A Guideline for Determining the Requirement for Professional Engineering Involvement in the Design and Implementation of Electrical and Control System Installations

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1. Introduction

The Association of Professional Engineers and Geoscientists of Manitoba (APEGM) is the legislatively constituted organization responsible for the administration and enforcement of *The Engineering and Geoscientific Professions Act* of the Provincial Legislature (the Act). APEGM requires that all technical practitioners who carry out work involving the application of engineering principles are qualified to do so and to provide the necessary licensing. These activities are performed by APEGM so that standards of performance within the profession can be maintained above a prescribed minimum level in the interests of safety and for the protection of the public at large.

With changes in technology and the evolution of the electrical industry, there are indications that certain aspects of electrical systems and control systems designs are not always being carried out by people authorized to do so by the Act. This raises significant safety, legal, and liability issues for those designing, using and owning such systems.

Persons or organizations affected by this lack of adherence to the Act include: licensed practitioners who may subsequently have to deal with systems produced under such a circumstance, owners and purchasers who may unknowingly have acquired such systems and the associated consequences, non-licensed practitioners performing such services, and the public at large. Individuals may be adversely affected by such systems since they may not be sufficiently knowledgeable regarding the lack of conformance with legally defined standards and, as a result, could suffer material loss.

It is the intent of this document to provide guidance regarding the legal requirement for professional engineering involvement in the design of electrical and control systems. This guideline includes:

- An overview of the Act and the consequences of non-compliance.
- Categories of systems that are subject to professional engineering involvement.
- Provisions, requirements and scope of coverage of the Canadian Electrical Code (CEC) and the Canadian Standards Association (CSA)
- Typical methods of project delivery showing the relationship between the professional engineer, the supplier, the installer and the owner/purchaser.

2. The Engineering and Geoscientific Professions Act

The Engineering and Geoscientific Professions Act (the Act) is statute of the Manitoba Legislature, which establishes the Association of Professional Engineers and Geoscientists of the Province of Manitoba (APEGM) for, among other purposes, the governing and regulating of the practice of professional engineering in Manitoba so that the public interest is safeguarded. The public interest is defined in that Act as "the well-being, convenience and concern of the public at large."

The practice of professional engineering is:

- any act of planning, designing, composing, measuring, evaluating, inspecting, advising, reporting, directing or supervising, or managing any of the foregoing;
- that requires the application of engineering principles; and
- that concerns the safeguarding of life, health, property, economic interests, the public interest or the environment.

While the Act provides for some exceptions, only persons registered as professional engineers with APEGM or corporations that hold a Certificate of Authorization issued by APEGM are authorized to provide services that constitute the practice of professional engineering.

With respect to this guideline, many of the actions involved in the design and certification of certain electrical distribution systems, and certain electrical control systems come within the scope of the practice of professional engineering.

A copy of the Act can be viewed on the internet at
www.apegm.mb.ca/keydocs/act/index.html

2.1. Certificate of Authorization

As the majority of the contracts for the provision of engineering services are entered into with partnerships or corporations which are legal entities separate and apart from the individual professional engineers who generate the professional services and who interface with the client, the Manitoba Legislature has legislated that such entities are required to hold a permit issued by the regulating body, in this case, APEGM. The permit is called a Certificate of Authorization. As a public interest measure the Legislature has further prescribed that the holder of a Certificate of Authorization must have professional liability insurance.

2.2. Exceptions

While the Act provides for exceptions for certain persons engaged in their occupation, there is no exception from the Certificate of Authorization requirement for entities if engineering services are being provided at the interface between the entity and the customer. One of the exceptions for persons is that nothing in the Act applies to prevent an electrician licensed under *The Electricians Act* from carrying on the trade of electrician. However, that exception does not provide authority to an electrician to provide professional engineering services.

2.3. Consequences of Non-Compliance

The Act provides that every person who violates any of its provisions is guilty of an offence and liable, on summary conviction, in the case of a first offence to a fine of not more than $10,000, and in the case of a second or subsequent offence to a fine of not more than $20,000.

Some of the provisions germane to the activities addressed by this guide are that:

- no individual other than a person who is registered or licensed as a professional engineer may engage in the practice of professional engineering;
- no entity that does not hold a Certificate of Authorization may advertise, offer or provide professional engineering services; and
- no person may knowingly engage or contract with a corporation or partnership that does not hold a Certificate of Authorization for any work that requires the services of a professional engineer.

Additionally, and with respect to liability in a civil action and accountability under the disciplinary provisions of the Act, professional engineers and holders of a Certificate of Authorization may inadvertently assume responsibility for design work based on a consulting engineer's functional design or performance specification that is incorporated in a project if it in turn was not carried out by another holder of a Certificate of Authorization or professional engineer.

