

RMIG
Risk Management
Implementation Guideline
for Consulting Engineers

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Risk Management Definition



Risk Management is to reach out to an uncertain future and bring it under control.

As old as humanity - it is one of the most audacious advances of mankind and is as much part of life as the air that we breathe. It is the blueprint for survival.

Without uncertainty, life would be like a movie whose ending you always knew. Free will, our most precious attribute as humans, would be meaningless.

Uncertainty provides the challenges that make life exciting and is the source of the greatest achievements in all human endeavour.

To manage risk is to favourably improve the odds of uncertainty by proactive decision making.



Paraphrased from The Nature of Risk by P L Bernstein in Mastering Risk

James Pickford, Executive Editor, Prentice Hall 2001

Risk and Quality Management

Two Sides of the Same Coin

Quality Management consists of a number of processes that are aimed at improving the effectiveness and efficiency of your business through controls and records that aim to minimize errors and causes of re-work in the production chain. Quality Management therefore enhances the output of your business and assures its productive robustness. A Quality Management system consists of documenting the processes as they apply to your business and regularly controlling, auditing and improving these processes.

Risk Management on the other hand represents a process by which you protect your whole business against internal and external threats. The process can vary in complexity from a simple set of house rules on business ethics and conduct to an advanced system in which risks are systematically identified, quantified, evaluated, remedied and administered for sustainability.

Risk and quality management are consequently two sides of the same coin. On their own, neither can assure the successful outcome of your business and its procedures.

This distinction will assist you to understand that risk and quality management are separate processes. They are complementary and inter-dependent and they may even be inter-related. To know that they are separate processes will raise your awareness that they both need to be addressed in a structured manner. This, however, does not mean that you should always separately identify them before dealing with them. The important thing is to systematically manage both risk and quality in order to maximize the success of your business.

Special Note

This is not simply another guideline on Risk Management. It is a guideline detailing the implementation of good Risk Management procedures in consulting engineering practice. As such it mirrors what has been said over the years in various documents on the subject, some of which have been produced by FIDIC and various Associations of Consulting Engineers, but it goes a step further by illustrating practical methods of implementation.

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1. Introduction to the Risk Management Guideline

The nature, complexities, exposures and size of your business will largely determine the level of sophistication required for your risk management processes as summarised in this introduction and expanded upon in the more detailed explanations that follow thereafter.

Although practical exigencies require that a particular individual or committee is appointed to assume responsibility for the management of risk, nothing can be worse than the principals then washing their hands of it. Quality and Risk Management are innate elements of the culture of an organization and need to be patronized at the highest level to ensure that all personnel are acutely aware of the never ceasing risks to the organization and actively involved in assuring its quality. None of the rules in the guideline will be of any use unless owned by everyone and pursued in all aspects of the business. This can only happen if pursued from the top and participated in by all, consciously and sub-consciously.

1.1 How to Use the Guideline

There are many ways in which risks can be managed. These range from simple house rules to advanced systems. The approach that you adopt depends to a large extent on your skill and experience in Risk Management. The Guideline covers three levels of Risk Management from which you can select the level suitable for your requirements and compatible with your abilities. It is structured in such a way that you can progress from a simple “cover-all” approach to a detailed specific system as you gain experience and insight.

The three levels of Risk Management are presented in Section 4 and include simple measures to pre-empt practice risk, formal but qualitative evaluation of primary risks and systematic all-inclusive quantitative evaluation of risks.

It must be emphasized that you are not required to advance in the level of sophistication at which you manage the risks in your practice. Once you find the appropriate level of Risk Management for your practice, there is no need to progress any further unless changes in the practice or in the business environment occur.

Quality Management plays an integral role with Risk Management in ensuring the sustainability of your business. The principles and processes underlying Quality Management and CESA’s requirements in this regard are presented in the companion Quality Management Implementation Guideline, QMIG,2021.

Project delivery is a substantial part of most Engineering Consultancies and the risks to which they are exposed as a result are completely different from the enterprise risks that they may experience. Guidelines on managing the risks during the delivery lifecycle of projects are presented in a separate section.

1.2 Level 1: Informal Enterprise Risk Management

Informal Enterprise Risk Management generally applies to small or low-risk businesses.

The most basic step to manage the risks in your practice is to place responsibility for Risk Management with a specific principal who should take the following actions.

1. Implement the FIDIC Risk Management Manual, 1997, as house rules on how to conduct business in your practice. The house rules are summarized under the following headings in Appendix 2:
 - Professionalism
 - Communications
 - Avoiding and managing disputes
 - Business practices
 - Technical procedures
 - Professional liability insurance
 - Fiscal and corporate liability.
2. Facilitate a set of house rules by observing the standards and procedures given in the CESA Practice Notes listed in Appendix 11.
3. Categorise the sources of risk that affect your business under the following headings as presented in Section 4.1.
 - Professional risk
 - Public risk
 - Commercial risk
 - Employer risk
 - Health and safety risk
 - Statutory/legislation risk
 - Legal/contractual risk
 - Financial risk
 - Administrative risk.
4. Prioritise the risks and decide how the risks will be managed and mitigated in the following ways as further described in Section 3.
 - Avoid risk
 - Reduce risk
 - Transfer risk
 - Accept risk.
5. Communicate the actions required to manage the risks in the practice to all staff.
6. Proactively monitor the effectiveness of the actions taken to manage and mitigate the risks.
7. Observe the principles and processes underlying Quality Management and CESA's requirements in this regard as presented in the companion Quality Management Implementation Guideline, QMIG 2021.

1.3 Level 2: Stepping-Stone Enterprise Risk Management

Stepping-Stone Enterprise Risk Management generally applies to medium sized businesses or where risk exposure can potentially damage the business significantly.

The actions taken under the Informal Enterprise Risk Management system described above should be augmented by the following considerations in Stepping-Stone Enterprise Risk Management.

1. Formal commitment across the company to an on-going qualitative Risk Management process.
2. Familiarisation with the methods available for identifying risks and selection of a method for identifying the risks in your practice.
3. Familiarisation with the Primary Risk Evaluation Process.
4. Identification of the Primary Risks in the various categories referred to above in a "cause-risk-effect" format and entering every risk with all the relevant information in a Risk Register. The number of Primary Risks to the key aspects of concern in your practice should be limited to probably not more than say 30.
5. Qualitative evaluation of the probability and impact of each risk identified, ranking them in descending order of magnitude in terms of probability and impact and determining the most threatening ones.
6. Identification of the risks requiring additional analysis and response review planning. Undertaking project comparative and critical risk analyses and analysing the risk activities for trends.
7. Periodic updating of the Primary Risk Evaluation.
8. Undertaking of issue-based risk assessments as required and implementation of remedial actions.

1.4 Level 3: Advanced Enterprise Risk Management

Advanced Enterprise Risk Management generally applies to multi-disciplinary enterprises dealing with complex projects where risk exposure can potentially ruin the business.

The following processes are warranted.

1. Determine from the types and levels of risk exposure of the business, whether Advanced Enterprise Risk Management is worth the time and effort.
2. Familiarise yourself with the Advanced Enterprise Risk Management Process.
3. Identify projects, aspects or issues in your business that have particularly high priorities or that have very small margins for cost and schedule overruns. The full Fault Tree for Engineering Consultancies presented in the guideline may be used for this purpose.

4. Fully develop the relationships between predecessor and successor risks on the projects, aspects or issues considered in structured Fault Trees.
5. Determine as accurately and objectively as practically possible the data on which the probabilities and impacts of the risks are based.
6. Quantitatively evaluate the probabilities and impacts of the risks and gauge the tolerability of the risks.
7. Determine the Expected Monetary Value, EMV, of the risk as the product of the probability and the impact and rank the risks in terms of EMV.
8. Evaluate the differences in risk between projects in terms of EMV or determine whether a project can be completed within a given EMV or what underlying risks need to be addressed to satisfy a given EMV or assess whether a new project should be taken on, on the basis of EMV.

1.5 Project Lifecycle Risk Management

A Risk Management Plan for delivering a project should be prepared as detailed in Appendix 12 whenever your practice is involved in more than two phases of the delivery lifecycle of a project. This would apply irrespective of the level of Enterprise Risk Management that may be appropriate for your business.

2. Enterprise Risk Management

2.1 Introduction

The aim in this Guideline is to show Consulting Engineers how to manage the wide range of risks in their businesses. The Guideline caters for the needs of all sizes of firms, from sole practitioners to large multi-discipline organizations. It also caters for differences in skill and experience in risk assessment and in the level of sophistication that may be required in Engineering Consultancies.

2.2 How to Protect Your Practice

The risks in your business are analogous to the loads on a structure and the quality of your business, to the strength of the structure. Load must not exceed strength and strength must stand up to load – each must be managed in recognition of the other. Similarly, for Risk and Quality. The purpose of Risk Management is to pre-empt the hazards that may impact on your business whilst that of Quality Management is to ensure that your business is sufficiently robust to withstand the hazards when they occur. Risk or Quality Management in isolation cannot assure the successful outcome of your business.

Your business will be best protected by continuously managing both the risks to which it is exposed as well as the quality of its operations.

Quality Management has been actively pursued for some time and has, to a large extent, become part of modern business practice with the availability of good standards and implementation guidelines. Risk Management is rapidly gaining recognition and although extensively covered in the literature on the subject, very little practical guidance is available to the broad spectrum of Consulting Engineers on how to implement appropriate and sustainable Risk Management Systems in their businesses.

2.3 What is Risk Management?

Risk Management is the process whereby you identify the risks which, if they materialize, can affect the ability of your business to function and survive. It can be as simple as thinking about what could happen and making sure that you have sensible contracts with all your clients for all the work that you do. Risk Management can also be formalized by adopting the structured process outlined in Figure 1, page 18, and more fully described in Appendix 1.

Once you have identified and evaluated the potential risks you can manage them in the following alternative ways:

2.3.1 Avoiding Risk

This means not engaging in any activity that carries a risk. There are, however, very few activities in life and in business that do not involve risk. Nevertheless, should the risks outweigh the potential for reward, then such an activity should be avoided.

2.3.2 Reducing Risk (Mitigation)

This means adopting measures to reduce the risk to such an extent that the activity becomes viable when measured against the potential return associated with the particular activity.

2.3.3 Transferring Risk

This means transferring the risk to another party. Risks are typically transferred by way of an insurance contract where the insurance underwriter undertakes to indemnify the business against specific risks in return for receiving monetary compensation in the form of an insurance premium. Risks can also be transferred to other parties including Clients, Contractors and various styles of Joint Venture Partners.

Sometimes a combination of the above Risk Management options may be adopted e.g. a business may retain a portion of the risk (excess or deductible amounts) and transfer the balance of the risk to the insurance company.

Note that risk transfer is a two-way street. Inappropriate transfer of risk to Consulting Engineers by Clients and their legal representatives will magnify the consequences of a risk that does eventuate, both for the Engineer and for the Client (who very likely will be acting under a false sense of security). Whatever form of risk transfer is pursued, it should always be ensured that the party to whom the risk is transferred is able to finance that risk.

2.3.4 Accepting Risk

This means that the risks involved in undertaking the activity are acceptable. This particular activity is then undertaken as the potential gain is of such a magnitude that it outweighs the associated risks.

2.4 Levels of Enterprise Risk Management

The three levels of Risk Management are presented briefly as follows, in rising order of sophistication. In the simplest approach, you may adopt codes of conduct as the inherent value systems on which you would implicitly rely to minimize the risks to your business. The next level of sophistication would require that you systematically identify the primary risks to your business, qualitatively evaluate them and then actively manage them. The risks in most businesses would be adequately addressed at this level.

At the third level you would identify the risks to your business more extensively and in greater detail, quantitatively evaluate their incidence and impact on your business and manage them on an on-going basis. You would in principle address particularly risky projects, aspects or issues in your practice in this way.

The following notes will enable you to evaluate your current level of understanding, what level of Risk Management would be appropriate for your business and what advanced level of Risk Management you may want to pursue.

2.4.1 Informal Enterprise Risk Management

The elements of Informal Risk Management are presented below. These in principle comprise “house rules” to contain the risks to which you may be exposed and quality management to ensure that you will be able to deal with the risks when they occur.

i. Know the Sources of Risk in your Business

The sources of risk in your business can in principle be dealt with under the following headings:

- Professional risk
- Public risk
- Commercial risk
- Employer risk
- Health and safety risk
- Statutory/legislation risk
- Legal/contractual risk
- Financial risk
- Administrative risk.

Dealing with the various sources of risk enables you to address specific areas of uncertainty, rank the risks in order of priority and evaluate the effectiveness of measures that you may implement to mitigate the risks.

ii. Simple Measures to Pre-empt Practice Risks

Risk Management is not a complicated process. It is most successful when it is carried out by everyone in the organisation all the time. For day-to-day use, the house rules that you should observe to minimise the risks to your business may be summarized as shown in Appendix 2 as taken from the FIDIC Risk Management Manual, 1997.

Close scrutiny of the house rules will show that they broadly fall into two categories, namely, those to pre-empt and minimise the risks and those to assure the quality of your business. The fact that some of the rules are aimed at quality should not unduly concern you in view thereof that risk and quality management are different sides of the same coin and in simple Risk Management approaches will tend to appear together.

In many instances, implementation of the house rules is facilitated by adhering to the standards and procedures given in the CESA Practice Notes listed in Appendix 11. The Practice Note relevant to a particular risk aspect can be identified from the titles and keywords given in the appendix.

iii. Implement Simple Risk Management Plan

Implementing a basic Risk Management Plan involves the following:

- Risk Management must be driven from the top down. If the practice is large enough, a specific director or partner should be given the responsibility for Risk Management in the organization. This is often combined with the responsibility for Quality Management.
- Identify and document all the risk factors that have an influence on the business.
- Prioritize the risks and decide how the risks will be managed and mitigated.
- Communicate to all role players the actions required to manage the risks in the organization.
- Monitor on an on-going basis the effectiveness of the actions and take remedial action where necessary. Refer to Appendix 12 for a basic Risk Management plan for delivering a project.
- Scan the environment on an on-going basis to identify new risks or any changes in the potential severity of already identified risks.

2.4.2 Stepping-Stone Enterprise Risk Management

This stage is a stepping-stone for you to become familiar with the methods and procedures of rigorous Risk Management and to acquire the necessary skills by analysing the primary risks in your business as an introductory exercise in terms of the process presented in Appendix 6. With this purpose in mind, you want to deal with a limited number of risks to avoid being overwhelmed by the task. If you are familiar with and experienced in quantitative Risk Management, you may omit this stage.

The Primary Risk Management process presented in Appendix 6 includes a definition of risk; identification, capturing and registering of the primary risks; evaluation and ranking of the primary risks and implementing the process. Identifying the risks to which your business may be exposed is the most important aspect of Risk Management. Although Fault Tree analysis is the most suitable method, other methods are briefly described to make you aware of their availability, but also to establish the context of Fault Tree analysis.

Risks are captured in a “cause-risk-effect” format, which essentially represents individual nodes in the Fault Tree for risks. The main purpose of this simple format is to enable you to learn how to identify the primary risks in your business without having to pay attention to the potentially complex relationships between adjoining risks in the Fault Tree. Also, to learn how to determine the cause of the risk and the effect that it would have should it occur.

It is proposed that you identify the primary risks with the assistance of a number of your colleagues in the business in face-to-face workshops. Also, that you capture the primary risks together with their causes and effects on flip charts stuck to the walls of the room in which the workshop is held. Guidelines are presented in

Appendix 6 on these aspects. Guidelines are also given on qualitative evaluations of the probability and impact of the risk in terms of subjective rankings.

The identified risks are assembled in a risk register including the cause, risk, effect, potential owner, response strategy, potential risk trigger, probability ranking, impact ranking and overall risk ranking. A cut-off ranking may be selected to identify the risks with the highest rankings that need to receive priority attention. It is explained how the average risk ranking for a project may be used to determine the comparative riskiness of different projects, the efficiency with which you are addressing the risks in your business and identifying risks that occur most frequently in different projects.

Finally the steps to implement Stepping-Stone Risk Management are presented. Most practices will quite adequately deal with their risks at this level of Risk Management, which in addition will soundly prepare them on the relevant underlying principles towards Advanced Risk Management.

Every node in the Fault Tree in Appendix 9 represents a potential primary risk to your business. As a result, you may use the Fault Tree as a prompt to identify the primary risks that you may wish to consider in terms of the cause-risk-effect format. The Fault Tree also assists you in identifying the causes and the effects of the primary risks.

2.4.3 Advanced Enterprise Risk Management

The Advanced Risk Management process is presented in Appendix 7 and the full Fault Tree for all the risks in your business in Appendix 9, from which it can be seen that a comprehensive analysis of all the risks in your business is indeed very onerous. Advanced Risk Management is only justified on projects, aspects and issues in your business that have particularly high priorities or that have very small margins for cost and schedule overruns.

The risks to which Engineering Consultancies are exposed are common to most practices irrespective of the particular branch of engineering or the size of the practice. This is major advantage in that once the full Fault Tree is developed, not much further effort is required to identify the risks in any particular practice. Different practices may select only those sections of the full Fault Tree that they wish to consider and only enter the probabilities and impacts for the risks that apply to their own circumstances.

A further advantage of the full Fault Tree is that it is a useful checklist of the risks that have been considered in other practices in that it has been developed with the input from a range of consultancies in South Africa. It is expected that the full Fault Tree will be improved further yet by continuing contributions from member firms.

The overall context of the various categories of risk that you may have to deal with in your practice is illustrated in the high-level Fault Tree in Appendix 8. The text format of the Fault Trees in Appendices 8 and 9 enables you to consider very large numbers of risks in relatively little space. It also enables you to transport the Fault Trees into Excel spreadsheets in which subsequent columns could be used for sensitivity analyses.

Guidance is given in Appendix 7 on how to quantitatively evaluate the probabilities and impacts of the risks. Adjectival scores and anecdotal frequencies are provided

next to the numerical scales to assist you in developing a sense for the very small values that are given for the numerical probabilities. The numerical scales for the probabilities are comparable to those used by Actuaries and therefore ensure that proposals for insurance and applications for finance that you may lodge with the Financial Services sector will comply with applicable norms.

Internationally recognized tolerable thresholds for lifetime probabilities of total loss of life, money and property are given in Appendix 7. Factors to adjust these for partial and inconvenient losses of life, money and property are also given. The steps to implement Advanced Risk Management are presented in conclusion in Appendix 7.

To summarize, Advanced Enterprise Risk Management differs from Stepping-Stone Enterprise Risk Management in the following respects.

