

This draft has not been approved and is subject to modification.



APEGGA

*The Association of
Professional Engineers, Geologists
and Geophysicists of Alberta*

Guideline of Professional Responsibilities in Developing Software

DRAFT 4.2

October 2005

FOREWORD

An APEGGA guideline presents procedures and practices that are recommended by APEGGA. In general, an APEGGA Member should conform to the recommendations in order to be practising in accordance with what is deemed to be acceptable practice. Variations may be made to accommodate special circumstances if they do not detract from the intent of the guideline.

Guidelines use the word *should* to indicate that among several possibilities, one is recommended as particularly suitable without necessarily mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain course of action is disapproved of but not prohibited (*Should* equals *is recommended that*). The word *shall* is used to indicate requirements that are mandatory and must be followed (*Shall* equals *is required to*). The word *may* is used to indicate a course of action permissible within the limits of the guideline (*May* equals *is permitted*).

PARTICIPANTS

APEGGA's Practice Standards Committee (PSC) publishes practice standards and guidelines to promote high levels of professional service. A PSC subcommittee with the following membership prepared the draft guideline:

Mr. D.H. (Dave) Currie, P.Eng., Chair
 Mr. A.L. (Larry) Adorjan, P.Geoph.
 Mr. K. (Ken) Chapman, I.S.P.
 Mr. M. (Tex) Gamvrelis, P.Eng.

Mr. R.J. (Rich) Isaac, P.Eng.
 Mr. D.D. (Dion) Lux, P.Eng.
 Mr. R.H. (Hugh) McLeod, P.Eng.
 Mr. B.R. (Bruce) Palmer, P.Geol.

The final development of the guideline was greatly assisted through significant contributions of time and expert knowledge by:

Mr. S. (Shawn) Abbott
 Mr. B.G. (Barry) Brown, P.Eng
 Mr. P.R. (Paul) Brown, P.Eng.
 Mr. P. (Peter) Davenport
 Mr. J. (John) Harauz, P.Eng.
 Dr. R.C. (Ron) Hinds, P.Geoph.
 Mr. R.S. (Richard) Huntrods, P.Eng.
 Mr. C.S. (Chris) Jones, P.Geol.

Mr. M. (Martin) Kratz, LL.B.
 Mr. J.L. (Jamie) Marriott, P.Eng.
 Mr. S. (Steve) McConnell, M.Sc.
 Dr. I. (Iain) Robertson
 Mr. R.F. (Ron) Starman, P.Eng.
 Mr. R.P. (Ross) Vogt, P.Eng.
 Mr. J.D. (John) Voth, P.Eng.

Computer Information Processing Society (CIPS)
 Institute of Electrical and Electronics Engineers Computer Society's (IEEE-CS) Professional Practices Committee
 Software Human Resources Council (SHRC) of Canada

Comments that would help to improve this document should be addressed to:

Ms. L.M. (Lianne) Lefsrud, P.Eng.
 Assistant Director, Professional Practice, APEGGA
 1500 Scotia One, 10060 Jasper Avenue
 Edmonton, Alberta T5J 4A2
 E-mail: llefsrud@apegga.org
 Fax: (780) 426-1877

TABLE OF CONTENTS

FOREWORD.....	i
1 OVERVIEW.....	1
1.1 SCOPE.....	1
1.2 PURPOSE.....	2
1.3 REFERENCES.....	2
1.4 DEFINITIONS.....	2
2 PROFESSIONAL PRACTICE ISSUES FOR ENGINEERS, GEOLOGISTS, AND GEOPHYSICISTS.....	3
2.1 MANAGING RISK AND RESPONSIBILITY.....	3
2.2 RESPONSIBILITIES FOR ENGINEERING AND GEOSCIENCE SOFTWARE.....	5
2.3 ENGINEERING, GEOLOGICAL, AND GEOPHYSICAL SOFTWARE REQUIRING AUTHENTICATION.....	6
2.4 ASSOCIATED PROFESSIONAL DOCUMENTS REQUIRING AUTHENTICATION.....	7
2.5 PROFESSIONAL RESPONSIBILITIES FOR MULTI-DISCIPLINARY PROJECTS.....	7
2.6 SAFETY AND SECURITY CONSIDERATIONS.....	8
2.7 FUNCTIONAL RESPONSIBILITIES.....	10
2.8 PROCEDURAL GUIDELINES.....	11
3 SUMMARY.....	12