3. Systems Subject to Professional Engineering Involvement

This section describes when the involvement of a Professional Engineer is required. It is anticipated that as electrical system complexity continues to evolve, further review of categories to be included will be required.

3.1. Guiding Principles

In some instances, The Canadian Electrical Code (CEC) and local inspection authority amendments will specify when a Professional Engineer is required. Beyond that, the assessment involves a case-by-case review of the issues. The following questions were developed to aid in this assessment.

- Does the issue in question include items beyond a commodity-based component? A commodity-based component is usually a standard off the shelf product that has not been customized by the original equipment manufacturer (OEM) or other third party. This could include such items as relays, motors, motor starters, and standard motor control centers (MCC).
- Is it a system? A system involves the interconnection of several components such as MCCs, starters, and controllers integrated together into an overall installation. Such installations often involve several design aspects including interrupting ratings, protection coordination, interlocking, definition of functional requirements, site specific implementation issues and safety shutdowns for protection of equipment, personal, and the environment.
- Does the design, service, or issue involve the application of engineering principles to solve a specific application problem?
- Is interlocking necessary for life safety, process and equipment protection, or environmental protection?
- Is there any life safety or environmental issues involved?
- Is software being developed for the purpose of equipment control or interface that incorporates any of the issues described above?

If the answer to any of the questions above is yes, then professional engineering involvement is likely required. If any doubt should exist, the issue should be referred to APEGM for an opinion.

3.2. Electrical Systems Requiring Professional Electrical Engineering

In the case of electrical systems, it is the position of APEGM that a professional electrical engineer must take responsibility for the development of designs and associated implementation for new, altered or extended systems as follows:

- Electrical services of over 450 Volts and over 200 Amps;
  - Fault level calculations and over current protection co-ordination are not a typical skill of an installer or even a technical designer. Extensions to existing electrical services could be compromised even by the addition of a relatively small over current device if it is not properly sized.
- Buildings falling within Part 3 of the Manitoba Building Code (current edition).
  - Emergency lighting and exit lighting installations are not necessarily straightforward and thus require adequate attention to achieve its life safety function.
  - Electrical alterations and modifications to building life safety systems may inadvertently impair the emergency operation of building life safety systems.
- Electrical design of Water/Waste Water Treatment facilities.
- Fire alarm systems
  - Fire alarm systems are a primary life safety system. Lives depend on the continuity of its function during extreme conditions. Interconnection between these systems and other systems including sprinkler systems, elevator system, kitchen fire suppression systems, fir pump controllers, etc. require a complete understanding of the applicable codes and standards including those other than electrical. Fire protection system verification must adhere to a high level of standard to adequately perform its function.
- Lightning protection
- Power factor correction equipment other than individual motor applications.
- On-site electrical power generation equipment.
- Electrically hazardous locations defined under Section 18 of the Canadian Electrical Code.
  - Hazardous locations often require additional standards (NFPA, etc.) for proper design. In addition, some hazardous materials

are incompatible with others and a potential hazard can occur simply by storing certain chemicals together. The complexity of these applications and the need for appropriate design documentation requires the involvement of professional engineering.

- Designated heritage buildings.
  - Heritage Buildings improperly modified may cause irreparable damage and a long term safety hazard.
- Lighting associated with agricultural processing areas that are federally mandated.
  - Agricultural processing areas have federally mandated lighting requirements for consumer safety. Lighting levels are subject to many factors including lamp lumen depreciation, lamp dirt depreciation, co-efficient of utilization, etc. not typically within the design capacity of installers. Proper design and installation in these areas are a public safety issue.
- Manufacturing and/or process applications where electrical safety interlocks are not integral with CSA approved equipment.
- Patient Care facilities.
  - Electrical systems in even very small specialty health clinics have ground related complexities which can cause patient safety issues.
- Other applications where sufficient complexity exists and issues of personnel or environmental safety are present (refer to Section 5 of this document).
  - Environmental contamination arising from improperly designed systems can lead to health concerns.

3.3. Control Systems Requiring Professional Electrical Engineering

This section is intended to provide guidance on the required use of a professional engineer for work involving control systems.

Control systems for machine control, process control, materials handling, etc. tend to be complex in nature and can be designed to utilize any combination of relays, programmable logic controllers (PLC), loop controllers, personal computers, and dedicated digital controllers. The designer is required select a control strategy that includes the selection of control hardware and software and to incorporate all necessary safety interlocks. Safety issues arising from machinery or process operation must be considered and conformance to all applicable codes and standards must be maintained.

Given the life safety and engineering issues inherent in these systems, it is the position of APEGM that the following list of control systems require the involvement of a Professional Engineer.