- Many more risks are identified and dealt with
- The relationships between predecessor and successor risks are fully developed in a structured manner
- Top Events are identified
- The underlying sub-causes are identified to the lowest level where operator error is in principle the root cause of the risks
- The probabilities of the risks are expressed numerically in terms of decimal fractions or percentages instead of qualitative rankings
- The impacts of the risks are expressed numerically in terms of monetary values and real lengths of time instead of subjective rankings.

The sheer number of entries in Appendix 9 is of major importance in that it illustrates how many things can go wrong and that, even if the likelihood of things going wrong is relatively small, the overall probability of failure as the sum of a great number of small entries can still be considerable. This is why Risk Management in your practice requires your continuous concerted attention.

3. Managing Risks during Project Delivery Lifecycle

A Typical project has the following phases:-

1. Feasibility Phase
2. Appointment Phase
3. Conceptual Design Phase
4. Design Phase
5. Contract Award Phase
6. Implementation Phase
7. Commissioning and Post Contract Phase.

A brief description of the risks involved during each of the phases and possible remedies are detailed below. The ideal method of dealing with these project risks is to draw up a standard checklist of the risks and remedies. Each project should be measured against the checklist through the various stages. Ideally the Risk Management checklist should be completed by the dedicated risk manager or an objective risk auditor. At the end of each project the risk checklists should be reviewed for completeness and compliance with all the risk remedies.

3.1 Feasibility Phase

The feasibility phase aims to establish the financial, technical and environmental viability of a proposed project.

This phase includes the gathering of all relevant information as well as the production of documentation in sufficient detail and accuracy to enable the Client to establish the viability of a project.

During this phase the Consultant is normally working at risk as it is not immediately certain if a project will be viable.

The major elements of risk during this phase are the following:

- (a) Uncertainty regarding the recovery of costs should the project not be feasible
- (b) Clarity regarding the scope of the project in order to avoid re-work or duplication
- (c) Lack of the necessary skills resulting in incorrect, incomplete or late information
- (d) Material assumption and/or design assumptions that could result in incorrect conclusions regarding the feasibility of a project
- (e) Creating the perception that costs and other technical estimates are final and a 100% accurate projection of the final figures
- (f) Not interpreting the project scope and specifications correctly resulting in incomplete information.

Potential risks and possible remedies during the feasibility phase are detailed in Appendix 12 – Table 1.

3.2 Appointment Phase

The appointment phase of the project sets the technical, contractual and financial framework within which consulting services are to be provided. It is the foundation on which any successful project is built.

The appointment phase starts with receipt of the initial enquiry from the Client and culminates in the signing of an agreement for consulting services. Essential elements of this phase include ascertaining the Client's requirements, deciding whether or not to participate in the project, defining the scope of services, preparing a proposal including conditions of offer and entering into a contract with the Client. Along the way, you must decide whether you have the necessary skills and resources to carry out the project and whether you wish to work for the Client concerned. You and the Client need to agree on the terms of contract, quantum of the fee and method of payment, limitation of liability, programme of work and all other aspects of the appointment that define obligations and responsibilities of the parties to the agreement.

The main risk during the appointment phase of the project is failure to fully define acceptable terms and conditions of your appointment and on methods of dealing with departures from the conditions on which the proposal was prepared.

Note that this is the moment that risk may well be transferred from the Client to you. Do not accept risk transfer unless you are equipped to handle it. Instead encourage the Client to mitigate the risk in a reasonable manner. For example, a Client may seek to transfer the risk of ground conditions and foundations to the Engineer. More appropriate mitigation may be to carry out more investigations and/or to commission a peer review.

Remember that you are undertaking to do what is in the contract regardless of circumstances. Absolute statements are binding unless the obligation is qualified in some way. For instance agreeing to insure for three years is an absolute commitment that may embarrass you if there is no one to buy the insurance from or if the required insurance is unreasonably expensive.

Also, include in the agreement that the client is responsible for related risks that should be included, but are omitted for one or other reason. In addition, ensure that both overt and covert project scope creep will be addressed in writing and that all variations will be documented and compensated for.

Potential risks and possible remedies during the appointment phase are detailed in Appendix 12 – Table 2.

3.3 Conceptual Design Phase

The conceptual design phase translates the Client's brief into a project specific schematic design document.

This phase includes the gathering of all relevant information and production of conceptual design documentation for approval by the Client and all other relevant professionals.

Included in this phase is a determination of the firm's capabilities to execute the brief, technical competency and experience of staff, knowledge of any relevant national and international design standards, knowledge of local authority requirements and standards as well as any environmental impact study requirements.

You need to consider the risk at this stage that the project is terminated, and the possibility that the Client continues to rely on the sketch design without further advice from you and then blames you when he gets into trouble.

Potential risks and possible remedies during the conceptual design phase are detailed in Appendix 12 – Table 3.

3.4 Design Phase

The detail design phase translates the conceptual design into detailed design documentation and working drawings.

The detailed design phase starts with the approved schematic design, which is then translated into detailed documentation for use by the Contractor, Quantity Surveyor and other professionals. The documentation should adhere to the required standards of all approved authorities.

Potential risks and possible remedies during the design phase are detailed in Appendix 12 – Table 4.

3.5 Contract Award Phase

During this phase the consultant is required to assist in preparing detailed tender documentation, bills of quantities, adjudication of tenders and awarding of contracts.

Potential risks and possible remedies during the contract award phase are detailed in Appendix 12 – Table 5. The risks in the tables are that you fail to follow the prescribed procedures and that you are then sued by an unsuccessful Tenderer or that you appoint an incompetent or financially inadequate Contractor. It is particularly important that the Consulting Engineer puts his reservations in writing if the client appoints a Contractor that he did not recommend.

3.6 Implementation Phase

The implementation phase involves the site handover to the Client, monitoring the construction activities on site and certification of progress payments to Contractors.

During this phase the Consultant must ensure that the Contractor adheres to the design specifications while construction is in progress. The Consultant must be available to answer questions from the Contractors, issue site instructions where necessary or revise design documentation where applicable.

One of the major risks during this phase is the prevention of accidents during the construction period. The incomplete documentation of changes or of field design

modifications is a significant risk and the primary cause of PI incidents in many instances.

Potential risks and possible remedies during the implementation phase are given in Appendix 12 – Table 6.

3.7 Commissioning and Post Contract Phase

This phase includes the final snagging of the structure, commissioning of all equipment and systems and issuing of final acceptance certificates.

The Consultant must also arrange for the production and distribution of record drawings and operating/maintenance manuals.

Potential risks and possible remedies during the commissioning and post contract phase are detailed in Appendix 12 – Table 7.

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Last but not the least, a sincere word of appreciation to the CESA staff who steered the guideline through the process of uploading on the CESA website.

6. Figures

Figure 1: Risk Management Process (After Standards Australia and Standards New Zealand, 1999)

7. Appendixes

7.1 Appendix 1 - Risk Management Process

The Risk Management process may be illustrated graphically in terms of the sequence of tasks involved as shown in Figure 1. The tasks, their purpose and the procedures required may be described briefly as follows after the AS/NZS 4360:1999 Standard.

Context of Risk Management

The context of Risk Management includes strategic, organization, internal, evaluation and structural considerations that may be described briefly as follows.

The strategic context defines the relationship between the attributes and functions of the organisation and the characteristics, perceptions and expectations of the environment. The crucial elements in this relationship should be determined to secure the best support and to avoid anything that may impair the Risk Management process.

The organizational context defines the objectives, capabilities, and strategies of the organisation. The Risk Management should be compatible with the culture and criteria of the organisation.

The Risk Management should be to the advantage of that part of the organisation in which it is carried out and should take its goals, objectives, strategies, budgets and parameters into account. The Risk Management should also take cognisance of the other parts of the organisation and their relationships with the part in which it is pursued.

The acceptability of risk and the proposed treatment may be based on operational, technical, financial, legal, social, humanitarian or other suitable criteria that may be affected by internal and external perceptions and legal requirements. The appropriate criteria in this regard should be determined at the outset.

The Risk Management may involve a number of elements that may be interrelated and variable in nature and scope. A logical structure accounting for these aspects ensures that important risks are not overlooked.

Risk Identification

The purpose of this task is to identify all the relevant events that can occur whether or not they are under control of the organisation and whether or not they appear to be important. A well-structured systematic process is critical for this purpose.

Generic sources of risk and risk impact provide a systematic way in which it can be assured that all the risks are identified, particularly where the risks are numerous. Classes of risk that may be considered for this purpose include commerce, law, economics, human, nature, politics, technology, management and personal. Classes of risk-impact include in addition to the preceding, environment, finance, health and

safety, product professional and public liability, property damage and security. Other techniques that may be used to identify risks are flow charts, brainstorming, systems analysis, systems engineering techniques and scenario analysis.

The next step is to identify all the causes and the interrelationships between the causes. It is important that no significant causes are omitted. The causes mainly assist in determining the probabilities of occurrence of the events.

Risk Analysis

The sources of risk, the consequences of the risk and the relative frequencies of the consequences are considered in the risk analysis. The purpose of the risk analysis is to evaluate and rank the risks and to determine the treatment.

The consequences and their relative frequencies are combined to produce the level of risk and may be determined by statistical analysis and calculation or by subjective estimate where no past information is available. Sources of information may include records, relevant experience, industry practice and experience, published literature, market intelligence, experiments and prototypes, models and qualified judgment. Techniques that may be applied to obtain information include structured interviews, multi-disciplinary workshops, questionnaires, numerical simulation and fault and event trees. Wherever possible, the confidence that may be placed on the estimates of levels of risk should be recorded.

Any one of three types of risk analysis may be considered. These are qualitative, semi-quantitative and quantitative in rising order of complexity and cost.

- Qualitative risk analysis is used to identify risks that need more detailed consideration or where a higher level of analysis is not justified for the purpose required or for the quality of data available. The magnitude and likelihood of potential consequences are defined in terms of descriptive or qualitative scales in this type of analysis.
- In semi-quantitative analysis, numerical values are assigned to the preceding qualitative scales to produce a more detailed prioritization of the risks.
- In quantitative analysis, likelihood is expressed as probability or relative frequency and consequence in terms of monetary, technical, human or other suitable measures of severity. Sensitivity tests of assumptions and data are useful in quantitative risk analysis, because some of the estimates may be imprecise.

Risk Evaluation

The risk that results from the analysis is evaluated by comparison with established criteria. Qualitatively determined risks should be compared with qualitative criteria and quantitatively determined risks, with quantitative criteria. Risk and gain are two sides of the same coin. The level of risk that is accepted is determined by the magnitude of the associated gain and the risk avidness or the risk aversion of the decision maker. Gain can either represent reduction in liability or increase in asset. If more than one party has an interest in the outcome, the various views on the acceptability of the risk need to be considered. If the resulting risk is low it may be accepted with minimal treatment and monitored periodically to ensure that it remains low. If it is not low, treatment should be considered as discussed below.

Risk Appetite

The extent to which evaluated risks require treatment will be determined by the willingness of the consultant or other parties involved to accept risk. An organisation's willingness to accept risk, or appetite for risk, will depend largely on what it stands to gain if the risk does not materialise, and its ability to absorb the consequences if it does. The possibility of lasting or strategic gains may increase the appetite for risk whereas the possibility of reputational damage or financial ruin will decrease it.

Risk Treatment

Risk treatment consists of identifying, assessing, selecting, planning and implementing one or more treatments. Possible treatment options include avoidance of the risk by not engaging in the activity that causes the hazard, reducing the likelihood of occurrence of the hazard, reducing the consequences, transferring the risk or retaining the residual risk that remains after partial remediation. Assessing the risk involves comparison of the costs of implementing the options with the associated benefits. The option with an optimum balance between risk and net gain is the one selected. If no one option is clearly superior, the analysis may be repeated on the basis of more accurate procedures and data.

Preparing Treatment Plan

The treatment plan should identify responsibilities, implementation milestones, expected outcome, budgets, performance measures and the review process to be set in place.

Implementing Treatment Plan

The successful implementation of the treatment plan requires an effective management system in which the methods chosen are specified and the responsibilities and accountabilities assigned and monitored against specified criteria.

Monitoring and Review

To ensure that changes in risk are noted, it is necessary to monitor the risks, the effectiveness of the risk treatment plan and the effectiveness of the strategies and management system required to control treatment implementation.

Communication and Consultation

Communication and consultation are important considerations at each step of the Risk Management process to ensure that those responsible for the Risk Management and those with a vested interest, understand the basis on which decisions are made.

Communication should take place at all levels within the organisation to create an awareness of the most important risks to which the organisation is exposed, the need

for risk management and the procedures available to manage risk. Risk and quality management should form an integral part of the induction process of all members of staff.

Documentation

Each stage of the Risk Management process should be documented to demonstrate that the process is conducted properly, provide proof that a systematic approach is followed, provide a record of the risks, provide decision makers with a record of the plan, provide a mechanism for accountability, facilitate on-going monitoring and review, provide an audit trail and communicate information.

7.2 Appendix 2 - House Rules to Pre-empt Practice Risks

The aspects that you should keep in mind for day-to-day management of the risks to your business may be summarised as follows from the FIDIC Risk Management Manual, 1997.

Close scrutiny of these house rules will show that they broadly fall into two categories, namely, those to pre-empt and minimize the risks and those to assure the quality of your business. The fact that some of these rules are aimed at quality should not unduly concern you in view thereof that risk and quality management are different sides of the same coin and in simple Risk Management approaches will tend to appear together.

1. Professionalism

- 1.1. Protect public health, safety and welfare
- 1.2. Uphold standards of the profession
- 1.3. Master business skills and maintain technical competency
- 1.4. Attend to the non-technical aspects of your business
- 1.5. Promote trust between Clients, Professional Advisors, Contractors and own staff
- 1.6. Promote public knowledge of the profession
- 1.7. Follow rules of conduct and codes of ethics of the various professional bodies
- 1.8. Implement the relevant CESA Practice Notes on professional standards and procedures given in Appendix 11.

2. Communication

- 2.1. Avoid breakdown in communication between parties to the construction process
- 2.2. Prepare written communication with the recipient in mind
- 2.3. Avoid extreme words, words of promise, ambiguous words and jargon
- 2.4. All correspondence must be reviewed by a senior staff member
- 2.5. Do not rely on memory, but maintain clear and accurate records
- 2.6. Keep close contact with Clients
- 2.7. Keep lines of communication open and handle problems as they arise
- 2.8. Document and date all relevant discussion and communication
- 2.9. Implement the relevant CESA Practice Notes on professional standards and procedures, refer to Appendix 11.

3. Avoiding and Managing Disputes

- 3.1. Anticipate and avoid potential problems
- 3.2. Value long-term relationships with parties to the construction process
- 3.3. Consider entering into partnerships with Clients or Sub-Contractors to promote quality, productivity and loyalty
- 3.4. Consider project partnering to reduce claims, cost and schedule overruns
- 3.5. Prepare mechanisms to report, address and resolve disputes
- 3.6. Establish in-house crisis management procedures
- 3.7. Avoid claims and settle disputes as quickly as possible at the job site
- 3.8. Consider establishing a dispute review board at the start of a project
- 3.9. Consider making concessions to resolve disputes to everyone's benefit
- 3.10. Avoid litigation and rely on alternative dispute resolution methods
- 3.11. Implement the relevant CESA Practice Notes on professional standards and procedures, refer to Appendix 11.

4. Business Practices

- 4.1. Attend as much to the business of your practice as to its technical excellence
- 4.2. Acquire ability to identify and manage all potential project risks
- 4.3. Assess and allocate risks to the party (or parties) who can best manage/mitigate the various project risks at the outset
- 4.4. Ensure that the party to whom the risk is allocated is able to fund it
- 4.5. Evaluate the risks that various clients pose to your business at the outset
- 4.6. Insist on fair recompense for services rendered (fair recompense includes an element of staff training and supervision as well as research and development in addition to profit)
- 4.7. Adopt qualifications-based-selection for procurement of design
- 4.8. Ensure that your practice has the capability to provide the services tendered for
- 4.9. Prepare an accurate scope of services with the Client at the outset
- 4.10. Make specific provision that the Consulting Engineer will act as the Client's agent in respect of the Construction Regulations as a separate service and will be separately remunerated. The Client remains ultimately responsible for the implementation and adherence to the regulations
- 4.11. Prepare a succinct, fair and reasonably protective contract for the services offered
- 4.12. Limit obligations to the provision of service using reasonable skill, care and diligence
- 4.13. Include a limitation of liability clause in every contract for services except where this is prohibited by statute
- 4.14. Never contract to any requirement for which you are covered by your PI policy
- 4.15. Contract out of your PI policy exclusions
- 4.16. Stipulate clearly conditions of payment and remedies for non-payment in the services contract
- 4.17. Prepare and maintain realistic work programs
- 4.18. Clearly indicate the purpose, limitations and assumptions on which cost and time estimates are based
- 4.19. Ensure that both Prime and Sub-Consultants carefully evaluate each other before entering into a contract
- 4.20. Carefully select Joint Venture Partners for their professional integrity and financial soundness

- 4.21. Ensure that Joint Venture Agreements are signed where applicable. Such Joint Venture agreements should not conflict with but complement the main services agreement
- 4.22. Select, train and retain good quality personnel
- 4.23. Maintain adequate resources to support commitments
- 4.24. Carefully manage entrepreneurial and/or opportunity risks that the practice engages in to ensure that its resources are not unduly jeopardized
- 4.25. Implement the relevant CESA Practice Notes on professional standards and procedures, refer to Appendix 11.

5. Technical Procedures

- 5.1. Commit to quality at every level of your practice. Do the job right the first time
- 5.2. Provide safety nets to ensure that mistakes are caught and corrected in good time
- 5.3. Do not make decisions that the Client should make, only provide him with the information to do so
- 5.4. Document all design and recommendations that you and others may make
- 5.5. Ensure that designs are reviewed and documented at the appropriate stages of the project
- 5.6. Give special attention to the materials and products specified
- 5.7. Ensure that the Client understands that oversights and errors will occur and will be addressed jointly
- 5.8. Specify mechanisms whereby discovered oversights and errors will be addressed, especially under adversarial conditions
- 5.9. Have in place a procedure for responding to requests for clarification from tenderers
- 5.10. Include construction phase services including construction monitoring in primary scope of services
- 5.11. Ensure that site supervision is performed by qualified and experienced staff. Appropriate monitoring checklists should be used during each site visit and copies must be signed and filed
- 5.12. Have in place schedules and procedures that the Contractor and Consultant are required to follow on construction to give effect to the Consultants obligations
- 5.13. Ensure that the Contractor understands that the Consulting Engineer is only appointed as agent on behalf of the Client in respect of the Construction Regulations
- 5.14. Allow adequate time for testing and commissioning of all project services before occupancy
- 5.15. Maintain an interest in the project and contact with the Client after completion
- 5.16. Implement the relevant CESA Practice Notes on professional standards and procedures, refer to Appendix 11.