1 OVERVIEW

As the regulator of the professions of engineering, geology and geophysics in Alberta, APEGGA's role is to maintain appropriate standards and guidelines of professional practice to uphold the protection of public interest. This document outlines Members' professional and ethical obligations in developing software.

1.1 SCOPE

It is recognized that the professional engineer, geologist, or geophysicist is most often part of a software development team that includes others such as Information Systems Professionals (I.S.P.)¹, computer scientists, and technologists. However, this document focuses specifically on the role of APEGGA Members who assume professional responsibility for software projects.

This document reviews the professional responsibilities of Professional Members of APEGGA to ensure that public interest is protected, by:

- recognizing professional and ethical² responsibilities with software development and use, especially safety and security consideration;
- accepting professional responsibilities in product delivery (i.e., final review and stamping);
- delineating responsibilities for multi-disciplinary projects (i.e., hardware and software interfaces such as piping and instrumentation diagrams); and
- recognizing professional responsibilities of Members in the different software development roles and during the various stages of software development.

The scope of this guideline has been necessarily limited to the professional responsibilities of APEGGA Members. This is not meant to be a technical document; as others have already developed excellent standards and best practices (i.e., ANSI/UL,³ CSA⁴, IEEE-CS⁵, ISO⁶, IEC,⁷ SEI-CMM/CMMI^{®8}, SAE⁹, RTCA¹⁰). Professional Members are advised to direct themselves to these other references, as required.

- 1 Information Systems Professional of Canada (I.S.P.), a certification designation granted by Canadian Information Processing Society (CIPS) provincial bodies, as professions are regulated on a provincial basis). CIPS is a Canadian professional association that provides leadership in information systems and technologies by developing and promoting quality standards and practices, research, certification, and professional development while safeguarding the public interest. Available URL: www.cips.ca.
- 2 In addition to APEGGA's *Code of Ethics*, there is a documented software engineering code of ethics, which both the IEEE Computer Society and Association for Computing Machinery (ACM) have endorsed (also endorsed by many companies) that should be mentioned. Available URL: <http://computer.org/computer/code-of-ethics.pdf> and www.acm.org
- 3 American National Standards Institute (ANSI) is a premier source for timely, relevant, actionable information on national, regional, international standards and conformity assessment issues, URL: www.ansi.org. Underwriters Laboratory Inc. (UL) has developed more than 800 Standards for Safety to help insure public safety and confidence, reduce costs, improve quality and market products and services. Available URL: www.ul.com.
- 4 Canadian Standards Association (CSA) is a not-for-profit membership-based association serving business, industry, government and consumers in Canada and the global marketplace. CSA works in Canada and around the world to develop standards that address real needs, such as enhancing public safety and health. Available URL: www.csa.ca
- 5 Institute of Electrical and Electronics Engineers (IEEE) is the world's largest technical society. The IEEE is organized into 37 technical societies, including the Computer Society (CS), which

1.2 PURPOSE

The purpose of this document is to outline the ethical and professional responsibilities of APEGGA Members and to provide guidance for others in their interfacing with Professional Members. This guideline should be regarded as an addition to, but not a substitute for, specialized software training.

1.3 REFERENCES

This guideline is to be read in conjunction with the following documents:

Guideline for Ethical Practice V2.0, APEGGA, March 2003.

Practice Standard for Authenticating Professional Documents V2.0, APEGGA, April 2002.

Guideline for Relying on Work Prepared by Others V1.0, APEGGA, June 2003.

Development of Consulting Rate Structures and Contracts - Guideline for Professional Members V1.0, APEGGA, February 2005.

