re-creation can be done on site or under controlled conditions in a laboratory or similar facility. It is often employed to evaluate and/or reinforce the testimony of witnesses, or to corroborate physical evidence available at the scene.

Re-creation can also be done before the fact. Engineers regularly build mathematical and physical models of designs that they subject to simulated or real stresses so as to observe the results. Tank and wind tunnel testing, mentioned above, are examples where engineers observe the impacts of water and air flow on scaled down models of ships, aircraft, structures, and other objects in order to assess the consequences of particular approaches. There are many other

methods available to engineers to replicate conditions beforehand for the purposes of identifying concerns, assessing options, and refining ideas.

Sampling can be an important technique for physical investigations. Manufacturing engineers, for example, may wish to assess the performance of assembly line products before they go to market. Civil engineers, similarly, may need to evaluate the condition of infrastructure such as pipes or roads. A typical method for either is to sample an appropriate proportion of products or segments of road or piped network, and subject them to measurement or performance tests. For some products, testing is frequently destructive, so it is obvious why a sampling approach is required. Even if sampling is non-destructive, however, it is usually much more economical. Essentially the same rules govern sampling and evaluating physical entities as apply to sample surveys of people. Engineers should be familiar with the mathematics of sample construction and evaluation in these cases also.

Regardless of the technique employed, Professional Engineers carrying out investigations and studies should thoroughly and carefully document the conduct of their work. There are several reasons for this. The most fundamental is to communicate results to others including, possibly, an employer or client who has authorized or will pay for the investigation or study. Documenting methodology and results allows clients, other engineers, and other interested parties to evaluate the work. It also adds the work to the body of engineering knowledge so that it can be used as secondary source material by subsequent investigators. Others may wish to replicate the methodology to confirm results.

(10.4) Ethical Considerations

Studies and investigations have an obvious relationship to the paramount responsibility of the engineer for the public welfare. As stated above, investigations and studies are undertaken by engineers to increase their knowledge of particular situations. The prudent engineer assesses all of the issues related to a design or practice and thoroughly investigates all of the implications. Investigations and studies are also relevant to reducing liability and to addressing the ethical responsibilities of Professional Engineers.

Investigations and studies are required as background to the design function to ensure that engineering designs work properly and safely. Clearly, for example, structural engineers must know before undertaking construction whether their designs will stand up. They can assess their prospects by applying their professional knowledge of materials and mathematics in the design stage, but it is nearly always advisable to subject concepts to testing that will replicate complex natural conditions as well. Failure to do so can increase the risk inherent in engineering works for the public.

Studies and investigations conducted by engineers can also address public welfare by identifying and quantifying risks in order to take preventative and/or remedial action. Assessments of infrastructure condition by structural or civil engineers fall in this category. This type of work allows engineers to define whether risks exist and to what extent. With this knowledge they can determine remedial measures that will reduce risks to humans and the environment.

Engineers faced with concerns for public welfare should therefore be prepared to undertake appropriate studies or investigations to address uncertainties. As knowledgeable professionals, Professional Engineers are obliged to apprise clients or responsible authorities of the need for such work when it arises and to define the most appropriate approaches and methodologies. In

the event an engineer is uncertain of the best methods of investigation, Canon 6 requires that he or she should limit expressions of opinion to areas in which he or she has “adequate knowledge, competence, and honest conviction.” If concerns extend outside the specialty of a particular engineer, he or she should be prepared to consult with engineers and/or other professionals with the appropriate background.

In some circumstances, engineers may find themselves pressured not to undertake studies or investigations. Studies and investigations usually increase costs and extend the required time for project execution. Clients or supervisors with constrained budgets or deadlines, or simply indifferent to potential consequences, may not be willing to grant the time or money necessary for needed inquiry. Under these circumstances an engineer whose “professional judgement is overruled” to “present clearly to his clients or employers the consequences to be expected.” The engineer shall refrain from unprofessional conduct or from actions which he considers to be contrary to the public good regardless of the position of his employer or client. This suggests that an engineer who is urged to undertake an engineering assignment without carrying out studies or investigations he or she considers necessary may have to resign the assignment or position depending on their view of the perceived severity of the consequences.