6. Professional Liability Insurance

- 6.1. General practitioners are not required to know everything about professional liability insurance, but must approach knowledgeable institutions for assistance on professional liability insurance
- 6.2. Apart from relying on expert insurance brokers for advice, Consulting Engineers should still inform themselves on the following aspects:
 - 6.2.1. Find out how professional liability insurance works
 - 6.2.2. Understand basic concepts of professional liability insurance and review your own policy document

- 6.2.3. Understand the extent and limitation of coverage provided
- 6.2.4. Understand the policy exclusions
- 6.2.5. Note the factors that determine the price of professional liability insurance
- 6.3. Ensure that the policy is in force retroactively when the services were rendered and is still in force when the actual claim is made
- 6.4. Notify the insurer immediately a claim is made against the practice or when circumstances may lead to a claim being made
- 6.5. Consider specific project insurance to reduce risks all round as well as potential disputes
- 6.6. Arrange separate insurance cover to meet statutory requirements and business and personal risks
- 6.7. Disclose to the professional indemnity insurer that the practice is appointed as agent of the Client in respect of the Construction Regulations
- 6.8. Ensure that your company's PI policy covers past and present individual principals and staff
- 6.9. If an engineering company ceases to exist, ensure that run-off cover is maintained
- 6.10. Implement the relevant CESA Practice Notes on professional standards and procedures, refer to Appendix 11.

7. Fiscal and Corporate Liability

A professional practice, irrespective of whether it is constituted as a partnership, close corporation or company, has a legal obligation to comply with a series of Acts and associated Regulations. The following as amended are the most important of these in the South African context.

- 7.1. Basic Conditions of Employment Act, 1997
- 7.2. Skills Development Act, 1998
- 7.3. Broad-Based Black Economic Empowerment Act, 2003
- 7.4. Preferential Procurement Policy Framework Act, 2000
- 7.5. Employment Equity Act, 1998
- 7.6. The King Commission Report on Corporate Governance
- 7.7. Occupational Health and Safety Act, 1993
- 7.8. Construction Regulations to the OHS Act, 2003
- 7.9. Mine Health and Safety Act, 1996
- 7.10. National Environmental Management Act
- 7.11. Companies Act, 2008
- 7.12. Close Corporations Act, 1981
- 7.13. Income Tax Act, 1962
- 7.14. Value Added Tax Act, 1991
- 7.15. Engineering Profession Act, 2000

It is impossible for professional practices to have intimate knowledge of all these Acts and it is very important to seek professional advice on these matters.

7.3 Appendix 3 - Methods of Risk Identification

A wide range of risk identification methods is available, many of which are similar to one another with subtle variations. The most commonly used methods are described in principle below, Stone & Webster Engineering Corporation (1991).

Safety Review (SR)

A safety review is an inspection-based technique, which identifies design characteristics, operating and maintenance procedures that may be hazardous and equipment and process changes that may require review. It involves physical inspection of the plant and interviews with the personnel.

Checklist Analysis (CA)

Checklist Analysis is used to identify known hazards, design deficiencies and potential accident situations associated with usual equipment, materials, procedures and operations. Checklist analysis is most commonly used when a significant body of experience and knowledge on the subject is available.

Relative Ranking (RR)

The attributes of hazardous chemicals or process conditions associated with operations or facilities are ranked for comparative purposes in this analysis. This enables areas or operations that are exposed to particularly severe consequences or particularly high-risk probabilities to be identified.

Preliminary Hazard Analysis (PHA)

Preliminary Hazard Analysis is usually employed at conceptual design stage when hazards can be corrected at minimum cost. It also assists in identifying operating guidelines or approaches that can be used during the life of the project.

What-If Analysis (WI)

What-if analysis is a creative brainstorming technique that utilizes what-if questions to identify hazards and consequences of concern with regard to any aspect of a design or operation. It is highly dependent on the experience and knowledge of the study team.

What-if/Checklist Analysis (WI/CA)

What-if/checklist-analysis combines the brainstorming ability of the what-if method with the experience base of checklist-analysis. It is applicable to any type or any stage of a process or activity, but is not as systematic as HAZOP or FMEA methods presented below.

Hazard and Operability Study (HAZOP)

Hazard and Operability Studies are systematic exercises aimed at identifying potential hazards and operating problems. A multi-disciplinary team methodically brainstorms the facility to identify design deviations. HAZOP is a powerful technique that requires considerable investment and manpower. The outcome comprises the identified design-deviations and the causes, consequences, safeguards and corrective actions therefor.

Critical Task Analysis (CTA)

Critical Task Analysis is a technique that systematically analyses the work in terms of safety, quality and efficiency by involving the personnel who actually does the work. The purpose of a critical task analysis is to determine procedures and practices required to obviate an unduly high job risk. It is also used to identify critical tasks in a multi-task process.

Failure Modes and Effects Analysis (FEMA)

Failure Modes and Effects Analysis is a systematic method of examining the modes and effects of failure of equipment and systems. It is an inductive method that concentrates on the individual components of a system and identifies improvements in system design. The two disadvantages of the analysis are that it does not address human shortcomings or the relationship of the system or component under consideration with other systems or components.

Failure Modes Effects and Criticality Analysis (FMECA)

An FMEA becomes a Failure Mode Effects and Criticality Analysis if criticalities or priorities are assigned to the effects of the failure modes. The purpose of an FMECA is to classify the potential failure modes in terms of severity and probability of occurrence.

Fault Tree Analysis (FTA)

Fault Tree Analysis accounts for the combinations and relationships between equipment failures, human shortcomings and environmental factors that surround a potential accident scenario. It is a deductive method. An undesirable top event is postulated and the underlying causal events traced backward until the root causes are determined or until the probabilities of the causes can be determined with confidence. Fault tree analysis can be performed by individuals or in facilitated workshops and lends itself to spreadsheet calculation. It can be carried out in terms of calculated or subjectively assigned probabilities.

Event Tree Analysis (ETA)

Event Tree Analysis enables the consequences of potential hazards of any kind to be systematically evaluated in all of their ramified detail. It is an inductive method in which the adverse effect of a postulated event on personnel, equipment, systems or processes is evaluated in terms of severity and probability of occurrence. Event tree

analysis can be performed by individuals or in facilitated workshops and lends itself to spreadsheet calculation. It can be carried out in terms of calculated or subjectively assigned probabilities.

Cause Consequence Analysis (CCA)

Cause Consequence Analysis combines the inductive and deductive reasoning of event tree analysis and fault tree analysis to establish the relationship between accident sequences and basic causes.

Human Reliability Analysis (HRA)

Human shortcomings can be addressed in most of the hazard evaluation methods presented above. However, when the interaction between man and machine is complex, specialized methods such as Human Reliability Analysis are required.

7.4 Appendix 4 - Selection of Risk Identification Method

Selection of the most appropriate risk identification method is one of the critical steps to ensuring the success of a particular risk evaluation study. There is a wide range of issues that affect the selection of the method for any particular risk study. These may include one or more of the following:

1. Motivation for doing the study
2. Type of results that are required
3. Type and quality of information that is available to the study
4. Characteristics of the problem
5. Perceived risk associated with the problem
6. Availability of resource
7. Preference of study leader or management.

The selection should primarily be based on the motivation for the study and on the type of results required. Other factors may contribute to the decision, but should not dictate the selection. The comprehensiveness and cost of the study should mirror the importance of the risk.

7.5 Appendix 5 - Basic Probability Concepts

Cause and Effect

All phenomena are governed by the axiom of causality, which simply means that a phenomenon cannot take place without a cause. It also means that a phenomenon is the consequence of a cause. Phenomena are determined by the sequence of preceding causes. The words consequence, effect and event mean the same and are used interchangeably in this guideline.

Causes that are subject to uncertainty in turn underlie the uncertainties in the resulting effects. Risk Management is aimed at reducing uncertainty in events that are yet to take place and decision making at predicting uncertainty in such events for the purpose of informing the decision.

Uncertainty and Variability

Variability represents diversity in a population that cannot be reduced by additional measurement. Uncertainty represents partial ignorance or the lack of perfect knowledge that may be reduced by further measurement. It is necessary in some statistical analyses to distinguish between uncertainty and variability. However, this distinction is not necessary for the purposes in this guideline in which the terms uncertainty and variability are used interchangeably.

Faults and Events and Fault and Event Trees

The ultimate consequence of which the underlying causes are required to be identified and evaluated, is referred to as the "Top Event" and the underlying causes that represent the trunks and branches of an upside down tree, as a "Cause Tree". The tree is referred to as a "Fault Tree" when probabilities are assigned to the causes. The terms Cause Tree and Fault Tree are used interchangeably in this guideline. Different levels for a Fault Tree for Enterprise Risks are given in Appendices 8 and 9.

The Top Event represents the risk of which the potentially detrimental consequences are referred to as "Events". Several sequentially successive events may be analysed in the form of the branches of a right way up tree that is referred to as an "Event Tree". The Event Tree includes the probabilities of the consequences at successive stages as well as the associated degrees of severity. Event Trees are also referred to as Decision Trees. A typical Event Tree is presented in Appendix 10.

Dependent and Independent Causes

The causes in a Fault Tree may be dependent or independent of each other.

Causes that are required to occur at the same time to give effect to a particular risk are said to be dependent. The probability of the particular risk is given by the product of the probabilities of the underlying dependent causes. For example,

$$P = P_1 P_2 P_3 P_4 \dots P_N, \text{ for } N \text{ number dependent causes} \\ [1]$$

Causes of which the occurrence gives rise to a particular risk irrespective of the occurrence of other causes are said to be independent. The probability of the particular risk is given by the sum of the probabilities of the underlying independent causes less the products of the probabilities of all combinations of the underlying independent causes. For example,

$$P = P_1 + P_2 + P_3 - P_1 P_2 - P_2 P_3 - P_3 P_1$$

$$P = 1 - (1 - P_1)(1 - P_2) \dots (1 - P_N), \text{ for } N \text{ number independent causes} \\ [2]$$

Fault Tree Gates

The relationship between dependent causes in a Fault Tree is represented by an **AND** gate and that between independent causes, by an **OR** gate. Most of the causes in the Fault Tree for the risks in Engineering Consultancies are related to each other by these two types of gate.

Risk

Risk is equal to the product of the probability of an event and the severity of the impact if the event were to occur. Risk is also loosely used in this guideline to signify a hazard or a threat.

Lifetime Probability

Lifetime probability denotes the unit number of times that an event may occur in 70 years.

Advanced Probability Concepts

The mathematical concepts of probability that underlie Risk Management are part of Boolean Algebra, a special branch of mathematics. The mathematical treatment of probability is complex and not within the scope of this guideline in which the objective is to introduce Risk Management on a self-help basis to a broad spectrum of consulting engineers for everyday use.

7.6 Appendix 6 - Primary Enterprise Risk Evaluation Process

Introductory Observations

The objective of the Primary Enterprise Risk Evaluation process is to identify the primary risks and qualitatively evaluate their potential effect on the sustainability of your business. The number of risks considered is limited to ensure that the task remains manageable whilst you are learning the basics of Risk Management and developing the skills to apply these to your business.

You should at the outset identify a small group of participants to carry out the proposed Primary Enterprise Risk Evaluation. Risk identification is best carried out in face-to-face workshops with a number of participants that are representative of all stakeholders and all levels of staff involved in the aspect considered. Persons that have a related interest should be included and possibly also competitors and clients. The workshops should be planned and completed without unnecessary delay. A designated person should assume responsibility for the Primary Risk Evaluation.

Definition of Risks

Risks are “uncertain events” that have both a cause and an effect. Differentiate risks from facts by using the “cause-risk-effect” format to name the risks. A genuine risk may be defined as one that has a “definitive cause” and that leads to a clearly “identified effect”.

Many risks are not real risks, but causes of other yet unidentified risks. Always look for the root cause. Ensure that the effect is clearly identified and observe that effects can be more than just time and cost, e.g., reputation, injury and damage.

Although you are not dealing with Fault Trees yet, it should be observed that primary risks are at the root, that is, lowest levels of the relevant fault trees. Also, that the effects of primary risks can be at any higher level in the relevant Fault Trees.

Opportunities are the positive opposites of threats and should like threats be identified. Both threats and opportunities are uncertain events.

Capturing Primary Risks

Primary risks may be captured in the proposed workshops on sticky notes, flip charts or standardized forms. Sticky notes and flip charts are useful in workshops on risk identification and are essentially similar in that they allow for group thought and interaction, encourage and stimulate the participants to think out-of-the-box, allow for in-depth analysis of risk and allow for unlimited pursuit of all possible risks. Sticky notes and flip charts may take more time and may have to rely on participation from fewer people than standardized forms, but the overall benefits far outweigh the drawbacks.

The biggest disadvantages of standardized forms are that they do not ensure ownership of the Primary Risk Analysis and therefore do not enjoy the concerted input into the identification of risks that is essential. Another major disadvantage of standardized forms is that you are not able to instruct the members of your

organization in the principles, methods and procedures of Risk Management in the same way that you are able to do when you use sticky notes or flip charts. Checklists are a particular variation of standardized forms to identify risks, but in addition to the above disadvantages, hamstringing the process in an undesirable way.

Flip charts have some major advantages over sticky notes. You can display flip charts against the walls of the room as the process progresses and you can continue to add notes to earlier completed flip charts as the process unfolds and out-of-the-box thinking comes to the fore and new ideas rise to the surface. In this way do you have the benefit of the versatility that sticky notes may offer. Flip charts can be rapidly captured in type script and rendered in any desirable digital format for subsequent manipulation and arrangement.

Group participation in the identification of the primary risks facilitates subsequent evaluation of the probabilities and impacts of the risks.

Identification of Risks

The primary risks may be identified in the categories of your business presented in Section 4.1. This will systematically structure subsequent management of the risks. Although you are not yet involved in Fault Tree Analysis, you may find that the Fault Tree in Appendix 9 is a useful prompt on aspects that you may want to consider as primary risks. The structure of the Fault Tree may also be a useful example to follow in Advanced Risk Management if you were to proceed that far.

You may find that reviews of past risks, brainstorming of yet unidentified risks and “pre-mortems” encourage new ideas and may be useful stimuli to identify the primary risks in the proposed group workshops. Other tools such as Affinity diagrams, the Delphi technique and SWOT analyses, expert interviews, cause and effect diagrams and failure modes and effects analyses are also available to assist you in identifying the primary risks, but generally are not required in risk identification workshops.

You should limit the number of primary risks to the key aspects of concern in your business and should aim not to exceed about 30 risks in total otherwise the task may become overwhelming. Of the 30 primary risks you will probably only take action on 5 as first objective.

Output of Risk Identification

The output of the risks identified may be presented in a Risk Register as shown in Table 1. Capture all the relevant information including potential owners of risks, potential triggers of risks and potential risk response strategies.

Evaluate Identified Risks

The next step is to qualitatively evaluate, that is, subjectively measure, the probability and impact of each risk identified with the view to determining the most threatening ones.

Knowing when and how often a risk may occur during a process or the life cycle of a project will help to determine its impact and your response to it. Risks that could occur later in the process or the project should be rated higher, because their impacts would be greater. Risks that could impact an important stage of a process or a project should be rated higher than ones that could affect less important activities. Risks that may occur more than once may need the same response every time or a unique response for each occurrence.

The validity of assumptions that were made when the risks were determined is important and should be reviewed, because invalid assumptions may increase the probability and the impact of the risks.

The amount and reliability of data on the risks are important and should likewise be reviewed, since insufficient and unreliable data may again increase the probability and the impact of the risks.

Once you are sure that you have enough information about all the identified risks, you may determine the probability and impact for each risk. Probability is the likelihood that a risk will occur and impact denotes the effect that the risk will have on the process or the project if it occurs. Impact encompasses all possible impacts.

Respectively assess the probability and impact of the risks in terms of the significance scales in Tables 2 and 3. These scales are proposed guidelines and may be changed to suit your own circumstances. The scales in Table 3 in particular may not cover all the risk categories that you may have to deal with, but will assist you in developing scales along similar lines to suit your own requirements.

Rating	Adjectival Score	Anecdotal Frequency	Probability	Lifetime Probability
8	Certain (i.e. Fact)	Once/Year	1/1	70
7	Very High	Once/10 Years	1/10	7
6	High	Once/100 Years	1/100	0.7
5	Moderate	Once/1000 Years	1/1 000	0.07
4	Low	Once/10 000 Years	1/10 000	0.007
3	Very Low	Once/100 000 Years	1/100 000	0.000 7
2	Extremely Low	Once/1 000 000 Years	1/1000 000	0.000 07
1	Practically Zero	Once/10 000 000	1/10 000	0.000 007

		Years	000	
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The workshop participants are unlikely to agree at first on their individual assessments of probability and impact. However, with some practice they will soon learn how to quickly reach consensus on large numbers of risks observing that the exercise is not about decimal point accuracy, but sieving out the most severe threats.

Remember that the scales in Tables 2 and 3 do not represent tolerable levels, but the probability in your view that the risk will occur and the impact again in your view that it will have when it occurs.

Risk Ranking

Rank the risks by multiplying the ratings for probability and impact for each risk as shown in the matrix in Table 4.

Decide on a risk ranking above which you will remediate the risks. These will fall in the top right hand corner of the matrix. The cut-off ranking will to a certain extent be determined by the number of risks that need to be remediated or that you may wish to deal with.

The average risk ranking for a particular project may be determined as the sum of the risk rankings for each risk that exceeds the cut-off ranking divided by the number of such risks. This will enable different projects to be compared with each other and a decision to be taken on which risks in which of the projects will be remedied together with the cost of such exercise.

Average risk rankings for projects will also enable you to monitor the efficiency with which you are addressing the risks in your practice. Average risk rankings will also enable you to decide whether you should be taking on projects that may seem to be unduly risky and if you do, what aspects of such projects should be given particular attention from the outset.

In addition to average risk rankings, you should also be aware of the number of risks in a project that lie close to the cut-off ranking, but just below it. A relatively large number of such lower ranked risks can also signify a potentially risky project.

You may find that a particular activity is the most risky in a large number of your projects. You may alternatively find that an activity with a relatively lower risk ranking occurs in almost all your projects. Such trends should be identified and addressed as the overall most cost effective contributions to managing risks in your practice.

An activity that lies on the critical path of a project should be given special attention even if the risk ranking for the activity appears not to be too high, because it will have a wide ranging effect if it were to materialize.

The cause-risk-effect format adopted in Stepping-Stone Enterprise Risk Management effectively examines particular nodes in the relevant overall Fault Tree. As such, every activity examined in principle has predecessor and successor activities. An activity with two or more predecessor activities might have more risk than is apparent if you look at that activity in isolation.