1.4 DEFINITIONS

For the purposes of this guideline the following terms and definitions apply.

Act

The *Engineering, Geological and Geophysical Professions Act*, R.S.A. 2003, c. E-11.1.

Association

The Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA).

-
- 6 develops and maintains technical standards for software development. IEEE-CS maintains approximately 50 standards in computing science and engineering. Available URL: www.ieee.org
- 7 International Organization for Standardization is a network of the national standards institutes of 156 countries. It is a non-governmental organization, occupying a special position between the public and private sectors. Available URL: <http://www.iso.ch>
- 8 International Electrotechnical Commission (IEC) develops international standards and conformity assessment for government, business and society for all electrical, electronic and related technologies. Available URL: <http://domino.iec.ch/>
- 9 Carnegie Mellon University's Software Engineering Institute (SEI) has developed the Capability Maturity Model for Software (also known as the CMM and SW-CMM) which has been a model used by many organizations to identify best practices useful in helping them increase the maturity of their processes. In 2000, the SW-CMM was upgraded to [CMMI](http://www.sei.cmu.edu/cmml/models/)® (Capability Maturity Model Integration). Available URL: <http://www.sei.cmu.edu/cmml/models/>
- 10 Society of Automotive Engineers (SAE), promotes standards development, events, and technical information and expertise used in designing, building, maintaining, and operating self-propelled vehicles for use on land or sea, in air or space. Available URL: <http://www.sae.org/>
- Organized in 1935 as the Radio Technical Commission for Aeronautics (RTCA) today includes roughly 250 government, industry and academic organizations from the United States and around the world. RTCA, Inc. is a private, not-for-profit corporation that develops consensus-based recommendations regarding communications, navigation, surveillance, and air traffic management (CNS/ATM) system issues. Available URL: <http://www.rtca.org/>

Authentication

Application of the Professional Member's stamp, signature, and date.

Professional Member

A professional engineer, professional geologist, professional geophysicist, registered professional technologist (engineering), registered professional technologist (geological), registered professional technologist (geophysical), licensee or permit holder entitled to engage in the practice of engineering, geology, or geophysics under the Act.

Professional Document (s)

Documents that express a professional opinion upon which someone else may rely; both hard copies and electronic copies of design documents, requirements, specifications; including documentation of an operating environment (compiler, software versions, etc.); testing specifications; test procedures for critical components of software interfaces; interpretation of test results; implementation procedures/guides; user guides; reports or other documents that express engineering, geological or geophysical work as contemplated in the Act (sections 3, 6 and 8) or Regulations (section 54), or reproductions of same.

Regulations

The Engineering, Geological and Geophysical Professions Act General Regulation consisting of Alberta 150/99 and 37/2003, and Registered Professional Technologist (Geological) and Registered Professional Technologist (Geophysical) Regulation consisting of Alberta Regulation 36/2003.

2 PROFESSIONAL PRACTICE ISSUES FOR ENGINEERS, GEOLOGISTS, AND GEOPHYSICISTS

2.1 MANAGING RISK AND RESPONSIBILITY

Developing software is an inherently risky proposition – balancing budget and schedule constraints while ensuring the efficiency, effectiveness, integrity, security, privacy, safety, and quality of the software. The software development process is a complex undertaking comprised of specifying, designing, implementing, and testing. Professional Members contribute to the success of software development projects. However, APEGGA is primarily concerned with their responsibility for minimizing the risk of failure and ensuring public safety and security.

Typically, the software project is usually aligned with larger programs intended to fulfill a system or business need. Project failure is then directly related to a failure to achieve the required or desired change, within the available time and resource constraints of the project. It is uncommon to find a software project where failure can be measured in purely technical terms. In addition to technical failure, there also may be change, service, and/or market failure:

- **Technical Failure** – The project faced challenging technical requirements with clearly defined technical objectives. Failure was due to an inability to meet the technical challenge.
- **Change Failure** – The project involved work with software, but its objective was to achieve some organizational change. Failure to achieve that change caused the project to fail.