- The integration of control components into an overall system (including software) where life safety or conformance to established standards must be demonstrated.
- Boiler controls for custom applications.
- Conveying equipment controls as part of an integrated installation.
- Water/Waste Water Treatment controls.
- Pollution control systems.
- Food processing control systems.
- Pharmaceutical manufacturing control systems.
- Ventilation control systems for hazardous locations.
- Any other control system that involves the protection of life, the environment, or equipment .
- Aspects of building control systems that may interface to other life safety systems

Involvement of a Professional Engineer for control systems design would include detailed system design and component selection, functional description of operation, and final verification. The performance of detailed work can be done by others under the supervision of an engineer with the final responsibility taken by professional engineer.

3.4. The Canadian Electrical Code and Canadian Standards Association Certification - Engineering Requirements

The Canadian Standards Association (CSA) prepares codes and standards for the manufacturing and installation of equipment with the purpose of maximizing public safety. CSA also tests equipment to ensure that the standards are being met. Equipment that meets the specifications and passes all tests receives a CSA label.

The specific code dealing with the installation of electrical equipment is the Canadian Electrical Code (CEC), which is CSA C22.1, titled "Safety Standard for Electrical Installations." The statutory responsibility for the safety of electrical installations is within the jurisdiction of each province. In Manitoba an amended CEC is accepted as law. Responsibility for amending and enforcing the CEC outside the City of Winnipeg rests with Manitoba Hydro, which maintains an inspection department for this purpose. Inside the City of

Winnipeg this responsibility rests with the Plans Examination Department and the Electrical Inspections Branch.

Rule 2-014 of the CEC: “Plans and Specifications” has been amended by both Manitoba Hydro and the City of Winnipeg. The clauses presently read as follows:

- Winnipeg Electrical Bylaw

  (1) The Owner shall appoint a Professional Engineer, entitled to practice in the Province of Manitoba, who shall be responsible for the preparation of the electrical drawings, supervision of the electrical installation and certification that the installation has been installed in accordance with the applicable by-laws, on the following types of electrical installations:

  (a) High Voltage

  (b) High Buildings as defined by Subsection 3.2.6 of the Manitoba Building Code

  (c) Buildings where the electrical service requirements exceed 750 KVA

  (d) Power factor correction of electrical installations, other than individual motor applications; and

  (e) Any other type of installation where it is deemed necessary in the opinion of the Designated Employee.

- Manitoba Hydro

  (1) Plans and specifications shall be required for:

  (a) The installations operate at voltages in excess of 750 Volts or

  (b) Electrical installations covered by section 18,20,22, or 24 of the Code; or

  (c) Such other installations as may be prescribed by the inspection Department

  (2) Drawings and specifications as required by Rule 2-014(1) (a) (iii) shall be prepared and signed by, and bear the seal of, a registered professional engineer

(3) For large complex installations, at the discretion of the Chief Electrical Inspector, the responsible professional engineer shall submit a letter to the Inspection Department stating his or her responsibility for the installation to ensure conformity with the approved plans and specifications

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3.5. Understanding CSA and ULC

3.5.1. Compliance With CEC And Its Referenced Standards Does Not By Itself Constitute A Safe Design.

The CEC code is not a design manual, but is a set of rules that define the minimum allowable ratings and settings for the application of equipment in specific circumstances. In cases where these circumstances clearly exist, if the code is followed precisely, a safe and reliable installation will result.

For more complex installations, it is often necessary to interpret the code to ensure that the installation conforms. This requires that engineering principles be applied for areas such as safety interlocks, protection co-ordination, interrupting capacities, etc. In all cases the design must be reviewed by a professional engineer who then assumes responsibility for the installation by placing his/her stamp and signature on the design.

3.5.2. CSA And ULC Labeling Of Components And Assemblies Of Components

Individual electrical components and assemblies of components require labeling by CSA, ULC or similar organizations before they can be used as part of an electrical installation. These products have been built and tested to meet the specified standards . However they only grant compliance to the component(s) in question. They do not comment on the application of the components when used as part of a larger system and they do no comment on suitability of application. For these aspects the services of a professional engineer are often required depending on the magnitude of “larger electrical system” in question.

Note that there is no code or standard that defines the functional aspects of a control or power electrical system. In order to ensure that the system functions as expected, the services of a professional engineer should be retained.

4. Project Delivery Methods:

There are many methods of project delivery a business or client can choose to implement a new electrical system or electrical control system. Some of the more common methods presently practiced are described below together with the implications for engineering responsibility.

4.1. Detailed Design, Tender, Construct:

In this method of project delivery a client engages a professional engineer directly to prepare drawings and specifications. These documents are used to tender the work and the successful Contractor constructs the work. The engineering responsibility for the work remains with the engineer who sealed the drawings. Shop drawings are submitted by the Contractor and are reviewed by the professional engineer to ensure the integrity of his/her design is maintained.