Implement Stepping-Stone Enterprise Risk Management

The steps to implement Stepping-Stone Enterprise Risk Management involve the following:

1. Commit to an on-going qualitative Risk Management process
2. Familiarize yourself with the methods available for identifying risks, Appendix 3
3. Familiarize yourself with the criteria for selecting a method for identifying the risks, Appendix 4
4. Familiarize yourself with the Primary Enterprise Risk Evaluation process in this appendix
5. Designate a particular person with a vested interest to assume responsibility for the Primary Enterprise Risk Evaluation
6. Undertake a Primary Enterprise Risk Evaluation of your business
 - 6.1. Enter every risk in the Risk Register in Table 1
 - 6.2. Complete the risk response planning as presented in Section 4
7. Implement the findings of the Primary Enterprise Risk Evaluation
 - 7.1. Arrange the risks in descending order of magnitude and identify the severest ones for attention in terms of the cut-off ranking
 - 7.2. Identify the risks requiring additional analysis and response review planning
 - 7.3. Do project comparative and critical risk analyses
 - 7.4. Analyse the risk activities for trends
8. Periodically update the Primary Enterprise Risk Evaluation
9. Implement the findings of the updated risk assessment
10. Undertake issue-based risk assessments as required and implement remedial actions
11. Determine whether to proceed to Advanced Enterprise Risk Management.

Rating	Impact Severity	Personal Health & Safety	Animal Health	Environmental Damage	Reduction Time/Cost Reserves	Financial Loss/Year (Rands)	Loss on NPV	System Loss, Down Time (Months)	Reputation	Legal
1	Nil	Not Affected	No Injury	Zero	Zero	Zero	Zero	Zero	No News	None
2	Insignificant	Severe Exhaustion	Minor Injury	Minor Inside Plant Boundaries	25%	Insignificant	< 5%	Minor Functional	-	-
3	Minimal	Minor Injury/1 st Aid Treatment	Moderate Injury	Major Inside Plant Boundaries	50%	Insignificant	5%	-	Local News	-
4	Minor	Moderate Injury /Medical Attention	Major Injury	Minor Outside Plant Boundaries	75%	1 –10 T	> 5%	0.1 – 0.5	-	Reportable Incident
5	Moderate	Serious Injury /Reduced Workday	Permanent Injury	Moderate Reversible Short Term Local	100%	10 –100 T	< 10%	-	Regional News	Legal Fines
6	Major	Multiple Injuries /Production Loss	Individual Deaths	Major Reversible Short Term Regional	115%	100 T –1 M	10%	0.5 – 2	-	Severe Legal Fines
7	Disruptive	1 Fatality	Multiple Deaths	Serious Reversible Long Term Regional	125%	1 –10 M	> 10%	-	National News	Punitive Legal Fines
8	Incapacitating	> 1 Fatality	Herd/Pride Deaths	Serious Reversible Long Term National	135%	10 –100 M	< 15%	2 – 6	-	Temporary Loss Operating Permit
9	Destructive	> 10 Fatalities	Regional Devastation	Very Serious Likely Irreversible National	145%	100 –500 M	15%	-	World News	Loss of Operating Permit
10	Catastrophic	> 100 Fatalities	Species Extinction	Catastrophic Irreversible National or Global	Project Fails	> 500 M	> 15%	Critical > 6	-	Major Business Interruption

Notes

T and M denote Thousand and Million respectively

Probability Ranking	Certain	8	8	16	24	32	40	48	56	64	72	80
	Very High	7	7	14	21	28	35	42	49	56	63	70
	High	6	6	12	18	24	30	36	42	48	54	60
	Moderate	5	5	10	15	20	25	30	35	40	45	50
	Low	4	4	8	12	16	20	24	28	32	36	40
	Very Low	3	3	6	9	12	15	18	21	24	27	30
	Extremely Low	2	2	4	6	8	10	12	14	16	18	20
	Practically Zero	1	1	2	3	4	5	6	7	8	9	10
		1	2	3	4	5	6	7	8	9	10	
		Nil	Insignificant	Minimal	Minor	Moderate	Major	Disruptive	Incapacitatin	Destructive	Catastrophic	
		Severity of Impact Ranking										
Table 4: Risk Ranking Matrix												

7.7 Appendix 7 - Advanced Enterprise Risk Management Process

Introduction

It can be seen from the full Fault Tree for all the risks in your business in Appendix 9 that a comprehensive analysis of all the risks is very onerous. Advanced Enterprise Risk Management is only justified on projects, aspects and issues in your business that have particularly high priorities or that have very small margins for cost and schedule overruns.

The risks to which Engineering Consultancies are exposed are common to most practices irrespective of the particular branch of engineering or the size of the practice. This is major advantage in that once the full Fault Tree is developed, not much further effort is required to identify the risks in any particular practice. Different practices may select only those sections of the full Fault Tree that they wish to consider and only enter the probabilities and impacts for the risks that apply to their own circumstances.

A further advantage of the full Fault Tree is that it is a useful checklist of the risks that have been considered in other practices in that it has been developed with the input from a range of consultancies in South Africa. It is anticipated that the full Fault Tree will be improved further yet by continuing contributions from member firms.

Identification of Enterprise Risks

Fault Trees remain the most suitable method for identifying the risks in Engineering Consultancies. The overall context of the various categories of risk that you may have to deal with in your practice is illustrated in the high-level Fault Tree in Appendix 8 whilst the comprehensive exposition of all the risks in your business is presented in Appendix 9.

The text format of the Fault Trees in Appendices 8 and 9 enables you to consider very large numbers of risks in relatively little space. It also enables you to transport the Fault Trees into Excel spreadsheets in which subsequent columns can be used to examine the sensitivity of the risk to variations in the assigned probabilities as illustrated in the examples below.

Decision Making

A sequence of successive consequences may emanate from the Top Event that may be arranged in increasing or decreasing severity in a Decision Tree as shown for example in Appendix 10. Every branch in the tree requires that you decide whether an event can or cannot occur at given probabilities. The probabilities for the two subsequent events are complimentary, that is, if the probability that the event can occur is denoted by p , the probability that it cannot occur is given by $(1-p)$. The product of the probability that the event can occur and the impact that it would have if it did occur denotes the concomitant risk and signifies the end point of the Decision Tree along that branch. The other branch may give rise to the next bifurcation and so on until all the subsequent branches have reached terminal points.

Quantitatively Evaluate Probabilities

The probability of a risk may be taken from the last column in Table 2 in Appendix 6 based on your sense of the imminence of the risk in terms of the adjectival score and anecdotal frequency referred to in the table. You may be assisted in this process by considering the frequency at which the particular risk has occurred in the past or the remoteness at which it may be expected to occur in the future. You may alternatively be able to rigorously calculate the probability if you have sufficient underlying data. On occasion people are able to estimate the probabilities of different risks, but don't realize that the risks lie at different levels in the Fault Tree and are, as a result, related. This enables a very useful control check on the accuracies of the risks via the progressive gates in the tree.

You should not take fright at the small numbers for the low probabilities in Table 2. A probability of 1 in a 1000 is not that small and indeed represents very attractive betting odds. Cars that are worth R1.0 million are on occasion raffled at R1200 per ticket subject to the condition that the number of tickets is limited to 1000. The attractiveness of this situation illustrates that a likelihood of 1 in 1000 is not beyond the comprehension of the average person. 1 in 1 million is not that remote either and is in any event the level of risk that people are prepared to and comfortable with to expose themselves in everyday situations.

It is essential that you adopt the probabilities in Table 2, Appendix 6, for yet another, perhaps more important, reason. The outcome of your risk assessments very often is the basis for project, asset and medical insurance proposals or applications for project finance. The probabilities in Table 2 are based on value scales that the Actuaries who may adjudge your proposals and applications are used to in the Financial Service Sector. Larger probabilities that you as Engineer may be more

comfortable with may signify unduly high risks to the Actuaries who will forthwith reject your proposals and applications.

The above notes enable you to determine single values for the probabilities. Yet for most risks the probabilities are uncertain and vary over a continuous range. Ample reference is available in the literature on dealing with distributions of probabilities instead of single values.

Quantitatively Evaluate Impacts

The impact of a risk may be taken from the quantitative entries in Table 3 in Appendix 6, or from values that you may determine for your particular circumstances. You may alternatively calculate the actual value of the impact based on information that you may have. Injury statistics including the numbers of injuries and the medical and insurance costs involved may be used in respect of personal health and safety in respect of construction sites and mines.

Tolerable Thresholds for Enterprise Risks

Although it may often not be explicitly stated, the probability of failure for which an engineering system or facility is designed denotes the unit number of times that the system or facility may fail during the life of the system or facility. 70 years is a representative length of time for the lifespan of man and the period for which systems or facilities are designed. Lifetime probability of failure therefore denotes the unit number of times that a system or facility may fail during 70 years and should not exceed a tolerable threshold based on the same period of time.

Tolerable risk criteria for loss of life may accordingly be presented after Whitman (1984) as shown in Figure 7-1 in terms of lifetime probability and potential number of lives lost. The ordinate axis may alternatively represent a relative lapse in time as shown based on Table 2, Appendix 6, as an aid to the meaning of the very small values for lifetime probability shown.

Tolerable risk criteria for total loss of property may be presented after Cole (1993) as shown in Figure 7-2 in terms of lifetime probability and the potential dollar value of property lost. The ordinate axis may alternatively represent a relative lapse in time as shown based on Table 2, Appendix 6.

Tolerable risk criteria for total loss of money may be presented after Cole (1993) as shown in Figure 7-3 in terms of lifetime probability and potential money lost in dollars. The ordinate axis may alternatively represent a relative lapse in time as shown based on Table 2, Appendix 6.

It may again appear to you that the values for the tolerable lifetime probabilities of total loss are very small and may be difficult to satisfy. You should not be unduly concerned, because the probability of total loss in principle represents the product of a number of dependent events that need to occur at the same time for the risk to arise.

If for example, the probability of the foundations of a railway bridge across a river failing under hydraulic action is 1%, the probability of the river being in flood is 1%, a train crossing the bridge at the time of failure is 1.7% and 100 people can potentially lose their lives on the train landing in the water, the overall probability of fatal injury amounts to $0.01 \times 0.01 \times 0.017 = 1.7 \times 10^{-6}$ compared to a tolerable threshold of 7×10^{-5}

from Figure 7-1. The acceptable threshold is about 40 times larger than the risk of fatal injury.

The probability of 1% for the foundations failing under hydraulic action is quite high, but represents a real situation for relatively old bridges. The probability of 1.7% for the train being on the bridge at the time of collapse is equivalent to one train crossing over the bridge every hour and taking 1 minute to do so.

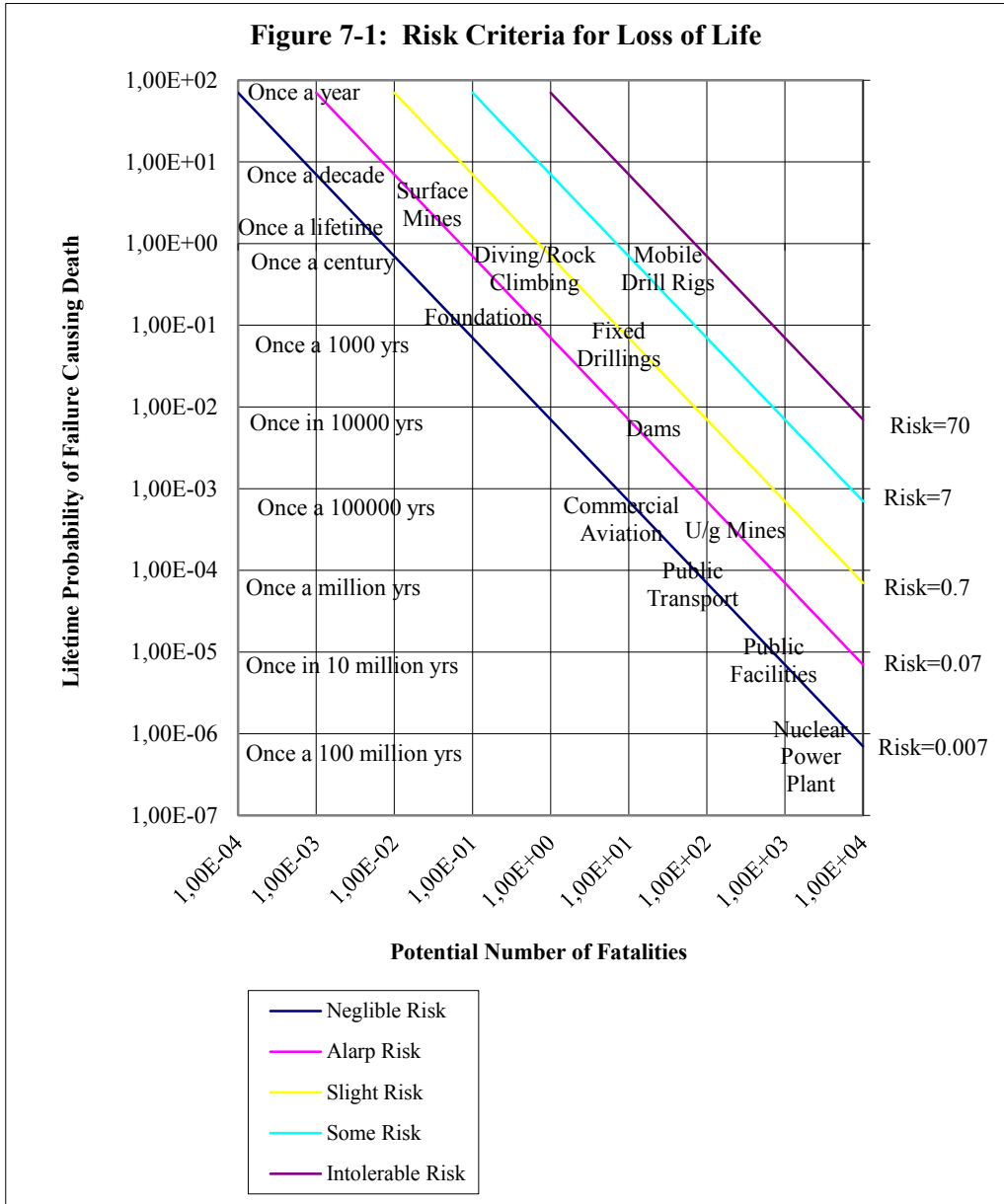
According to Cole (1993) one may increase the tolerable thresholds for total loss by a factor of 10 to obtain tolerable thresholds for partial loss and by a factor of 100 to obtain tolerable thresholds for inconvenience or nuisance.

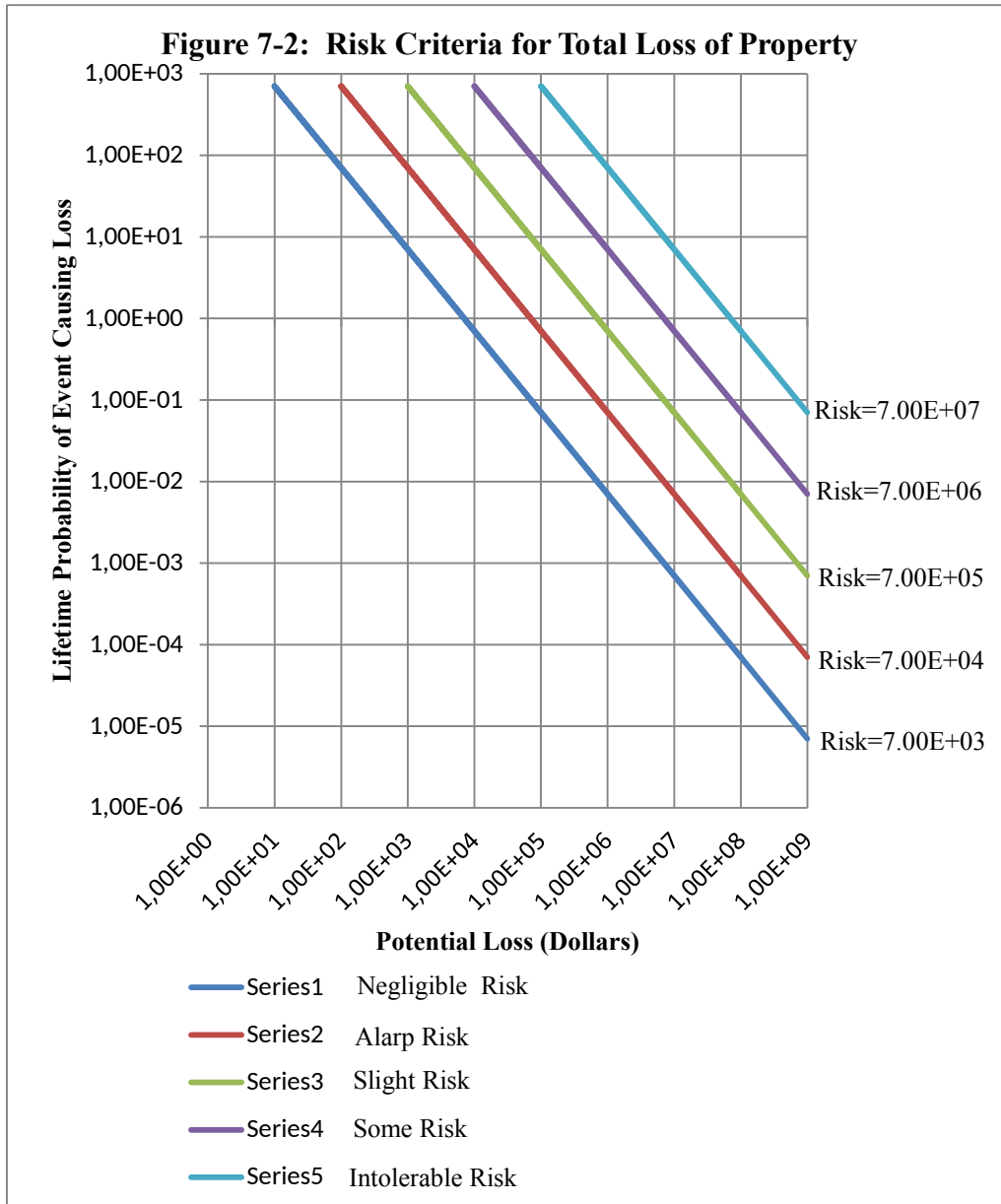
Implement Advanced Enterprise Risk Management