- Service Failure – The project worked on a software-based service. Its objective was to achieve a specified level of service. Failure to meet service commitment caused project failure.
- Market Failure – The project worked on a software product. Its objective was to achieve a certain market impact. Failure to achieve that market impact caused the project to fail.

There is a need to provide proactive means to defend public safety and security as it may be affected by software failure. “Many companies building safety-critical software are not using proper procedures from a software-engineering and safety-engineering perspective”.¹¹ There are many instances of software failure leading to data or identity theft, fraud, economic losses, damage to physical property, and even loss of life. Market forces, the legal system, and other authorities are usually relied upon to defend public welfare. However, these act after the fact.

The law of civil obligation (torts) may be applicable in these kinds of cases. That increases the importance of providing guidance to Members who wish to be software developers of the need for proposed care and attention in the design, programming, testing, implementation and use of software systems and for such Members in taking such care.

Professionals are reminded of APEGGA’s *Code of Ethics*, which states that they “shall, in their areas of practice, hold paramount the health, safety and welfare of the public, and have regard for the environment.”¹² Also, professionals must ensure that appropriate action or notification of the proper authorities occurs in any instance where they believe that public safety or the environment is endangered, or where required by relevant legislation, regulations, approvals, or orders.

In some instances, APEGGA Members may be the only employees in a company, agency, government department, or other entity who have a legal obligation to protect the public interest.¹³ The courts expect a higher standard of care from professionals than from the public at large. Professionals also share corporate responsibility for the quality of products and services delivered. Under Canadian legislation an individual can be deemed to be a party to an offence if he or she acquiesced in the commission of the offence.¹⁴ Therefore, Professional Members must assess the risk of software failure as a function of the probability and consequences of such failure¹⁵ and provide necessary

11 “An Investigation of the Therac-25 Accidents”, Nancy Leveson, University Of Washington and Clark S. Turner, University Of California, Irvine. *IEEE Computer*, Vol. 26, No. 7, July 1993, pp. 18-41. Available URL: http://courses.cs.vt.edu/~cs3604/lib/therac_25/therac_1.html .

12 *Guideline for Ethical Practice*, APEGGA, April 2003. Available URL: www.apegga.com

13 As noted above, there may also be other professionals such as I.S.P. holders present or also working on the project.

14 *Plain Language Guide: Bill C-45 - Amendments To The Criminal Code Affecting The Criminal Liability Of Organizations* [Justice Canada; Last updated Feb. 3, 2004] Available URL: <http://canada.justice.gc.ca/en/dept/pub/c45/> The amended Act came into force on March 31, 2004.

15 *Risk Management: A Guideline for Managers, A National Standard for Canada*, CAN/CSA-850-97 (reaffirmed 2002).

safeguards.¹⁶ An example of this is the design of Programmable Logic Controls (PLCs) with mechanical redundancies that mitigate the risk of failure.

2.2 RESPONSIBILITIES FOR ENGINEERING AND GEOSCIENCE SOFTWARE

Responsibility and accountability is twofold, between professionals who are involved in: 1) the development (specifying, designing, implementing, testing, and support) and 2) the use of engineering, geological, and geophysical software. First, the Professional Members responsible for the software development process must ensure that the software is fit for use by others. Fitness for use is not limited to functionality – but must also give due regard to reliability, usability, security, and privacy concerns. Second, as users, the Professional Members shall be responsible to ensure that the software is used within its parameters and with an understanding of the underlying engineering/geoscience principles, assumptions, limitations, design constraints, and validity/reliability of results.