As outlined in our discussion of the practice of investigations and studies, it is also important for engineers to share the results of these inquiries.

The engineer should endeavour to make reports and other information reasonably available to other engineers. This suggests the use of “engineering societies, schools and the scientific and engineering press” to communicate. These avenues should most definitely be employed if innovations in research or interesting results justify dissemination. Even if procedures or results are standard, it is important to share the information to facilitate the secondary research that is an essential early step in nearly all studies and investigations.

In the event a client or employer wishes to suppress information, the engineer must distinguish between legitimate business or organizational priorities and actions that may be illegal or threatening to the public welfare. A good example is environmental investigations carried out by engineers. Investigations can be required for land transactions, or development can reveal contamination or other problems that may be very expensive to resolve. Some clients or employers may feel that they would prefer not to know, if such investigations will identify an expensive obligation or void a lucrative deal. An engineer in these circumstances is first obliged to inform his or her superior or client however unpleasant the information may be. This information will normally include direction as to the actions that should be undertaken and the legal requirements to do so, including obligations for disclosure.

It may also be the case that investigations of this type reveal information about surrounding circumstances beyond the interest of a client. Investigations of soil contamination, for example, may reveal impacts on lands bordering a client’s property or conveyed extensively via a watercourse or underground fracture. Again, the first obligation of the engineer is to his or her client or employer. The client or employer should be advised to inform other property owners and/or relevant authorities. In the event the client or employer declines to do so, the engineer must consider legal requirements, and the threat to the public and the environment from inaction. If the engineer judges that legal requirements are not being addressed and/or public or environmental welfare is jeopardized, he or she should inform the client or employer of the required response. If the employer or client declines to take the necessary action, the Professional Engineer should do so him or herself, after informing the client or employer of their intention.

Although the consequences of this type of initiative may be difficult to accept, preservation of individual and professional integrity is of utmost importance. One of the reasons, in addition to their specialized professional knowledge, that engineers are selected or engaged to undertake investigations and studies is the high standards of their profession. The knowledge that engineers are obliged to adhere to a strict Code of Ethics and will face disciplinary consequences if they fail to do so, is an important assurance to the multiple parties interested in the results of investigations and studies. This standard of professionalism distinguishes the reliability of studies and investigations conducted.

(11) UTILITIES ENGINEERING

(11.1) Introduction

Utilities are systems developed and managed by engineers to serve specific public needs. In Nova Scotia they are identified under the *Public Utilities Act* to include tramways and intra-municipal buses, water, electricity, telephone, steam heat, and geothermal resources and energy (RSNS, Chapter 380, s.1, revision corrected 1997). Companies, commissions, and governments engaged in the provision of these utilities are all subject to regulation by the Nova Scotia Utilities and Review Board under the *Utility and Review Board Act* (Acts of 1992, Chapter 11, s.1).

There are other utilities delivered outside these acts such as sewers and some forms of telecommunications but they are not considered below. The focus of this section is on the role of engineers in designated public utilities and the influence of public regulation on their activities and responsibilities.

(11.2) Work Environments

Some of the utilities designated under Nova Scotia legislation are delivered by large organizations with intricate interrelationships. Examples are Nova Scotia Power, and Halifax Water. On the other hand, bus services and water utilities serving Nova Scotia towns generally have relatively few employees and fairly straightforward organizational relationships.

Utilities can be provided by the public or private sectors. In Nova Scotia, water and sewer systems, and roads are typically provided by governments, while electricity, telephone and telecommunications services are usually supplied through private companies. There is a trend to privatize some services that have traditionally been administered by governments. Nova Scotia Power, for example, is a privately held company that was originally a Provincial Crown Corporation providing essentially the same service.

Traditionally, municipal governments provided utilities through commissions, which are corporate bodies established as separate entities by municipal governments to provide a specific service. Halifax Water is an example of this approach. The number of commissions providing utilities has, however, been severely curtailed. The *Municipal Government Act*, which was adopted in late 1998, no longer enables municipalities to establish commissions. Several remain, however, and are likely to continue to have important roles in the delivery of specific services.