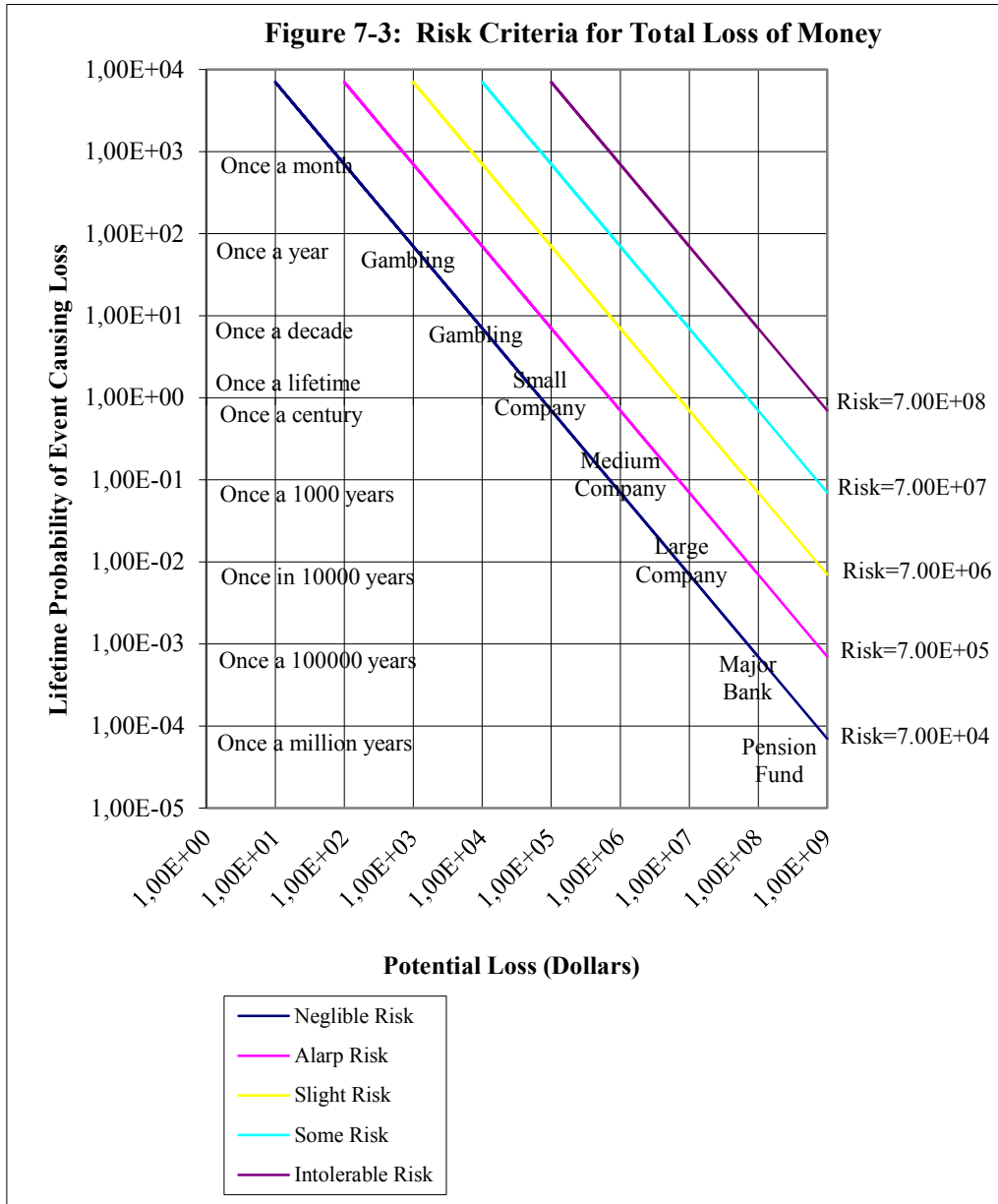
The steps to implement Advanced Enterprise Risk Management involve the following:

1. Determine whether Advanced Enterprise Risk Management is worth the time and effort for your business, projects or issues
2. Familiarize yourself with the Advanced Enterprise Risk Management process in this appendix
3. Undertake Advanced Enterprise Risk Management of projects, aspects or special issues
4. Designate a particular person with a vested interest to assume responsibility for the proposed Advanced Enterprise Risk Evaluation
5. Implement the findings of Advanced Enterprise Risk Management
 - 5.1. Determine the data on which the probabilities and impacts of the risks are based as accurately and objectively as practically possible
 - 5.2. Assess the effects of uncertainties in the values for the probabilities and impacts by evaluating the sensitivities of the risks to variations in the values
 - 5.3. Evaluate the tolerability of the risks of total, partial and inconvenient losses in terms of recognized quantitative thresholds presented above
 - 5.4. Determine the Expected Monetary Value, EMV, of the risk as the product of the probability and the impact
 - 5.5. Rank the risks in terms of EMV and select a threshold above which the risks will be addressed
 - 5.6. Alternatively, evaluate the differences in risk between projects based on their cumulative EMV's
 - 5.7. Determine whether a project can be completed within a given EMV, or what underlying risks need to be addressed to satisfy a given EMV
 - 5.8. Evaluate the risk and advisability of taking on a new project in terms of EMV
6. Periodically update Advanced Enterprise Risk Management

7. Implement findings of updated Advanced Enterprise Risk Management.







7.8 Appendix 8 - Fault Tree for High-Level Enterprise Risks

“**OR**” denotes independent causes in subsequent paragraphs of like indentation and “**AND**”, dependent causes in subsequent paragraphs of like indentation. These high-level Enterprise Risks are expanded in greater detail in Appendix 9.

Top Event – Business Not Successful

1. Professional Short Falls **OR**

- a. Completion of **Project 100** unsatisfactory **OR**
 - i. Pre-tender cost estimate & program of work inaccurate **OR**
 - ii. Overrun on cost of construction attributable to Consultant **OR**
 - iii. Delay in completion of construction attributable to Consultant **OR**
 - iv. Works function inefficiently/ineffectively **OR**
 - v. Works fail structurally **OR**
 - vi. Site health and safety not sufficiently assured **OR**
 - vii. Public security not sufficiently assured **OR**
 - viii. Public health & safety not sufficiently assured **OR**
 - ix. Environmental friendliness/acceptability of project contested **OR**
 - x. Dispute proceedings instituted on construction contract
- b. Completion of **Project 200** unsatisfactory **OR**
- c. **OR**
- d. **OR**
- e. Completion of **Project N** unsatisfactory

2. Business Operational Risks and Liabilities **OR**

- a. Contractual liabilities **OR**
 - i. Project appointment liabilities **OR**
 - ii. Project performance liabilities
- b. Statutory liabilities **OR**
 - i. Potential proceedings under OH&S Act **OR**
 - ii. Potential proceedings under Engineering Professions Act **OR**
 - iii. Potential proceedings under Preferential Procurement Policy Framework Act
 - iv. (other Acts)
- c. Delictual liabilities re injuries & damages to persons & property **OR**
 - i. Not acted as “reasonable person” **OR**
 - ii. Not acted with due care & diligence **OR**
 - iii. Not adhered to standards/regulations **OR**
 - iv. Not worked in terms of current state of the art **OR**
 - v. Careless trivial design decisions made
- d. Commercial liabilities **OR**
 - i. Insufficient spread of technical staff/middle age gap **OR**
 - ii. Sustainability of practice not planned **OR**
 - iii. Senior consultants priced out of market **OR**
 - iv. Lose specialisation due to inappropriate business model
- e. Public (“slip & fall”) liabilities **OR**
- f. Directors liabilities (individual responsibility re corporate structure) **OR**
- g. Employee liabilities **OR**
- h. Health & Safety liabilities

3. Financial Shortcomings OR

- a. Corporate liabilities OR
 - i. Business capitalisation inadequate OR
 - ii. Financial management inadequate
- b. Trading shortfalls
 - i. Income in general short OR
 - ii. Income on **Project 100** short OR
 - iii.OR
 - iv.OR
 - v. Income on **Project N** short
 - vi. Costs in general long
 - vii. PI insurance costs on **Project 100** (Sub-Tree 3.b.ix.) long OR
 - viii.OR
 - ix.OR
 - x. PI insurance costs on **Project N** (Sub-Tree 3.b.ix.) long OR
 - xi. Business operational liability costs long

4. Administrative Shortcomings

- a. Production management poor OR
- b. Financial management poor OR
- c. Administrative support poor OR
- d. Computer support poor OR
- e. Communications support poor OR
- f. Document production support poor OR
- g. Data storage system poor OR
- h. Staff care poor

7.9 Appendix 9 - Fault Tree for Practice Risks All Inclusive

“OR” denotes independent causes in subsequent paragraphs of like indentation and “AND”, dependent causes in subsequent paragraphs of like indentation.

Top Event – Business Not Successful

1. Professional Short Falls OR

- a. Completion of **Project A** unsatisfactory OR
 - i. Pre-tender cost estimate & program of work inaccurate OR
 - (1) Misunderstanding on purpose, constraints, qualifications, information, scope, program & cost of project (Sub-Tree A) OR
 - (2) Client or project manager ignorant of project complexity or level of expertise required OR
 - (3) Items of work incompletely scheduled (Sub-Tree B) OR
 - (4) Quantum of work inaccurately measured (Sub-Tree B) OR

- (5) Unit costs inaccurate
- ii. Overrun on cost of construction attributable to Consultant **OR**
- (1) Misunderstanding on purpose, constraints, qualifications, information, scope, program & cost of project (Sub-Tree A) **OR**
 - (2) Inappropriate budget or programme restraints/expectations **OR**
 - (3) Expectation of complete services despite partial services appointment **OR**
 - (4) Items of work incompletely scheduled (Sub-Tree B) **OR**
 - (5) Inadequate provisions or excessive discounting **OR**
 - (6) Quantum of work inaccurately measured (Sub-Tree B) **OR**
 - (7) Unforeseen adjustment in work on site **OR**
 - (a) Oversight of particular aspects **OR**
 - (b) Wrong/inappropriate/incomplete design
 - (8) Unforeseen adverse conditions/circumstances **OR**
 - (a) Unforeseen variation in key parameters **OR**
 - (b) Insufficient site exploration
 - (9) Poor administration of progress payments **OR**
 - (a) Responsible staff not experienced & qualified **OR**
 - (b) Payments made without inspection, measurement and certification of work
 - (10) Poor financial controls by Contractor (p=0) **OR**
 - (11) Incorrect interpretation by manager of his duties and obligations
- iii. Delay in completion of construction attributable to Consultant **OR**
- (1) Start date delayed **OR**
 - (a) Permits delayed **OR**
 - (b) Misunderstanding between Client & Consultant
 - (2) Misunderstanding on purpose, constraints, qualifications, information, scope, program & cost of project (Sub-Tree A) **OR**
 - (3) Faulty design of permanent works **OR**
 - (4) Faulty design of temporary works **OR** (p=0)
 - (5) Items of work incompletely scheduled (Sub-Tree B) **OR**
 - (6) Quantum of work inaccurately measured (Sub-Tree B) **OR**
 - (7) Work incompletely programmed by Consultant **OR**
 - (8) Work incompletely programmed by Contractor **OR** (p=0)
 - (9) Faulty or poor quality construction by Contractor **OR** (p=0)
 - (a) Lack of attention **OR**
 - (b) Lack of commitment **OR**
 - (c) Lack of experience **OR**
 - (d) Lack of skills **OR**
 - (e) Lack of planning/programming **OR**
 - (f) Lack of management/coordination **OR**
 - (g) Lack of personnel resources
 - (10) Inefficient working by Contractor **OR** (p=0)
 - (a) Lack of attention **OR**
 - (b) Lack of commitment **OR**
 - (c) Lack of experience **OR**
 - (d) Lack of skills **OR**

- (e) Lack of planning/programming **OR**
 - (f) Lack of management/coordination **OR**
 - (g) Lack of personnel resources
 - (11) Corrective action not instructed timely **OR**
 - (a) Lack of attention/oversight **OR**
 - (b) Inexperienced in contract administration **OR**
 - (c) Understanding/interpretation of contract lacking **OR**
 - (d) Intimidated by Contractor
 - (12) Work not expedited by Contractor on instruction **OR** (p=0)
 - (13) Unforeseen adjustment in work on site **OR**
 - (a) Oversight of particular aspects (Sub-Tree B) **OR**
 - (b) Wrong/inappropriate/incomplete design (Sub-Tree B)
 - (14) Unforeseen adverse conditions/circumstances **OR**
 - (a) Unforeseen variation in key parameters **OR**
 - (b) Insufficient site exploration by Consultant
 - (i) Budgetary constraints **OR**
 - (ii) Time constraints **OR**
 - (iii) Lack of experience **OR**
 - (iv) Lack of skills
 - (15) Construction delayed by requirements of Construction Regulations attributable to Consultant **OR**
 - (a) Health & Safety Specification not prepared by Consultant **OR**
 - (b) Health & Safety Plan not compiled in good time by Contractor **OR** (p=0)
 - (c) Health & Safety Inspectors not appointed in good time **OR**
 - (d) Consultant not skilled & experienced to act as agent for Client **OR**
 - (e) Client remiss of duties in terms of OH&S Act **OR**
 - (i) Client unaware of his duties **OR**
 - (ii) Client's duties not confirmed with him **OR**
 - (iii) Client not adequately skilled & experienced to undertake duties
 - (f) Implementation of remedial actions unduly time consuming
 - (16) Major accidents & mishaps attributable to Consultant **OR**
 - (a) OH&S plan not implemented **OR**
 - (b) OH&S inspectors not experienced & qualified
 - (17) Labor disputes **OR** (p=0)
 - (18) Inclement weather **OR** (p=0)
 - (19) Natural disasters (p=0)
- iv. Works function inefficiently/ineffectively **OR**
- (1) Conceptual design faulty **OR**
 - (a) Misunderstanding on purpose, constraints, qualifications, information, scope, program & cost of project (Sub-Tree A) **OR**
 - (b) Wrong design concept (Sub-Tree C) **OR**
 - (c) Critical information on site not available or inaccurate **OR**
 - (i) Investigation/survey not available **OR**
 - (ii) Investigator not qualified
 - (d) Brief not adhered to **OR**
 - (e) Design process falls short (Sub-Tree B) **OR**
 - (f) Schematic documentation not commented on by relevant parties
 - (2) Detailed design faulty **OR**

- (a) Misunderstanding on purpose, constraints, qualifications, information, scope, program & cost of project (Sub-Tree A) **OR**
- (b) Approved conceptual design not adhered to **OR**
- (c) Design process falls short (Sub-Tree B) **OR**
- (d) Detailed design not presented in detailed design documentation
- (3) Working drawings faulty (Sub-Tree B) OR**
 - (a) Misunderstanding on purpose, constraints, qualifications, information, scope, program & cost of project (Sub-Tree A) **OR**
 - (b) Approved conceptual design not adhered to **OR**
 - (c) Drawing process falls short (Sub-Tree B) **OR**
 - (d) Detailed design not presented in detailed working drawings
- (4) Contract award or documentation faulty OR**
 - (a) Misunderstanding on purpose, constraints, qualifications, information, scope, program & cost of project (Sub-Tree A) **OR**
 - (b) Contract documents faulty **OR**
 - (i) Tender documents do not comply with prerequisite standards **OR**
 - (ii) Contract documents do not comply with appropriate JBCC, FIDIC or CESA documents
 - (c) Contract appointment process faulty **OR**
 - (i) Documents not collected & opened properly **OR**
 - (ii) Reasons for accepting successful tender not recorded in writing **OR**
 - (iii) Reasons for rejecting unsuccessful tenders not recorded in writing **OR**
 - (iv) Tenders not adjudicated on an unbiased & unprejudiced basis
 - (d) Appointed contractor not financially capable **OR**
 - (e) Appointed contractor not sufficiently experienced technically **OR**
 - (f) Appointed contractor not sufficiently experienced in contract administration & management **OR**
 - (g) Provisions of Preferential Procurement Policy Framework Act and Framework for Supply Chain Management not complied with **OR**
- (5) Project construction/implementation faulty**
 - (a) Inadequate site communications **OR**
 - (i) Queries from contractor not answered **OR**
 - (ii) Site instructions not issued **OR**
 - (iii) Site diary not kept
 - (b) Poor workmanship (non-compliance with design specifications) **OR**
 - (i) Incompetent site supervision **OR**
 - 1. Supervisory staff not suitably experienced **OR**
 - 2. Supervisory staff not suitably qualified
 - (ii) Site supervision not carried out in terms of agreed scope of work **OR**
 - 1. Inadequate trained or informed staff **OR**
 - 2. Agreed scope of work ignored
 - (iii) Inadequate checking methodology **OR**
 - 1. Site staff not provided with monitoring checklist forms **OR**
 - 2. Monitoring checklist forms not sufficiently detailed
 - (iv) Inadequate checking procedure **OR**

1. Monitoring checklists not completed during each site visit
OR
 2. Monitoring checklists not recorded properly
 - (v) Inadequate site instructions
 1. Site instructions not issued in writing **OR**
 2. Receipt of site instructions not acknowledged by contractor
OR
 3. Site instructions not properly filed
 - (c) Poor revision of design documentation **OR**
 - (i) Documents revised without careful consideration of all implications **OR**
 - (ii) Revised documentation not issued in time to all relevant parties
OR
 - (iii) Revised documentation not readily accessible to all interested persons
 - (d) Unclear delegation of responsibilities on multi-professional contracts
- v. Works fail structurally
- (1) Failure of foundations **OR**
 - (a) Conceptual design faulty (Sub-Tree 1.a.iv.(1)) **OR**
 - (b) Detailed design faulty (Sub-Tree 1.a.iv.(2)) **OR**
 - (c) Working drawings faulty (Sub-Tree 1.a.iv.(3)) **OR**
 - (d) Contract award faulty (Sub-Tree 1.a.iv.(4)) **OR**
 - (e) Foundation construction faulty (Sub-Tree 1.a.iv.(5))
 - (2) Failure of superstructure
 - (a) Conceptual design faulty (Sub-Tree 1.a.iv.(1)) **OR**
 - (b) Detailed design faulty (Sub-Tree 1.a.iv.(2)) **OR**
 - (c) Working drawings faulty (Sub-Tree 1.a.iv.(3)) **OR**
 - (d) Contract award faulty (Sub-Tree 1.a.iv.(4)) **OR**
 - (e) Superstructure construction faulty (Sub-Tree 1.a.iv.(5))
- vi. Site health and safety not sufficiently assured
- (1) Application of inappropriate Acts (e.g. MHS Act on non-mine property) **OR**
 - (2) Arbitrary interpretation of safety requirements **OR**
 - (3) Unclear delegation of responsibilities on multi-professional contracts
- vii. Public security not sufficiently assured **OR**
- (1) Concept of security system faulty **OR**
 - (2) Design of security system faulty (Sub-Tree B) **OR**
 - (3) Communication of system design faulty **OR**
 - (4) Implementation of security system faulty
- viii. Public health & safety not sufficiently assured **OR**
- (1) Concept of health & safety system faulty **OR**
 - (2) Design of health & safety system faulty (Sub-Tree B) **OR**
 - (3) Communication of health & system design faulty **OR**
 - (4) Implementation of health & safety system faulty