Professional Members involved in developing software should:

- explicitly document and explain the purpose and context of the software, the methodologies and input parameters, as well as the limitations of the software systems;
- disclose the scope of testing, particularly in terms of use cases which were proven out and the extent to which internal and field testing has indeed provided confirmation of suitability to purpose;
- provide realistic sample data and verified results to allow end users to test the reliability, functions, features, and performance of the software for themselves;
- provide conformance statements to applicable standards plus integration with the encompassing software system;
- provide clear and understandable documentation and procedures to users, including highlighting any limitations, risks, or cautions on the use of the software, or in respect of the format, content, input, or processing of the data and interpretation of processed results;
- review and directly disclose to the users any limits on the liability of the software developer and identify where there may be a need for use of back up or double checking procedures to verify proper operation of the software;
- provide, where applicable, for timely releases to software users of important bug fixes or software corrections that may affect the performance, reliability or accuracy of the software;
- provide, where applicable, timely continuing maintenance and support services for the software;
- provide, where applicable, timely continuing educational and training services for the users of the software;
- be prepared to provide timely access to source code for the software under suitable contractual terms (i.e., source code escrow arrangements) where needed by users who must be able to rely on the proper functioning and maintenance of the software;
- conduct their programming activities in accordance with all applicable software industry guidelines or standards;

16 Richard Feynman has summarized of the risks associated with the shuttle system, available URL: http://www.ranum.com/security/computer_security/editorials/dumb/feynman.html .

- maintain their programming activities in accordance with current software industry practices; and
- join, support, and participate in continuing educational programs of applicable industry associations and professional associations applicable to software development, such as CIPS, ACM, IEEE-CS, for example.

This list could be made longer. However, the purpose of this listing is to emphasize that there are many obligations that the Professional Member who wishes to develop software should be prepared to undertake, regardless of the development methodology used.

Professional Members in applying the software for professional purposes shall:

- critically assess the fitness of software products for the purpose at hand, considering the systems requirements for functionality, reliability, usability, security, and privacy;
- examine, understand, document, and communicate to all stakeholders the methodologies and input parameters, as well as the limitations of the results obtained;
- verify, where appropriate, new software releases against available standards for general use (e.g., SCADA systems against a security standard such as ISO/IEC 15408, or structural design software against hand calculations);
- take any necessary training available to understand the proper use of the software;
- maintain and use the software in accordance with the published documentation for the software; and
- apply sound technical and professional judgment based upon their experience and expertise that the results being provided by the software are reasonable.

2.3 ENGINEERING, GEOLOGICAL, AND GEOPHYSICAL SOFTWARE REQUIRING AUTHENTICATION

Software may embody engineering, geology, and/or geophysical principles upon which someone else may rely. As such, the software may be an engineering, geological, or geophysical product which requires Authentication as per the Act and the Regulations under the Act. Examples of such software include, but are not limited to:

- Data acquisition and analysis software for:
 - Data logging and data acquisition for engineering, geological, or geophysical applications
 - Remote sensing, Geographic Information Systems (GIS), photogrammetry, geospatial data, geometrical correction, data visualization and editing
 - Seismic data conversion, data processing and viewing, refraction and reflection interpretation
- Modeling and design software for:
 - Slope stability analysis
 - Thermal modeling
 - Air dispersion modeling
 - Geographic Information Systems (GIS) modeling
 - Petroleum resource appraisal systems
 - Ore reserves estimation and grade control systems
 - Structural analysis, pipe stress analysis, etc.

- Control software for:
 - Supervisory Control and Data Acquisition (SCADA) systems
 - Programmable Logic Controls (PLCs)
 - System Protection (power, telecommunications, oil and gas)

Professional Members are often developing software that is not engineering, geological, or geophysical related. Such software does not require Authentication as part of Professional Members' regulatory obligations.

However, Professional Members must recognize that their professional and ethical responsibilities remain the same, even if Authentication is not required. Professional Members should seek to familiarize themselves with the legal, ethical, and other responsibilities they may have in such cases. This may include, for example, studying and/or seeking the I.S.P. designation or other internationally recognized relevant computing professional designation.

2.4 ASSOCIATED PROFESSIONAL DOCUMENTS REQUIRING AUTHENTICATION

How is software to be authenticated? Similar to other engineering or geoscience projects or products, Authentication appears on the Professional Documents associated with the product or project. The design and construction documents associated with a bridge are 'stamped', not the bridge itself.