Most engineers involved in the provision of utilities are directly employed by utilities. There are normally consulting engineers who support utilities, especially in planning and design functions.

The engineering specialties required by the range of utilities found in Nova Scotia are varied, including especially mechanical, civil, and electrical services.

(11.3) Utilities Practice

Utilities are what economists refer to as “natural monopolies.” As most utilities take the form of networks, the monopoly arrangement is considered most efficient to avoid duplication and ensure co-ordinated development. The challenge to utility organizations is to maximize efficiency in the absence of the discipline normally provided by competition. One of the reasons for employing commissions in the past was to allow utility managers to focus on the technical issues of service provision without political “interference” that some believe can compromise operations. This remains an important issue for utilities. Because they provide services outside competitive markets, it is very important for utilities to develop and present the technical rationale for business actions. On the other hand, one of the presumed reasons the *Municipal Government Act* does not provide for commissions is a belief that political control is beneficial.

Working for a utility is a unique challenge for an engineer. The services provided by utilities are generally regarded as “essential.” Engineers working with utilities must reconcile responsibility to their employer and fellow employees with their duty to public welfare. They must also be cognizant of the authority of regulatory bodies.

In some cases utilities are expected to “manage demand” at socially and environmentally sustainable levels. For example, it is not generally considered desirable to maximize consumption of electricity, given that it implies consumption of fossil fuels in Nova Scotia and related output of pollutants to our environment. For more subtle reasons, it is also considered desirable to reduce consumption of water. In that case, over consumption will lead to excessive investment in storage and distribution capital. Engineers and managers with utilities that follow demand management policies, therefore, will not pursue the production and profit maximizing goals of more typical businesses.

In other cases the public role of utilities may call for different approaches. In some instances, managers may seek the opposite of demand management; they may be charged to increase consumption beyond “profitable” levels. For example, transit systems in Nova Scotia usually require subsidy. Increasing transit ridership, in these cases, may cost more than can be recouped in direct revenue (i.e., fares). Transit, however, has an important role as a manager of demand for private vehicles and roadways. It may be beneficial to society as a whole to operate this type of utility at “unprofitable” levels, if it is believed that a resulting reduction in private vehicle trips will offset the losses to the utility operation.

The mixture of business and social functions in utilities sets them apart. Engineers and others working for utilities must determine how to balance these objectives. In Nova Scotia, of course, the direction for doing so is governed by the Utilities and Review Board.

(11.4) Ethical Considerations

As outlined, there is a clear and intrinsic connection between public utilities whether publicly or privately supplied and public welfare. The paramount responsibility of the engineer for the public welfare, therefore, aligns with the purpose of a properly run utility. Both are obliged to address the needs of society first and foremost.

On the other hand, the mixed responsibilities of utilities setup potential ethical dilemmas. Goods and services are sold into a market without the discipline of competition, but with the more direct discipline of regulation. The engineer working for a utility must be conscious of both the responsibilities and goals of his or her employer. These obligations and objectives must be considered in relation to regulatory demands and public well being.

Because utility organizations in Nova Scotia are local or province-wide monopolies engineers in their employ may tend to be isolated. There may be few professional contacts outside their specific utility organizations, other than members of the consulting engineering groups that tend to support utilities. Many of these individuals may well have gained their experience within the same organizations. Utilities engineers, therefore, may benefit more than other specialist engineers from participation in professional societies. In particular, engineers with utilities should benefit from opportunities to share knowledge with utilities engineers working in other provinces and countries.

D APPENDICES

(1) PUBLICATIONS BY ENGINEERS NOVA SCOTIA

(1.1) General

The principal mandate, or “object” of Engineers Nova Scotia, is to regulate the practice of Professional Engineering and to govern its members in the public interest. To assist in this, the Association must establish standards of practice.

The Guidelines, Policy Statements, and other Association publications regarding the practice of Professional Engineering as presented in this Section are advisory. They reflect the normal expectations of a reasonable and prudent engineer both in professional practice and in dealings with employers, employees, clients, and the public at large.