- ix. Environmental friendliness/acceptability of project contested **OR**
 - (1) I&AP acceptance of project not secured in advance **OR**
 - (a) EIA & P not prepared beforehand **OR**
 - (b) Public requirements not satisfied/appeased
 - (2) Official acceptance of project not secured in advance
 - (a) EIA & P not prepared beforehand **OR**
 - (b) Environmental impact criteria not satisfied

- x. Dispute proceedings instituted on construction contract
 - (1) Overrun on cost of construction **OR**
 - (a) Overrun on cost of construction (Sub-Tree 1.a.ii.) **AND**
 - (b) Overrun on cost of material **AND**
 - (c) Contracting parties disagree on merit/materiality of overrun
 - (2) Delay in completion of construction **OR**
 - (a) Delay in completion of construction (Sub-Tree 1.a.iii.) **AND**
 - (b) Delay in completion material **AND**
 - (c) Contracting parties disagree on merit/materiality of delay
 - (3) Client's expectations of Works disappointed (PI insurance claim) **OR**
 - (a) Works function inefficiently/ineffectively (Sub-Tree 1.a.iv.) **AND**
 - (b) Client's disappointment material
 - (c) Client & Consultant disagree on merit/materiality of Client's disappointment
 - (4) Works fail structurally (PI insurance claim) **OR**
 - (a) Works fail structurally (Sub-Tree 1.a.v.) **AND**
 - (b) Structural failure material **AND**
 - (c) Client & Consultant disagree on merit/materiality of structural failure
 - (5) Public security breach (PI insurance claim) **OR**
 - (a) Public security not assured (Sub-Tree 1.a.vi.) **AND**
 - (b) Lapse in assurance of public security material **AND**
 - (c) Client & Consultant disagree on merit/materiality of lapse in security
 - (6) Public health & safety breach (PI insurance claim) **OR**
 - (a) Public health & safety not assured (Sub-Tree 1.a.vii.) **AND**
 - (b) Lapse in assurance of public health & safety material **AND**
 - (c) Client & Consultant disagree on merit/materiality of lapse in health & safety
 - (7) Environmental impact of project contested (PI insurance claim) **OR**
 - (a) Environmental acceptability of project contested (Sub-Tree 1.a.viii.) **AND**
 - (b) Environmental impact material **AND**
 - (c) Client & Consultant disagree on merit/materiality of environmental impact

b. Completion of **Project 200** unsatisfactory (Tree for Project A) **OR**

c.**OR**

d.**OR**

- e. Completion of **Project N** unsatisfactory (Tree for Project A)

2. Business Operational Liabilities OR

- a. Contractual liabilities (voluntarily accepted duties) **OR**
- i. Project appointment liabilities **OR**
- (1) Potential dispute re appointment on **Project 100** **OR**
- (a) Inappropriate terms/form of contract (e.g. construction works contract used for procurement of professional services) **OR**
- (b) Duration of contractual liabilities not limited **OR**
- (c) Maximum compensation for damages not capped **OR**
- (d) Unduly onerous contractual duties **OR**
- (e) Inappropriate budget or programme restraints/expectations **OR**
- (f) Expectation of complete services despite partial services appointment **OR**
- (g) Unduly onerous guarantees & warranties given **OR**
- (h) Unduly onerous insurance requirements accepted **OR**
- (i) Unrealistic project scope, time frames & budgets accepted **OR**
- (j) Dispute resolution process not specified **OR**
- (k) Contractual oversights/shortcomings by sub-Consultants **OR**
- (l) Contractual oversights/shortcomings by Joint Venture Partners
- (2) Potential dispute re appointment on **Project 200** (Sub-Tree 2.a.i.(1)) **OR**
- (3) **O**
- R**
- (4) **O**
- R**
- (5) Potential dispute re appointment on **Project N** (Sub-Tree 2.a.i.(1))
- ii. Project performance liabilities
- (1) Potential dispute re performance of **Project 100** (Sub-Tree 1.a.ix.) **OR**
- (2) Potential dispute re performance of **Project 200** (Sub-Tree 1.b.ix.) **OR**
- (3) **OR**
- (4) **OR**
- (5) Potential dispute re performance of **Project N** (Sub-Tree 1.e.ix.)
- b. Statutory liabilities (duties imposed by law) **OR**
- i. Potential proceedings under OH&S Act **OR**
- (1) Non-compliance with Construction Regulations **OR**
- (2) Not qualified to act as agent for Client
- ii. Potential proceedings under Engineering Profession of South Africa Act **OR**
- (1) Breach of Code of Professional Conduct (ethical practices) **OR**
- (2) Breach of Code of Practice (operational practices) **OR**
- (3) Breach of Continuing Professional Development Requirements **OR**
- (4) Breach of Act with regard to Category of Registration
- iii. Potential proceedings under Preferential Procurement Policy Framework Act **OR**
- iv. other Acts

- c. Delictual liabilities re injuries & damages to persons & property (duties imposed by law) **OR**
 - i. Not acted as “reasonable person” **OR**
 - ii. Not acted with due care & diligence **OR**
 - iii. Not complying with existing statutes or regulations **OR**
 - (1) Basic Conditions of Employment Act, 1997 **OR**
 - (2) Skills Development Act, 1998 **OR**
 - (3) Broad-Based Black Economic Empowerment Act, 2003 **OR**
 - (4) Preferential Procurement Policy Framework Act, 2000 **OR**
 - (5) Employment Equity Act, 1998 **OR**
 - (6) The King Commission Report on Corporate Governance **OR**
 - (7) Occupational Health and Safety Act, 1993 **OR**
 - (8) Construction Regulations to the OHS Act, 2003 **OR**
 - (9) Mine Health and Safety Act, 1996 **OR**
 - (10) National Environmental Management Act **OR**
 - (11) Companies Act, 2008 **OR**
 - (12) Close Corporations Act, 1981 **OR**
 - (13) Income Tax Act, 1962 **OR**
 - (14) Value Added Tax Act, 1991 **OR**
 - (15) Engineering Profession Act, 2000
 - iv. Not worked in terms of current state of the art **OR**
 - v. Careless trivial design decisions made
- d. Commercial liabilities **OR**
 - i. Insufficient spread of technical staff/middle age gap **OR**
 - ii. Sustainability of practice not planned **OR**
 - iii. Senior consultants priced out of market **OR**
 - iv. Lose specialisation due to inappropriate business model
- e. Public (“slip & fall”) liabilities **OR**
- f. Directors liabilities (individual responsibility re corporate structure) **OR**
- g. Employee liabilities **OR**
- h. Health & Safety liabilities

3. Financial Shortcomings **OR**

- a. Corporate liabilities **OR**
 - i. Business capitalisation inadequate **OR**
 - (1) Shareholder/investor capital insufficient **OR**
 - (2) Loan capital/overdraft facility insufficient **OR**
 - (3) Debt book long **OR**
 - (a) Invoice preparation deficient/careless **OR**
 - (b) Debt control poor
 - ii. Financial management inadequate
 - (1) Investment of operating capital unduly risky **OR**
 - (2) Interest on operating capital investment low **OR**

- (3) Fraudulent accounting **OR**
- (4) Fraudulent disbursement claims **OR**
- (5) Tax evasion **OR**
- (6) Incompetent audit
- b. Trading shortfalls
 - i. Income in general short **OR**
 - (1) Order book short **OR**
 - (a) Inability to secure work **OR**
 - (i) Unfair process adjudication **OR**
 - (ii) Poor definition of contractual requirements or scope of work **OR**
 - (iii) Failure to meet eligibility requirements (e.g. BBBEE, ISO9001, etc.) **OR**
 - (iv) Refusal to accept contract conditions
 - (b) Business model inappropriate
 - (i) Provide special services **OR**
 - (ii) Provide general services
 - (c) Marketing strategy inadequate
 - (i) Marketing effort inadequate **OR**
 - (ii) Marketing approach inappropriate **OR**
 - 1. All staff solicit appointments
 - 2. Dedicated senior staff solicit appointments
 - (iii) Marketing material inadequate **OR**
 - (iv) Brand underdeveloped **OR**
 - (v) Proposals/tenders disqualified
 - (vi) Geographic diversification limited **OR**
 - (vii) Market diversification limited **OR**
 - (viii) Discipline diversification limited **OR**
 - (ix) Business strengths not exploited **OR**
 - (x) Business opportunities not exploited
 - (d) Market image poor
 - (i) Black empowerment inadequate **OR**
 - 1. Ethnic representation of staff disproportionate **OR**
 - 2. Ethnic representation of ownership disproportionate **OR**
 - 3. Ethnic representation of board/management disproportionate
 - (ii) Location of practice unfavorable/sub-optimal **OR**
 - (iii) Perception of business/Consultant negative **OR**
 - (iv) Internal cost structure undercuts competitiveness **OR**
 - (v) Services considered/perceived to be expensive
 - (2) Fees structure falls short **OR**
 - (a) Hourly/daily charge out rates short **OR**
 - (b) Recovery of VAT not provided **OR**
 - (3) Productivity short **OR**
 - (a) Too little time sold **OR**
 - (b) Too much time taken
 - (4) Invoicing unduly delayed in Consultant's office
 - ii. Income on **Project 100** short **OR**
 - (1) Calculation of fees not confirmed in writing **OR**
 - (2) Calculation of fees short **OR**

- (a) Percentage short **OR**
- (b) Too much work for fee **OR**
- (c) Not provided for R&D required **OR**
- (d) Not provided for expert/special input
- (3) Recovery of disbursements not confirmed/provided **OR**
- (4) Additional fees for changes in project scope not provided **OR**
- (5) Fees for duties under Construction Regulations not provided **OR**
- (6) Client reneges on paying Consulting fee **OR**
 - (a) Client is unable to pay **OR**
 - (b) Client is unwilling to pay **OR**
 - (c) Client contests appointment **OR**
 - (d) Client's representative is not authorized to effect payment **OR**
 - (e) Client disputes invoice presented
- (7) Unforeseen foreign country costs
 - (a) Unfavorable local logistics **OR**
 - (b) Undue difficulties with telecommunications **OR**
 - (c) Undue difficulties with travel arrangements **OR**
 - (d) Unfavorable local fiscal arrangements re tax **OR**
 - (e) Unfavorable exchange rate
- iii. Income on **Project 200** short (Sub-Tree 3.d.ii.) **OR**
- iv. **OR**
- v. **OR**
- vi. Income on **Project N** short (Sub-Tree 3.d.ii.)
- vii. Costs in general long
 - (1) Salary costs long **OR**
 - (2) Bought out professional services long **OR**
 - (3) Office infrastructure costs long **OR**
 - (4) Cost of loan capital long **OR**
 - (5) Marketing budget spent inefficiently **OR**
 - (6) Marketing costs long (too much resources invested in proposals) **OR**
- viii. PI insurance costs on **Project 100** long **OR**
 - (a) Claim against practice established/or agreed to **AND**
 - (b) Damages long
 - (i) Deductible long **OR**
 - (ii) Deductible exceeds fee income **OR**
 - (iii) PI insurance not in place **OR**
 - (iv) PI insurance insufficient **OR**
 - (v) PI insurance of sub-Consultants not in place **OR**
 - (vi) PI insurance of Joint Venture Partners not in place **OR**
 - (vii) Durations of liabilities not limited **OR**
 - (viii) Maximum compensations not capped
 - (c) Taking on responsibilities beyond professional services covered in PI Insurance Policy (standard of care, fit-for-purpose, etc) **OR**
 - (d) Inappropriate supervision responsibilities particularly with incentive type contracts **OR**
 - (e) Inappropriate responsibility for alternative (contractor's) designs
- ix. PI insurance costs on **Project 200** (Sub-Tree 3.b.ix.) long **OR**
- x. **OR**
- xi. **OR**
- xii. PI insurance costs on **Project N** (Sub-Tree 3.b.ix.) long

- xiii. Business operational liability costs long

4. Administrative Shortcomings

- a. Cost accounting management poor **OR**
 - i. Time capturing system inefficient **OR**
 - ii. Invoice approval system inefficient
- b. Financial management poor **OR**
 - i. Credit control inefficient **OR**
 - ii. Debt control inefficient **OR**
 - iii. Bookkeeping services inadequate **OR**
 - iv. Auditing services inadequate **OR**
 - v. Financial performance reporting system inadequate
- c. Administrative support poor **OR**
 - i. Information (library) support services inadequate **OR**
 - ii. Administrative secretarial support poor **OR**
 - iii. Office clerical support poor **OR**
 - iv. Company secretarial support poor **OR**
 - v. Messenger services poor **OR**
 - vi. Field transport equipment & system inadequate
- d. Computer support poor **OR**
 - i. I&T systems & support inadequate **OR**
 - ii. Keyboard literacy of technical staff inadequate **OR**
 - iii. Computer literacy of technical staff inadequate **OR**
 - iv. PC availability inadequate **OR**
 - v. Internal computer network inadequate
- e. Communications support poor **OR**
 - i. Telecommunications system & support inadequate **OR**
 - ii. E-communications system & support inadequate **OR**
 - iii. Fax facilities & support inadequate
- f. Document production support poor **OR**
 - i. Drawing office support poor **OR**
 - ii. CAD facilities & support inadequate **OR**
 - iii. Copying facilities & support inadequate **OR**
 - iv. Printing facilities & support inadequate **OR**
 - v. Binding facilities & support inadequate
- g. Data storage system poor **OR**
 - i. Document storage & retrieval system inadequate **OR**
 - ii. Document storage facilities & support inadequate **OR**
- h. Staff care poor
 - i. Medical aid scheme inadequate **OR**
 - ii. End-of-career-income-replacement provision inadequate **OR**
 - iii. On-the-job-accident insurance provision inadequate

5. Sub-Trees

5.1 Sub-Tree A - Misunderstanding on Purpose, Constraints, Qualifications, Information, Scope, Program & Cost of Project

1. Communications not confirmed in writing **OR**
 - a. Telephone & other incidental conversations not recorded **OR**
 - b. Minutes of meetings not recorded **OR**
 - c. Correspondence not kept **OR**
 - d. Design assumptions not documented **OR**
 - e. Design assumptions of external service providers not confirmed in writing **OR**
 - f. Design documentation not recorded **OR**
 - g. Working drawings including revisions not recorded
2. Brief, including deliverables and delivery dates, not recorded in writing **OR**
3. Scope of work not determined in sufficient detail **OR**
4. Program of work not determined in sufficient detail **OR**
5. Particular items of work excluded, not specifically identified **OR**
6. Information, services & permissions provided by Client, not confirmed in writing **OR**
7. Limitations on cost & program by Client not confirmed in writing **OR**
8. Requirements on quality, life expectancy, use, performance, specification & capacity by Client not confirmed in writing

5.2 Sub-Tree B- Design/Drawing Process Falls Short

1. Inaccurate working **AND**
 - a. Lack of attention/concentration **OR**
 - b. Risk avoidance/do-it-right-first-time mindset poorly developed **OR**
 - c. Lack of commitment **OR**
 - i. Staff does not identify with Company **OR**
 - ii. Career development not provided **OR**
 - iii. Long term/promotional prospects poor/slow in coming **OR**
 - iv. Participation in business equity not available/long in coming
 - d. Lack of motivation **OR**
 - i. Reward inadequate **OR**
 - ii. Incentives inadequate **OR**
 - iii. Recognition inadequate **OR**
 - iv. Open communications lacking **OR**
 - (1) Complaints resolution system not available **OR**
 - (2) Two-way performance evaluation not available
 - v. Team-work poorly developed
 - (1) Recognition of individual-division performance unbalanced **OR**
 - (2) Recognition of specialist-generalist performance unbalanced
 - e. Lack of experience **OR**
 - i. Take on work not sufficiently experienced for **OR**
 - ii. Not enough experienced staff employed **OR**
 - iii. Experienced staff employed on non-essential work **OR**
 - iv. External service providers not sufficiently experienced

- f. Lack of skills and/or training **OR**
 - i. Take on work not sufficiently skilled for **OR**
 - ii. Not enough skilled staff employed **OR**
 - iii. Skilled staff employed on non-essential work **OR**
 - iv. External service providers not sufficiently skilled
 - g. Design software not properly checked for output accuracy **OR**
 - h. CAD software not properly checked for output accuracy **OR**
 - i. Relevant national & international design standards not adhered to **OR**
 - j. Relevant local authority regulations & standards not adhered to **OR**
 - k. Environmental impact assessment not undertaken **OR**
 - l. Parties interested & affected by environmental impact of project not consulted **OR**
 - m. Value engineering evaluation not carried out **OR**
 - n. Hard & electronic copies of design documentation and working drawings not filed in easily accessible way **OR**
 - o. Pressure of time
 - i. Program too tight (too little time) **OR**
 - (1) Not enough time allowed by Client **OR**
 - (2) Insufficient provision in budget for professional time **OR**
 - (3) Delivery date not adjusted to account for Client induced delay of starting time
 - (a) Delay in award of contract **OR**
 - (b) Delay in supply of items by Client
 - ii. Inefficient working (time wasted) **OR**
 - iii. Lack of personnel resources
 - (1) Lack of provision in project budget to appoint staff **OR**
 - (2) Remiss in appointing staff required in good time **OR**
 - (3) Required staff not available
2. Insufficient checking/review of designs, drawings & schedules
- a. Checking/review process not in place **OR**
 - b. Checking/review process not followed **OR**
 - i. Lack of provision in project budget to appoint reviewer **OR**
 - ii. Professional pride **OR**
 - iii. Lack of attention **OR**
 - iv. Lack of commitment **OR**
 - v. Lack of experience **OR**
 - vi. Lack of skills **OR**
 - vii. Lack of independence **OR**
 - viii. Review not documented, dated and signed **OR**
 - ix. Design output documentation not checked for compliance with design assumptions & project specifications **OR**
 - x. Design output documentation not checked for completeness & correctness **OR**
 - xi. Detailed design documentation & drawings not checked for compliance with relevant regulatory requirements, OH&S Act and environmental impact criteria
 - xii. Detailed design documentation & drawings not checked for do-ability
 - xiii. Pressure of time
 - (1) Program too tight (too little time) **OR**
 - (a) Not enough time allowed by Client **OR**

- (b) Delivery date not adjusted to account for Client induced delay of starting time
 - (i) Delay in award of contract **OR**
 - (ii) Delay in supply of items by Client
- (2) Inefficient working (time wasted) **OR**
- (3) Lack of personnel resources
- c. Checking/review process not pursued from start of project

5.3 Sub-Tree C - Wrong Design Concept

1. Misunderstanding between parties on purpose of project **OR**
 2. Problem technically complex **OR**
 - a. Wide range of specializations/disciplines involved **OR**
 - b. Unproven technology or development of new technology **OR**
 - c. Technology to address natural phenomena involved not readily available
 3. Problem technically novel/unique **OR**
 - a. Problem not previously addressed elsewhere **OR**
 - b. Key parameters very site specific
 4. Client overlooks nature of problem **OR**
 - a. Inattentive **OR**
 - b. Not experienced **OR**
 - c. Not interested **OR**
 - d. Subject to political/extraneous pressure
 5. Consultant overlooks nature of problem **OR**
 - a. Inattentive **OR**
 - b. Not experienced **OR**
 - c. Technically predisposed to inappropriate approach **OR**
 - d. Under pressure to quickly & inexpensively solve problem
 6. Consultant not suitably experienced to address problem **OR**
 7. Consultant not suitably skilled to address problem **OR**
 8. Time required to properly research problem not available **OR**
 9. Budget required to properly to address problem not available **OR**
 10. Reliance on flawed external information provided by client from previous studies **OR**
 11. Partial re-design or contractor's design incompatible with overall design concept.
-

7.10 Appendix 10 - Typical Event Trees

Decision Trees, as Event Trees are also known, are simulations of real situations and are used to determine the potential impacts in future of decisions taken today taking into account the associated probabilities and impacts. Costs may be considered at any stage in a Decision Tree as shown in the following example in which it is

determined whether prototyping a system is advisable. The costs and probabilities were determined by appropriate analyses of the relevant parameters.