The appearance of a Professional Member's stamp on a Professional Document is taken as indicative of a professional's involvement and acceptance of responsibility for the work contained in that document. Refer to APEGGA's Authentication Practice Standard for a detailed discussion.

The Professional Documents (either in electronic or hard copy form) associated with engineering, geological or geophysical software shall be authenticated and may include the following:

- design documents, requirements, specifications; including documentation of operating environment (compiler, software versions, etc.)
- artifacts produced during the course of design and development (i.e. tradeoff analysis, prototypes, analysis elements)
- risks being identified, engaged, mitigated, and a contingency plan
- testing specifications
- test procedures of software and its interfaces with critical components
- interpretation of test results
- implementation procedures and guide
- verification by an independent body/organization (e.g. security)
- user guides
- training materials and aids
- development and maintenance documents, tools, and aids

2.5 PROFESSIONAL RESPONSIBILITIES FOR MULTI-DISCIPLINARY PROJECTS

For multi-disciplinary projects, the involved Professional Members shall inform other members of the design team (including non-APEGGA professionals such as I.S.P.s) of

design decisions that will affect their disciplines, check for conflicts between disciplines and clarify areas where responsibilities are unclear. For example, there may be a need to clarify the responsibilities between the disciplines of two or more involved professionals with the following actions:

- responsibility for coordinating the work of technical specialists;
- interface among disciplines (e.g. software requirements for mechanical controls such as developing piping and instrumentation diagrams);
- clearly define responsibilities between the respective areas;
- normalize design criteria and assumptions to ensure consistency among the different areas within the discipline; and
- identify stakeholders of the software in terms of any design constraints being imposed upon the software or environmental conditions that places limitations upon the software.

A Professional Member, as required under the *Code of Ethics*, must only undertake work in their profession for which he or she is competent and qualified. Therefore, the project manager is entitled to assume that if a Professional Member undertakes an assignment for a portion of the work within the discipline, then the specialty Professional Member is assumed to be competent and qualified. However, if evidence arises that suggests the specialty Professional Member is not competent or qualified, then the engineering manager must undertake such additional work to ascertain whether the person is competent and qualified.

2.6 SAFETY AND SECURITY CONSIDERATIONS

Safety concerns necessarily increase the rigour of the software engineering process and verification is an especially important consideration. Also, extra effort is required for a safety-related system because of additional processes that may be required, e.g., hazards analysis, risk management, use of formal techniques, need for specialized tools etc.

NASA's new standard provides an example of the integrated approach that is required for software safety:¹⁷

"Software safety requires a coordinated effort among all organizations involved in the development of NASA software. This includes program/project/facility managers, hardware and software designers, safety analysts, quality assurance, and operations personnel. Those conducting the software safety activities will also interface with personnel from disciplines such as reliability, security, IV&V, human factors and environmental. The responsibility for development of a safe system, including the software elements, belongs to the program/project manager in conjunction with the local safety and mission assurance organization."

There may also be concerns regarding personal, corporate, and national security. More and more software projects are connecting into our information infrastructure. There is clear international recognition that the information infrastructure is the most critical element in a nation's critical infrastructure – failure of the information infrastructure could bring down all of the elements in the nation's critical infrastructure. It is possible that

17 Section entitled 'Software Safety Management' added to NASA-STD-8719.13B w/ Change 1, *Software Safety Standards*, July 8, 2004. Available URL: <http://www.hq.nasa.gov/office/codeq/doctree/871913.htm> .

Canada may impose additional legal or regulatory requirements on those organizations with significant connections to Canada's information infrastructure.