The Council of the Association has endorsed these publications. They cover varying aspects of a Professional Engineer’s responsibilities including the following:

- They outline the scope of services to be provided in the practice of professional engineering under various activities.
- They review various rules of practice.
- They are intended to provide a better understanding of the term “professional practice” in its various forms.

Unless otherwise indicated, these publications do not have specific legal authority. Their scope is not intended to be specific, limiting, or exhaustive. Not all services listed under any of the related activity Guidelines are to be provided on all projects. The engineer must exercise his/her professional judgement in recommending the services listed in such Guidelines that should be applied to a particular project.

- Engineers Nova Scotia Guidelines for Engineering Services in Land Development/Municipal Services (1991)
- Engineers Nova Scotia Construction Supervision: Statement of Policy (1991)
- Engineers Nova Scotia Guidelines for Selecting Consulting Engineers
- Engineers Nova Scotia Policy on Municipalities and Review of Drawings (1993)

- Engineers Nova Scotia Guidelines for Engineering Design Drawings Policy on the Registration of Companies (1990)
- Engineers Nova Scotia/Engineers Canada Guidelines on Prime Agreements between Client and Engineer (1996)
- Engineers Nova Scotia Policy on Engineering Being Performed by Professional Engineers(1993)
- Engineers Nova Scotia Engineering Profession Act, By-Laws and Code of Ethics (with revisions to1997)
- Engineers Nova Scotia Program Guide for the Engineer-in-Training Mentor Program(1995)
- Engineers Nova Scotia Guidelines on Reviews during Construction (1993) (Joint Brief with the NSAA to the Municipal Units of Nova Scotia)
- Engineers Nova Scotia Guidelines for the Design Construction and Inspection of Passenger Carrying Elevators and Paraplegic Lifts Installed Within the Province of Nova Scotia (1991)
- Engineers Nova Scotia Health and Safety Policy (1997)
- Engineers Nova Scotia Employment Dismissal Guidelines (1993) (currently being updated)
- Engineers Nova Scotia Guidelines for the Use of the Seal of a Professional Engineer (1988)
- Engineers Nova Scotia Environmental Guidelines for the Practice of Professional Engineering in Nova Scotia (1996)

(2) LIST OF RELEVANT LEGISLATION & CODES

- 1) Nova Scotia Department of Labour and Workforce Development Power Engines Act and Regulations:
 - a) Pressure Vessel Act and Regulations
 - b) Constructions Safety and Industrial Safety Regulations
 - c) Occupational Health and Safety Act
 - d) Workplace Hazardous Materials Information System Regulations
 - e) Managing Asbestos in Buildings (Code of Practice)
 - f) Coal Mines Regulation Act
 - g) Metalliferous Mines and Quarries Regulation Act
 - h) Temporary Workplace Traffic Control Regulations
 - i) General Blasting Regulations
 - j) Fall Protection and Scaffolding Regulations
- 2) Canadian Electrical Code
- 3) National Fire Code
- 4) National Building Code
- 5) Liquefied Petroleum Gas Regulations
- 6) Nova Scotia Fire Prevention Act
- 7) Environment Assessment Act
- 8) Prepare Installation Code
- 9) Canadian Standards Association (CSA) Publications
These are referred to in many Codes and give design criteria for many types of materials and systems.
- 10) The American Society of Mechanical Engineers (ASME) and the American Petroleum Institute (API) The Standards of ASME and API are also applicable in certain engineering designs.

(3) List of Engineers Nova Scotia Forms & Certificates

3.1 Certificate of Compliance

The Association of Professional Engineers of Nova Scotia

Certificate of Compliance

(Year)

This Certificate, issued by the Registrar of the Association of Professional Engineers of Nova Scotia, records that the firm of:

(Company Name)

being engaged in providing Engineering Services to the public,
is in compliance
with the requirements of Section 13B of the By-Laws of the Association
for the calendar year shown below.

(Company No.)

(Effective date)

(Registrar's Name)

This certificate requires renewal at the beginning of each calendar year.