It is evidently cheaper to prototype at an EMV, Expected Monetary Value, of R242 000,00 than not to prototype at an EMV of R315 000,00. The Decision Tree may be presented as follows in text form in which paragraphs of like indentation are juxtaposed.

- 1) Prototype system at a set up cost of R200 000,00
 - a) Likelihood of prototyping failing is 35% resulting in a loss of R120 000,00
EMV to prototype = R200 000,00+0,35xR120 000,00 = **R242 000,00**
 - b) Likelihood of prototyping passing is 65% at zero impact
- 2) Do not prototype system
 - a) Likelihood of system failure is 70% resulting in a loss of R450 000,00
EMV not to prototype = 0,70xR450 000,00 = **R315 000,00**
 - b) Likelihood of system passing is 30% at zero impact

In the next example the sensitivity of outbreaks of fire in TBM tunnels under construction due to various factors are considered. The probabilities shown are selected to illustrate the underlying logic and do not represent an actual case study.

- 1) Likelihood of flammable material being present is 100% for PVC conveyor belting and 5% for mineral aerosol
- 2) Likelihood of flammable material being ignited is 0,01% for conveyor belting and 10% for mineral aerosol
 - a) Likelihood of fire being detected is 95% for conveyor belting and 60% for mineral aerosol
 - i) Likelihood of fire being extinguished 98%
 - ii) Likelihood of fire not being extinguished 2%**Likelihood of fire** = 1,0x0,01x0,95x0,02 = **0,019%** for conveyor belting
 = 0,05x0,30x0,6x0,02 = **0,018%** for mineral aerosol
 - b) Likelihood of fire not being detected 5% for conveyor belting and 40% for mineral aerosol
 Likelihood of fire = 1,0x0,01x0,05 = **0,05%** for conveyor belting
 = 0,05x0,3x0,4 = **0,6%** for mineral aerosol

A detailed analysis showed that conveyor belting, hydrogen and mineral oil were the greatest sources fire risk in TBM tunnels. Tobacco smoking proved to be a major source of ignition, the banning of which resulted in a fourfold reduction in the risk of fire. Tobacco smoking has long been banned in mines but has only recently been recognized as a major source of ignition in the construction of utility tunnels.

A third example illustrates how Decision Trees can be applied to evaluate the risk of plant theft from construction sites. The probabilities shown represent a reported case study. Notice again that paragraphs of like indentation are juxtaposed.

- 1) Likelihood of plant theft not occurring **0,9**
- 2) Likelihood of plant theft occurring 10%
 - a) Likelihood of small plant theft 60%
 - i) Likelihood of security fencing not provided 70%
Likelihood of small plant theft = 0,1x0,6x0,7 = **0,042**

ii)	Likelihood of security fencing provided	30%	
	(1) Likelihood of watchman not provided	70%	
	Likelihood of small plant theft	$= 0,1 \times 0,6 \times 0,3 \times 0,7 =$	0,0126
	(2) Likelihood of watchman provided	30%	
	Likelihood of small plant theft	$= 0,1 \times 0,6 \times 0,3 \times 0,3 =$	0,0054
b)	Likelihood of medium plant theft	30%	
i)	Likelihood of security fencing not provided	90%	
	Likelihood of medium plant theft	$= 0,1 \times 0,3 \times 0,9 =$	0,027
ii)	Likelihood of security fencing provided	10%	
	(1) Likelihood of watchman not provided	90%	
	Likelihood of medium plant theft	$= 0,1 \times 0,3 \times 0,1 \times 0,9 =$	0,0027
	(2) Likelihood of watchman provided	10%	
	Likelihood of medium plant theft	$= 0,1 \times 0,3 \times 0,1 \times 0,1 =$	0,0003
c)	Likelihood of large plant theft	10%	
i)	Likelihood of security fencing not provided	99%	
	Likelihood of large plant theft	$= 0,1 \times 0,1 \times 0,99 =$	0,0099
ii)	Likelihood of security fencing provided	1%	
	(1) Likelihood of watchman not provided	99%	
	Likelihood of large plant theft	$= 0,1 \times 0,1 \times 0,01 \times 0,99 =$	0,000099
	(2) Likelihood of watchman provided	1%	
	Likelihood of large plant theft	$= 0,1 \times 0,1 \times 0,01 \times 0,01 =$	0,000 001

Notice that the overall likelihood of plant theft occurring amounts to 1,0, that is, the sum of all the bold entries. Small plant theft has a higher incidence than medium plant theft and medium plant theft a higher incidence than large plant theft. Providing security fencing and a watchman reduces the likelihood of all sizes of plant theft.

APPENDIX 11: INDEX CESA PRACTICE NOTES ON PROFESSIONAL PRACTICE - Revision July 2021				
Refer notes at bottom of APPENDIX				
Ref	Category	Sub Category	Title/Key Aspect	Keywords
Clients and Appointments				
PN27	C&A/agmt/2	Agreements (agmt) -	Client-Consulting Engineer relationship in the Modern Business Environment	Consulting Engineer, Practice, Client, Professional relationship, Care, Trust, Scope, Cost, Time, Codes of Conduct, ECSA, CESA, FIDIC
PN28	C&A/agmt/3		Consulting Engineer's Responsibilities, Duties and Obligations, and Liability	Professional, Conduct, Code of conduct, Duty of care, Inspection, Certificates, Professional services agreement, Guarantee, Liability, Responsibility, Performance, Obligations, Scope of Services, Authority, Monitoring
PN36	C&A/agmt/4 (Archived)		The Engineer's Obligations and Liabilities	Responsibility, Liability, Practice
PN29	C&A/agmt/5		Processes of Construction Monitoring	ECSA Guideline, Contract Administration, Construction Monitoring, Site Staff, Additional Service, Fees for Additional Services, Expenses and Costs
PN32	C&A/agmt/7		Framework agreements and term contracts	Framework Agreement, Term contract, Task order, procurement, professional services, construction services, ECSA Guideline, Panel Appointments
PN86	C&A/agmt/8 (Archived)		Appointment of Consulting Engineers by means of Regulation 32 of 'MFMA SCM Regulations'	Municipalities, municipal appointment, Regulation 32, SCM Regulations, consulting engineer, existing appointment, transfer of appointment
PN34	C&A/fees/1	Fees and Disbursements (fees) -	Advance notification of estimated fees	Fees, Estimates, ECSA Guideline, Client Notification
PN30	C&A/fees/10 (Archived)		Determination of appropriate hourly rates	Time-based fees, Hourly rates, ECSA Guideline, DPSA
PN35	C&A/fees/2		Cancellation fees	Cancellation Fees, Suspension, Termination, Cancellation, Abandonment, Justification
PN31	C&A/fees/4 (Archived)		Professional fees on M&E work	Mechanical works, Electrical works, Electronic works, Fee guidelines, ECSA Guideline, Time-based , Lump Sum, Percentage fee
PN33	C&A/fees/6 (Archived)		Cost of the works for building projects (M&E subcontracts)	Cost of Works, Fees, Building projects, ECSA Fee Guidelines, M&E subcontracts
PN83	C&A/fees/7 (Archived)		Fees for targeted procurement	Targeted procurement, Participation, Compliance auditing, Category Factor, Fees
PN41	C&A/fees/9 (Archived)		Procurement of consulting engineering services ito ECSA 2014 guideline for fees and services	Procurement, tendering, priced proposals, consulting services, 2014 Fee guidelines, ECSA Fee Guidelines, CESA Procurement Guideline for Consulting Engineering Services
PN45	C&A/fees		CESA Applications Guide: March 2021 ECSA Scope of Services and Remuneration for Consulting Engineering Services	Procurement, appointment, ECSA Guideline, scope of services, normal services, additional services, fees, percentage fees, hourly rates, time-based fees

APPENDIX 11: INDEX CESA PRACTICE NOTES ON PROFESSIONAL PRACTICE - Revision July 2021				
Refer notes at bottom of APPENDIX				
Ref	Category	Sub Category	Title/Key Aspect	Keywords
PN42	C&A/liab/1	Liability Aspects (liab) -	Guideline for Consulting Engineers and their Clients on processes for implementing Complex Multi-disciplinary complex projects	Scope of Services, Engineering Management, Multi-disciplinary projects, Project Cost Estimate, Control Procedures, Industrial projects, Heavy civil projects, target cost
PN19	C&A/liab/10		Appointing a construction Health and Safety agent in terms of the Construction Regulations, 2014	Construction Regulations, OHS ACT, Department of Labour, Health and Safety Agent, competent person, PrCHSA, SACPCMP, CBE
PN24	C&A/liab/2		Certificates beyond those required in conditions of appointment	Certificates; Absolute obligations; Contractual liability; Delictual liability; Risk; Negligence; Professional Services Agreement (PSA)
PN84	C&A/liab/4 (Archived)		Unsolicited proposals	Unsolicited Proposals, SANRAL, Fees, Success Fee, Value Engineering bonus, Risk, P.I. Insurance, Engineering Joint Venture, Scheme Development
PN65	C&A/liab/5		Engineer's responsibility in respect of the National Building Regulations and SANS 10400	National Building Regulations, SANS 10400, competent person, statutory requirements, procedures
PN1	C&A/liab/6		A comparison between Professional Indemnity Insurance & Performance bonds	Professional indemnity insurance; performance bonds; breach of professional duty; contractual obligations; guarantor; written guarantee
PN18	C&A/liab/7		Limitation of Liability - CESA standard form of agreement	Limitation of liability, quantum, duration, CESA agreement, Association of Consulting Engineers New Zealand (ACENZ)
PN85	C&A/liab/8 (Archived)		Dept Public Works - Form D Indemnification Requirements	Payment Certificate, Liquid document, Acknowledgement of indebtedness
PN20	C&A/liab/9		Occupational Health and Safety Act, 1993, and Construction Regulations, 2014	Occupational Health and Safety, OHS ACT, Consultant as Agent, Consultant as Designer, Construction Regulations, Health and Safety Plan

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Refer notes at bottom of APPENDIX				
Ref	Category	Sub Category	Title/Key Aspect	Keywords
Construction Stage Services				
PN49	CSS/admin/1	Contract Administration (admin) -	Tenderers Site Inspection for Civil Works	Site inspection, Tenderers meeting, Engineer, Employer's Agent, Tender documents, Notice to Tenderers, Addendum, GCC 2015
PN87	CSS/admin/11		Preparation of As-Built drawings and Operating manuals	As built drawings, operating manuals, test certificates, guarantees, changes, building, construction, site instructions, master plans, records, certificate of compliance, certificates
PN22	CSS/admin/2		GCC 2015 Contract Completion	Certificate, Practical Completion, Contract Completion, Final Approval, GCC 2015
PN60	CSS/admin/3		Guideline for the preparation of a Works Contract Document	Tender documents, Contract documents, Special conditions, General Conditions, GCC 2010, SANS, CIDB, Specifications, Schedules of quantities, Plans, Drawings
PN50	CSS/admin/4		Managing the risks of advance payment for materials not yet built into the permanent works	Materials on site, materials not yet built into the permanent works, ownership, Performance Guarantee (Bond)
PN59	CSS/admin/5		Specifying Conditions of Contract and Contract Data	Construction tender document, conditions of contract, contract data, employer's interest, multi-disciplinary works
PN80	CSS/admin/6		Payment for uninstalled material and equipment on site (M&E projects)	Off-site storage, Materials on site, Uninstalled, Contracts, Payment, Mechanical works, Electrical works, Direct contract, GCC contract, JBCC contract, transfer of possession, transfer of ownership
PN47	CSS/admin/7		"Guidelines for Employer's Agent's Representative on Works Contract"	Engineer, Engineer's Representative, Resident Engineer, Employer's agent, Employer's Agent's Representative, delegation of authority, Employer, Contractor, Contract
PN51	CSS/admin/8		Aspects of good contract administration	Engineer, Employer's Agent, Conditions of Contract, Contract documentation, Project management, claims
PN48	CSS/admin/9		The supervising engineer's liability resulting from the contractor's breach	Supervision, Monitoring, Liability, Negligence, Court ruling
PN21	CSS/admin/10	Payment Certificates	Payment Certificate, Liquid document, Acknowledgement of indebtedness	
PN23	CSS/claim/1	Claims and Insurance (claim) -	Contractor's claims under the SAICE General Conditions of Contract for Construction Works Third Edition (2015)	Contracts, Claims, GCC 2015, Disputes, Employer's Agent, Employer's Agent's Representative, Adjudication, Arbitration
PN 25	CSS/claim/2		Guidelines for insurance of construction contracts	Insurance, Contract Works; GCC; GCC 2015; "Specific Contract" policy; annual "blanket" policy; public liability; Contractor's All Risk
PN2	CSS/claim/3		Principal controlled insurance	Principal Controlled Insurance; Contractors All Risk Insurance; claims experience; supplementary cover; "gaps" in insurance cover; payment of excess

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Ref	Category	Sub Category	Title/Key Aspect	Keywords
Good Business Practice				
PN4	GBP/ins/1	Ins Aspects (ins) -	Public liability & 3rd party insurance	Public liability; delictual action; third party; damages; patrimonial and non-patrimonial loss; short term policy
PN5	GBP/ins/2		Risk alert - injuries on duty or in the workplace	Occupational Injuries, Compensation Commissioner, COID Act
PN67	GBP/leg/1	Legislative Factors (leg) -	Nomenclature on corporate and company emails/letterheads and other documentation	Nomenclature, letterheads, electronic communication, partnership, company, close corporation, corporate structure, Companies Act.
PN79	GBP/leg/2		Software licenses	Intellectual property, copyright, software license
PN58	GBP/leg/3		Employment Equity Act	Employment Equity Act, equal opportunity, workforce, staff, human resources, HR management, designated employer, unfair discrimination
PN72	GBP/leg/4		Skills development and associated acts	Skills Development Act; Skills Development Levies Act; South African Qualifications Authority Act; Skills Development Facilitator, Sector Education and Training Authority, Learnerships
PN57	GBP/leg/5		Consumer Protection Act & Built Environment	Consumer Protection Act, CPA, Built Environment, goods, services, National Credit Act, consumer, rights, product liability, supplier, National Consumer Commission
PN68	GBP/leg/6		Implications of the new Companies Act, 2008	New Companies Act, categories of companies, state owned, companies, public companies, personal liability companies, private companies, memorandum of incorporation, shareholders agreements, financial statements, committees, business rescue, solvency and liquidity, shares, prescribed officers and directors, shares, remedies
PN71	GBP/leg/7		Framework for measuring Broad-Based Black Economic Empowerment (BBBEE) for Built Environment Professionals	Broad-Based Black Economic Empowerment (B-BBEE), Amended Construction Sector Code, Exempted Micro-Enterprise (EME), Qualifying Small Enterprise (QSE), Built Environment Professional (BEP) and Contractors
PN88	GBP/leg/8		CETA requirements by CESA	SETA, CETA, Construction Sector Charter Council (CSCC), Skills Development Levy, Training
PN94	GBP/leg/09		Construction Charter requirements by CESA	Construction Sector, Construction Charter, code, Code of Good Practice, skills development levy, B-BBEE, scorecard, CESA membership, engineering firms, audit
PN55	GBP/ops/1		Practice Operation (ops) -	Establishing a consulting engineering practice
PN37	GBP/ops/2	Issuing Invoices & Late Payments		Payment, delay, non-payment, acknowledgment of debt, notice of intent, legal proceedings, invoice, accounts, invoices, statements, interest, fees, VAT
PN61	GBP/ops/3	Consulting Engineers & sustainable development		Sustainable development, sustainability, FIDIC Sustainability Pack, CESA Sustainability Reporting Framework
PN52	GBP/ops/4	Alternative business structures for consulting engineering practices		Partnership; incorporated company; private company; close corporation; association; joint venture
PN3	GBP/ops/5	Potential insurance risks working in Joint Ventures		Joint ventures; nominated third party; partnership; joint venture agreement; joint and several liability; culpable joint venture partner; professional risks; contractor's risks, professional indemnity insurance