Members must familiarize themselves with federal and provincial legislation that regulates electronic information, as required. PIPEDA ([Personal Information Protection and Electronic Documents Act](#))¹⁸ supports and promotes electronic commerce by protecting personal information that is collected, used or disclosed in certain circumstances, by providing for the use of electronic means to communicate or record information or transactions. Alberta's Personal Information Protection Act (PIPA) came into force as of January 2004.¹⁹ The purpose of PIPA is to govern the means by which private sector organizations handle personal information in a manner that recognizes both the right of an individual to have his or her personal information protected and the need of organizations to collect, use or disclose personal information for purposes that are reasonable. For systems storing personal data that are contemplated by PIPEDA or PIPA, a privacy audit or security/vulnerability assessment by a third party is advisable and, in many cases, required.

Specific industry sectors have developed software safety and security standards to be referenced by Professional Members, as required. These standards include, but are not limited to:

- ANSI/UL 1998, *Standard for Software in Programmable Components*. The scope of the standard applied to software whose failure could result in a risk of injury to persons or loss of property. The standard is intended for the evaluation of products that rely on software and microelectronics to perform safety-related functions. It is not intended to be used as the sole basis for reviewing safety-related functions, but to be used in conjunction with an application specific standard, directive, regulation or purchasing specification.
- ISO/IEC 61508, *Functional safety of electrical/electronic/programmable electronic safety-related systems*.²⁰ There are seven parts to this standard covering: general and specific requirements, determination of safety integrity levels, techniques and measures, etc.
- IEC 60880, *Software for computers in the safety systems of nuclear power stations*.²¹ This standard discusses software system principles and requirements.
- ISO13485:1996, *Quality systems -- Medical devices* & ISO 13485:2003, *Requirements for regulatory purposes*.²² Specifies, requirements for the design/development and, when relevant, installation, servicing, and quality management system for medical devices.
- RTCA DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*.²³ This document discusses software considerations for developers, installers, and users, when aircraft equipment design is implemented using microcomputer techniques.

18 Available URL: <http://laws.justice.gc.ca/en/P-8.6/>

19 Available URL: <http://www.oipc.ab.ca/pipa/>

20 Available for purchase at URL: <http://domino.iec.ch/>

21 Available for purchase at URL: <http://domino.iec.ch/>

22 Available for purchase at URL: <http://www.iso.org>

23 Available URL: <http://www.the-as9100-store.com/>

- SAE AS9100, *Aerospace Basic Quality System Standard*.²⁴ This is the quality system requirements for suppliers to the aerospace industry issued August, 2001. The Standard has approximately 80 additional requirements plus other requirements and 18 amplifications of the [ISO 9001:2000](#) Standard²⁵.

2.7 FUNCTIONAL RESPONSIBILITIES

APEGGA Members may assume many and various roles in the software development team. Note that the number of individuals required to support the following functions will vary with the degree of complexity, the project schedule, the size of the company, and the quantity of the professional services offered. Also note that depending on skill sets of the software development team, the allocation of responsibilities, accountability, and authority amongst personnel will vary - these roles will not be uniform from company to company. The following table lists various specialty roles, and the relative prevalence based upon company and project size.²⁶

Specialty	Number of Software Employees				Ratio Specialists: Generalists
	<10 0%	<100 10-25%	<1,000 15-35%	<10,000 20-40%	
Proportion of Specialists					
Architecture			X	X	1:75
Configuration Control			X	X	1:30
Cost Estimating			X	X	1:100
Customer Support		X	X	X	1:25
Database Administration		X	X	X	1:25
Education and Training				X	1:250
Function Point Counting			X	X	1:50
Human Factors				X	1:250
Information Systems				X	1:250
Integration				X	1:50
Maintenance and Enhancement	O	X	X	X	1:4
Measurement			X	X	1:50
Network		X	X	X	1:50
Package Acquisition				X	1:150
Performance				X	1:75
Planning				X	1:250
Process Improvement				X	1:200
Quality Assurance	O	X	X	X	1:25
Requirements			X	X	1:50
Reusability				X	1:100
Standards				X	1:300
Systems Software Support		X	X	X	1:30
Technical Writing	O	X	X	X	1:15

24 Available for purchase online at: <http://www.sae.org/>

25 ISO 9001:2000, Quality Management Systems—Requirements. This standard specifies requirements for a quality management system where an organization: needs to demonstrate its ability to consistently provide product that meets customer and applicable regulatory requirements; and aims to enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system and the assurance of conformity to customer and applicable regulatory requirements [adapted from the standard's abstract]. The "family" of quality management standards is sometimes colloquially called "ISO 9000". Available URL: www.iso.org.