The level of detail required in the tender drawings and specifications, with respect to control systems, needs to be beyond the block diagram and functional descriptions. Schematic diagrams, loop drawings, and interlocking are normally developed

In this arrangement there is normally no requirement for any additional professional engineer to be involved.

4.2. Performance Design, Tender, Construct:

In this method of project delivery a client engages a professional engineer to prepare drawings and specifications. Rather than provide a detailed design for all (or a portion) of the work, the drawings and specifications specify the performance requirements or concept of an electrical or electrical control system. The Contractor is responsible for the detailed design of the system and it is normally a requirement for the Contractor to engage a professional engineer for this work.

In this arrangement the client's professional engineer is responsible for the performance requirements while the Contractor's professional engineer is the responsible for the detailed design. Sealed shop drawings (and often design calculations) are submitted by the Contractor and are reviewed by the client's professional engineer. The client's professional engineer's review is generally limited to ensure conformance with the tender documents. This includes contractual

obligations, conformance with the performance specifications, and review of any physical constraints with other aspects of the work.

In this arrangement the engineering responsibility is split. Care needs to be taken to clearly define responsibilities. As the Contractor's professional engineer is unlikely to have direct access to the client, the client's professional engineer still has considerable engineering responsibility for performance functionality, application and safety.

4.3. Client Direct to Contractor:

In this arrangement a client contacts a Contractor directly to perform electrical work without engaging the services of a professional engineer. In the context of this section (3), a Contractor could be an electrical contractor, an electrical control and panel shop, an electrical switchgear manufacturer or other similar entity.

Notwithstanding the requirements for professional engineering mandated by the CEC as outlined in Section 5, the Work the client wishes to proceed with might involve the "practice of professional engineering" as defined in the Act. When this is the case either the client or the Contractor needs to engage a professional engineer. The guidelines to determine which type and / or nature of Work requires the services of a professional engineer are outlined in Section 6.

Note that the Client has a responsibility under The Engineering and Geoscientific Professions Act. Clause 59 of the act shown below outlines this responsibility.

"Prohibition on contracting with corporations and partnerships

59 No person shall knowingly engage, employ or contract with any person, corporation, partnership or other legal entity that does not hold a certificate of authorization for any work that requires the services of a professional engineer or professional geoscientist."

4.4. Design Build

In the design-build method the Client contracts directly with a single entity to provide both engineering and construction services. The engineering responsibility generally ranges between "Detailed Design, Tender, Construct" and "Performance Design, Tender, Construct:" An engineer is required for design build projects.

5. CONCLUSIONS

The mandate of APEGM includes the self-regulation of the engineering profession in Manitoba. It is incumbent on APEGM to protect the safety of all users of electrical equipment and systems. Companies providing professional engineering services to public or private corporations or individuals are required to hold a Certificate of Authorization issued by APEGM. This certificate is granted only to companies that have professional engineers in charge of the engineering work and that hold the pre-requisite insurance against errors and omissions.

The electrical and the control systems disciplines include a wide range of work that is done by a wide variety of companies. Some of this work is not regulated and can be performed by anyone, some of it involves work that by law must be done by journeymen electricians, and some of it involves the specific design of systems and the application of engineering principles and requires the services of a professional engineer. The boundary between these various areas is often not obvious to the layman.

Due to the wide range of work encompassed by the above disciplines, it is expected that this document will evolve continuously. The technologies are rapidly changing, and there are many circumstances and situations that have not yet been anticipated that will be further defined in future versions.

Current industry practices and techniques have been used as the basis of this document. However, there will be occasions when the requirement for a professional engineer is not clearly defined by this document. In those cases an opinion must be solicited from APEGM. There is no charge for this service.

In all cases safety is the overriding concern. There are many procedures, methods and types of equipment in the electrical and control systems fields that will work perfectly well under normal conditions, but can represent a major hazard to life and equipment under abnormal conditions. Although standards and codes exist to ensure equipment is manufactured and installed to eliminate hazards, the statutory responsibility for the safe design of the system and the analysis of abnormal conditions is the practice of professional engineering .

6. GLOSSARY

The Act
The Engineering and Geoscientific Professions Act of the Province of Manitoba

APEGM
Association of Professional Engineers and Geoscientists of the Province of Manitoba

CEC
Canadian Electrical Code

CSA
Canadian Standards Association

DCS (or DCIS)
Distributed Control (and Information) System

Engineer or Professional Engineer
Person registered or licensed by APEGM to practice engineering in Manitoba

HVAC
Heating, Ventilating and/or Air Conditioning

MCC
Motor Control Center

NFPA
The National Fire Protection Association

OEM Original Equipment Manufacturer

PLC
Programmable Logic Controller

Power Factor Correction
A design technique that adds inductive or capacitive reactance to the load. This is normally done to reduce the current drawn by the load.

UL
Underwriters Laboratories Incorporated

ULC
Underwriters' Laboratories of Canada