26 Excerpt from McConnell, Steve, *Professional Software Development – Shorter Schedules, Higher Quality Products, More Successful Projects, Enhanced Careers*, p. 91, Addison-Wesley, 2003.

Testing	O	X	X	X	1:8
Tool Development				X	1:250

O = Occasionally Present; X = Usually Present

Comprehensively defining professional responsibilities for each of these roles is a book-length topic and is outside the scope of this guideline. A detailed discussion of the responsibility, accountability, and authority associated with each role is discussed in detail by others:

- *SWEBOK Guide*²⁷
- Occupational Skills Profile Model developed by the Canadian Software Human Resources Council (SHRC)²⁸
- IEEE 1490, *A Guide to the Project Management Body of Knowledge*²⁹
- ISO/IEC 12207, *Information technology - Software life cycle processes*³⁰

2.8 PROCEDURAL GUIDELINES

The choice of software development methodology depends on the culture of the company, the experience and background of staff, and the type of software to be developed. As the learning curve for a development methodology is steep, once a certain methodology is chosen, it may be refined but rarely changed. Whatever development methodology is chosen there should be a clear understanding of why it was chosen and the benefits and pitfalls of choosing it.

Therefore, this guideline does not specify what development methodology or combination of methodologies is to be used or preferred. The only requirement is that organizations must choose a reliable, proven methodology, and put appropriate controls/processes in place that minimize any inherent risks within the chosen methodology.

There are many procedural guidelines and best practices to assist Professional Members that are readily available online via purchase or open-access. These standards include, but are not limited to:

- IEEE 1233, *Guide for Developing System Requirements Specifications*
- IEEE 830, *Recommended Practice for Software Requirements Specification*
- IEEE 1058, *Standard for Software Project Management Plans*

27 *Guide to the Software Engineering Body of Knowledge*, © IEEE 2004. This body of knowledge and recommended practices was compiled by the IEEE Software Engineering Coordinating Committee as 'generally recognized' knowledge by practitioners. SWEBOK Guide may be used for such purposes as accreditation of academic programs, development of education and training programs, certification of specialists, or professional licensing. It is available online at: <http://www.swebok.org>.

28 The Software Human Resource Council (SHRC) is a not-for-profit sector council, working with industry, education, associations and government to address employment issues that affect information technology workers at all points of their career paths, in all sectors of the Canadian economy. The SHRC has developed the Occupational Skills Profile Model (OSPM), in response to an urgent need for standardized skills in the Canadian IT sector, the public sector and educational institutions. Information is available online at www.shrc.ca.

29 Available URL: www.ieee.org

30 Available URL: <http://www.iso.ch>

- IEEE 1016, *Recommended Practice for Software Design Descriptions*
- IEEE 1063, *Standard for Software User Documentation*
- IEEE 829, *Standard for Software Test Documentation*
- IEEE 1008, *Standard for Software Unit Testing*
- IEEE 1012 and 1012a, *Standard for Software Verification and Validation*
- IEEE 1061, *Standard for a Software Quality Metrics Methodology*
- ISO/IEC 12207, *Software Life Cycle Processes*
- ISO/IEC 15288, *System Life Cycle Process*
- ISO/IEC 15939, *Software Measurement Process*
- ISO/IEC 16085 (aka IEEE 1540), *Software Risk Management Process*

3 SUMMARY

Professional Members may be involved in the development and/or usage of engineering, geological, geophysical or other software. Software failure may pose risks to public safety and security. Members must be aware of these risks and of their ethical and professional responsibilities to protect the public.

Many others have developed best practices, guidelines, and standards – some of which are listed here. Professional Members are advised to direct themselves to these other references, as required.