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PN93	GBP/ops/6	Risk Mgmt (risk) -	Identifying payment and other risk and how to deal with it	Interim payments, remedies for non-payment, suspension, termination, variations, exceptional events, Force Majeure, termination for convenience, professional indemnity insurance, limit of liability, third party liability, dispute resolution, signatories to the contract
Legal Responsibility, Disputes				
PN74	LRD/disp/1	Dispute Resolution (disp) -	Appointments to provide expert technical advice	Second opinion, expert witness, forensic engineering, insurance, claims, expert, expert technical advice
PN89	LRD/disp/2		Guidelines for Consulting Engineers as Expert Witnesses	Professional ethics; expert witness, litigation, giving evidence, cross-examination
PN38	LRD/disp/3		Statutory tariff of allowances - witnesses in civil and criminal cases	Subpoena; compensation; financial loss, witness, tariff of allowances
PN73	LRD/disp/4		Guidelines for engaging in Mediation	Mediation; General Conditions of Contract; written representation; mediation process; oral representation; settlement
PN7	LRD/disp/5		Prescription of claims arising out of the appointment of the Consulting Engineer	Prescription Act; Contract; delict; debt; interruption of prescription; liability
PN8	LRD/resp/1	Responsibility and Liability (resp) -	Consulting Engineers' Responsibilities in Delict when undertaking Design Checks'	Delictual liability; delict, contractual liability; errors and omissions, negligence, design check
PN56	LRD/resp/2		Guideline for independent review of the Designer's Work	FIDPM, designer, independent engineer, peer review, independent review, gateway review, risk treatment plan
PN53	LRD/resp/3		Alternative design and deviations in a civil engineering contract	Employer, designer, engineer, tenderer, contractor, alternative design, contractor's design, design deviations, design responsibility, turnkey, performance specification
PN6	LRD/resp/4		Turnkey projects and professional liability	Increased liability; under-design; performance guarantees; supervision/monitoring; repudiation of cover; fitness for purpose; turnkey
PN26	LRD/resp/5		Signing Contracts and other contract-related documents	Signatories; contacts, contractual documents; drawings, certificates; forms; instructions
PN54	LRD/resp/7		Retention of project drawings & records	Customer, records, preservation, legal requirements, document retention, electronic imaging, data messages
PN75	LRD/resp/8		Ownership of Engineering Work Product	Copyright, intellectual property, liability, ownership

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Professional Conduct & Development				
PN69	PCD/devm/1 (Archived)	Professional Development (devm) -	The marketing of professional services	Practice, professional service, marketing, selling, client/consultant relationship, value-added
PN70	PCD/devm/2 (Archived)		General guidance on publicity	
PN81	PCD/devm/4 (Archived)		Retired Principals in CESA	
PN9	PCD/intg/1	Integrity Mgmt (intg) -	Guideline for members' staff who become public representatives	Public Office, elected representative, conduct, integrity
PN82	PCD/intg/2		Corporate governance of a consulting engineering firm	Company, corporate governance, King IV report, governing body, director, conflict of interest, independence, ethics, integrity
PN78	PCD/intg/3 (Archived)		CESA Disciplinary procedure	
PN77	PCD/intg/6		The roles of ECSA and CESA	ECSA, CESA, Rules, By-laws, Code of Conduct, Registered Person, Member, Disciplinary Action
PN76	PCD/intg/7 (Archived)		Good professional conduct	Conduct, Code of Conduct, professional conduct, integrity management
Quality & Risk Management				
PN64	QRM/qual/1	Quality Aspects (qual) -	Structural failures in buildings - their cause and prevention	Structural failure, buildings, design process, construction process, risk, safety, insurance
PN44	QRM/qual/2		Implementing and maintaining a Quality Mgmt System	Quality Management System, ISO 9001:2015, accreditation, certification, Annual Declaration, self-Assessment
PN63	QRM/qual/3		Construction regulations: mandatory inspection of structures	Mandatory inspection, safety, structures, construction regulations, competent persons, safe for continued use, designers, owner, hazards, completion certificate
PN90	QRM/qual/4		Geotechnical Investigations, Legal and Professional Obligations	Geotechnical investigation, National Building Regulations, Occupational Health and Safety Act, site, dolomite, buildings, standards, codes, Department of Housing, township development, professional liability, collapse, PI insurance, accepted norms, failures, depth to rock, drilling methods, number of borings, remedial work, competence, soil conditions, structural designer, reasonable care, skill, diligence, negligence
PN91	QRM/qual/5		Transition from ISO 9001: 2008 to ISO 9001: 2015	Quality Management System, ISO 9001:2015, PDCA cycle, HLS

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Ref	Category	Sub Category	Title/Key Aspect	Keywords
PN14	QRM/risk/1	Risk Mgmt (risk) -	How to deal with Professional Indemnity claims	Claims; professional negligence; correspondence; engineering judgement; financial resources; professional fees; mistakes; reporting claims
PN39	QRM/risk/11		Determining the cost of working at risk and a success fee	Fees, risk, work at risk, pricing, success fee
PN66	QRM/risk/12		M&E Installations related to Civil Eng. Projects	Mechanical and electrical installations, design & supply, practice, consulting engineer, risk
PN11	QRM/risk/13		What to do when faced with a Professional Indemnity claim	Claims; professional negligence; correspondence; engineering judgement; financial resources; professional fees; mistakes; reporting claims
PN17	QRM/risk/14		Signing a "duty of care" undertaking	Duty of care; PI insurance, liability, risk, delict, breach, common law
PN92	QRM/risk/15		Unlimited Liability required by a Client	Unlimited liability, professional indemnity insurance, negligence, contract, sustainability, risk, indemnity
PN12	QRM/risk/2		An Engineer's liability for negligence	Negligence; contract; duty of care; remoteness of damage; immunity from claims; prescription, tort, delict
PN10	QRM/risk/3		How to reduce the consulting engineer's risks and exposure to claims	Risk, Claims, Exposure, Engineer's responsibility
PN43	QRM/risk/4		Legal risk mgmt :most important points	Risk management; professional liability; contract documentation, claims
PN15	QRM/risk/5		Legal risk mgmt service (LRMS)	Legal risk management; education; advice; assistance, AON, LRMS
PN16	QRM/risk/6 (Archived)		Minimum Professional Indemnity insurance cover	
PN13	QRM/risk/7		Guideline on reduced standards in civil engineering: potential for PI claims	Effective cost reduction; adequate cover; increased risk; disclaimers; indemnities, municipal services
PN62	QRM/risk/8		Consulting Engineer's responsibility & liability for pollution & environmental damage	Liability for pollution; liability for environmental damage; sustainable development; environmental impact assessment; professional indemnity insurance, NEMA, NEMA Section 28, NEMA Regulation 982.
PN40	QRM/risk/9		Working at risk	Work at risk, professional liability, liability, agreement

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Notes			
<p>There are currently 93 Practice Notes, PN's, available as follows on the CESA website for members. The website may be searched for PN numbers, categories, sub-categories and keywords as defined in this Appendix. The full list of PN's may alternatively be accessed as indicated on the website. Archived PN's that have been superseded are available on request.</p> <ul style="list-style-type: none"> • Use this APPENDIX as roadmap for the arrangement & content of the PN's • Note categories and sub-categories do not uniquely define topics • Identify possible keywords from this APPENDIX • Keywords appear in more than one PN • Particular topics may be dealt with in several PN's • Keywords are searched for in the full text of PN's • For simplicity search topics by single keywords • To search type the "keyword" in the search form, leave other fields blank, click "Search Now" and find search results at bottom • To search a Sub-category, first select the Category and then open the dropdown box to show the available Sub-categories under that Category 			

APPENDIX 12 – TABLE 1: POTENTIAL RISKS IN FEASIBILITY PHASE			
Potential risks	Possible remedies	Item checked	Action taken/Comment
1. Disputed communications	<ol style="list-style-type: none"> 1. Keep records of all telephone conversations, meetings, etc 2. Confirm all communication in writing 		
2. Insufficient / incorrect external information	<ol style="list-style-type: none"> 1. Ensure that up-to-date information is obtained from experienced professionals regarding geotechnical information; site surveys, specifications from third party equipment supplier, etc. 		
3. Incorrect design	<ol style="list-style-type: none"> 1. Ensure that all design assumptions are documented 2. Ensure that the design is performed by suitably qualified staff 3. Ensure that design software used is properly checked for accuracy of output. Manual calculation checks should be done to verify the output 4. Ensure that the design assumptions and actual designs are reviewed by an independent qualified staff member and that this review is documented, dated and signed 5. Ensure that all Joint Venture Partners are using the same design assumptions and do an independent review of the Joint Venture Partner's design 		
4. Design not "fit for purpose" or too expensive	<ol style="list-style-type: none"> 1. Ensure that the Client's expectations, specifications and time frames are documented. Clear up any ambiguities before commencing the design 2. Investigate alternative designs and materials that can be incorporated in the design. Ensure that the alternatives are based on reliable and proven information. 		
5. Incorrect or incomplete documentation.	<ol style="list-style-type: none"> 1. Ensure that the design documentation is in accordance with the design assumptions and the Client's brief 2. Ensure that final documentation has been checked for completeness and correctness 3. Ensure that documentation is distributed to the relevant parties in time to enable them to comment or provide additional information 4. Ensure that estimates prepared on the basis of your design includes adequate contingency amounts and that the assumptions on which the designs are based are documented 		
6. Confirmation of fees	<ol style="list-style-type: none"> 1. Reach agreement on the recoverability or otherwise of cost in the event that the project is not feasible or postponed 2. Ensure that provision is made in the fee agreement for additional fees in case of scope changes 		

APPENDIX 12 – TABLE 2: POTENTIAL RISKS IN APPOINTMENT PHASE			
Potential risks	Possible remedies	Item checked	Action taken/Comment
1. Disputed communications	<ol style="list-style-type: none"> 1. Keep records of all telephone conversations, meetings, etc. 2. Confirm all communication in writing 		
2. Failure to fulfil Client expectations	<ol style="list-style-type: none"> 1. Confirm brief in writing and clarify any areas of uncertainty 2. Provide a clear scope and programme of work in the proposal 3. List all items excluded from the scope of work 4. List any liability exclusion, eg asbestos 5. Provide a list of contract deliverables and estimated delivery dates 6. List all items, information, services or permissions to be provided by the Client 7. Confirm any limitations imposed by the Client (financial, programme, etc) on the scope of services in writing 8. Clearly establish the Client's requirements for the project with regard to quality, life expectancy, proposed use, performance, specification, capacity, etc 		
3. Consultant unable to deliver	<ol style="list-style-type: none"> 1. Ensure that you have the necessary skills and resources to carry out the project 2. Do not accept any unrealistic conditions that reduce your ability to perform such as programme or financial constraints. Avoid discounting your fee 3. Ensure provision is made for adjustment of delivery dates in the event of delays in the award of the contract or in the provision of items to be supplied by the Client 		
4. Client unable to fulfil obligations	<ol style="list-style-type: none"> 1. Make sure you know with whom you will be contracting particularly when the project is being run by a third party 2. Make enquiries about the track record and financial status of any new Clients especially when the Client has a history of switching consultants or failed projects 3. Ensure that the Client's representative is duly authorized to effect the transaction 4. Ensure that the Client has adequate funding in place 		
5. Adequacy of P.I. Insurance	<ol style="list-style-type: none"> 1. Ensure that your firm has adequate PI Insurance to cover the project 2. Ensure that your PI liability is limited in respect of duration and amount 		
6. Joint Venture agreements	<ol style="list-style-type: none"> 1. Assure that Joint Venture Agreements are in place where applicable 2. Ensure that the Joint Venture Agreements complement the main Client Agreement and that there are no conflicts 		
7. Confirmation of fees	<ol style="list-style-type: none"> 1. Calculation of the fee should be included in the agreement including recovery of disbursements 2. Ensure that provision is made in the fee calculation for additional fees in case of scope changes, etc 		
8. Occupational Health and Safety Act – Construction Regulations	<ol style="list-style-type: none"> 1. Ensure that the Client is aware of his duties in respect of the OHS Act and regulations (Construction Regulations) 2. Should the Client wish to appoint the Consultant as his agent, ensure that the appointment is in writing and adequate fees are payable for these duties 3. Ensure that you have the necessary skills and experience to accept the appointment as agent for the Client 		

APPENDIX 12 – TABLE 3: POTENTIAL RISKS IN CONCEPTUAL DESIGN PHASE			
Potential risk	Possible remedies	Item checked	Action taken/Comments
1. Disputed communication	<ol style="list-style-type: none"> 1. Keep record of all telephone conversations, meetings, etc. 2. Confirm all communication in writing 		
2. Insufficient / incorrect external information	<ol style="list-style-type: none"> 1. Ensure that up-to-date information is obtained from experienced professionals regarding geotechnical information, site surveys, etc. 		
3. Incorrect conceptual design	<ol style="list-style-type: none"> 1. Ensure that all design assumptions are documented 2. Ensure that the design is performed by suitably qualified staff 3. Ensure that design software used is properly checked for accuracy of output. Manual calculation checks should be done to verify the output 4. Ensure that the design is reviewed by an independent qualified staff member and that this review is documented, dated and signed 5. Ensure that all Joint Venture Partners are using the same design assumptions and do an independent review of the Joint Venture Partner's design 		
4. Design not "fit for purpose" or too expensive	<ol style="list-style-type: none"> 1. Ensure that a value engineering exercise is performed at the appropriate stages of the design cycle 		
5. Incorrect or incomplete documentation	<ol style="list-style-type: none"> 1. Ensure that the design output documentation is in accordance with the design assumptions 2. Ensure that documentation leaving your office has been checked for completeness and correctness 3. Ensure that schematic documentation is distributed to the relevant parties in time to enable them to make comments 4. Ensure that any estimate prepared on the basis of your design includes adequate contingency 		

APPENDIX 12 – TABLE 4: POTENTIAL RISKS IN DESIGN PHASE			
Potential risks	Possible remedies	Item checked	Action taken/Comments
1. Disputed communications	<ol style="list-style-type: none"> 1. Keep records of all telephone conversations, meetings, etc. 2. Confirm all communication in writing 		
2. Incorrect design documentation	<ol style="list-style-type: none"> 1. Ensure that the detail design is based on the approved conceptual design documents 2. Ensure that the design assumptions are documented 3. Ensure that the documentation is prepared by suitably qualified staff 4. Ensure that design software used is properly checked for accuracy of output. Manual calculation checks should be done to verify the output 5. Ensure that documentation is only issued after being checked and signed by a qualified professional staff member 6. Ensure that all authorizing authority requirements are met before documentation is issued 7. Ensure that Joint Venture Partners documentation adheres to all the requirements and are reviewed independently 		
3. Incomplete design verification	<ol style="list-style-type: none"> 1. Ensure that the design documentation provides sufficient detail to satisfy the following requirements <ol style="list-style-type: none"> 1.1. Build-ability issues 1.2. OHS Act requirements 1.3. Environmental requirements 2. Ensure that the final documentation conforms to the original design intent and project specification 		
4. Control of documentation	<ol style="list-style-type: none"> 1. Ensure that records are kept of all documentation issued as well as subsequent revisions 2. Ensure that copies, both hard copy and electronically, are filed in such a way that it is easily accessible to all interested persons 		
5. Inexperienced external service providers	<ol style="list-style-type: none"> 1. Should external service providers be used for the detailed design and documentation, ensure that: <ol style="list-style-type: none"> 1.1. The service provider is qualified and experienced to perform the work 1.2. His design assumptions are documented and checked 1.3. The service provider carries sufficient PI Insurance to cover his commitments under the project 1.4. Appoint the service provider on a back-to-back basis wherever possible 		
6. Inexperienced internal staff	<ol style="list-style-type: none"> 1. Ensure that junior and/or inexperienced staff are supervised 2. Undertake comprehensive design checks of all staff, especially junior and/or inexperienced staff 		
7. Scope creep	<ol style="list-style-type: none"> 1. Systematically and in detail document covert scope creep as it occurs 2. Notify the Client in terms of your agreement of such scope creep and timely submit claim for compensation 		

APPENDIX 12 – TABLE 5: POTENTIAL RISKS IN CONTRACT AWARD PHASE			
Potential risks	Possible remedies	Item checked	Action taken/Comments
1. Adjudicating tenders based on incomplete or incorrect information	<ol style="list-style-type: none"> 1. Ensure that all tender documents received comply to the prerequisite standards 2. Ensure that tender documents are collected and opened in an open and transparent forum 3. Ensure that decisions regarding tender awards are properly documented including reasons for accepting or rejecting tenders 4. Ensure that tenders are adjudicated on an unbiased and unprejudiced basis 5. Ensure that any Contractor initiated alternatives are fully evaluated and that re-design responsibility is clear 		
2. Appointing inexperienced Contractors	<ol style="list-style-type: none"> 1. Ensure that Contractors have the necessary experience, financial capability and management before a contract is awarded 		
3. Not complying with any legal requirements in appointed contracts	<ol style="list-style-type: none"> 1. Ensure that the provisions of the Preferential Procurement Policy Framework Act, 2000, the National Treasury legislation pertaining to Supply Chain Management and the prescripts of the Construction Industry Development Board are adhered to, where applicable 		
4. Legal requirements for appointing contractors	<ol style="list-style-type: none"> 1. Ensure that approved Contractors are appointed in writing making use of the appropriate documentation approved by the Construction Industry Development Board 		

APPENDIX 12 – TABLE 6: POTENTIAL RISKS IN IMPLEMENTATION PHASE			
Potential risks	Possible remedies	Item checked	Action taken/Comments
1. Disputed communications	<ol style="list-style-type: none"> 1. Keep records of all telephone conversations, meetings, etc. 2. Confirm all communications in writing 		
2. Delays, cost escalations or accidents due to improper site supervision	<ol style="list-style-type: none"> 1. Ensure that site supervision is carried out by suitably qualified and experienced staff 2. Ensure that site supervision is carried out in accordance with the agreed scope of service 3. Ensure that site staff are in possession of site monitoring checklist forms and that the forms include sufficient detail of items to be checked 4. A site monitoring check list should be completed during each site visit. A copy should be handed to the site representative of the Contractor and the original copy (signed by the Contractor) should be filed by the Consultant 5. Ensure that all site instructions are issued in writing and that the Contractors acknowledge receipt of on-site instructions in writing 6. Ensure that all site instructions are properly filed and followed up until completion 		
3. Prevention of accidents during construction	<ol style="list-style-type: none"> 1. Although a potentially dangerous situation may exist outside the Consultants area of responsibility all potential hazardous situations must be recorded in writing and brought to the attention of the relevant responsible persons 2. Avoid giving professional advice outside the staff members field of experience and training 		
4. Certification of progress payments without assessing work performed	<ol style="list-style-type: none"> 1. Ensure that progress payments are only made once a qualified person has inspected, measured and certified the work done 		
5. Uncoordinated revision of design documentation	<ol style="list-style-type: none"> 1. Ensure that documentation revisions are only done after careful consideration of all the implications of such a revision 2. Ensure that revised documentation is issued to all relevant parties in time 3. Ensure that revised documentation is filed in such a way that it is accessible to all interested persons 		

APPENDIX 12 – TABLE 7: POTENTIAL RISKS IN COMMISSIONING AND POST CONTRACT PHASE			
Potential risks	Possible remedies	Item checked	Action taken/Comment
1. Incomplete commissioning of systems	<ol style="list-style-type: none"> 1. Ensure that adequate time is allowed for commissioning and testing of equipment and systems 2. Document the results of all final testing and commissioning procedures 3. Prepare final snag lists and ensure that all items are followed up, corrected and signed off 4. Ensure that snagging and commissioning procedures are performed by suitably experienced staff 		
2. Incomplete information provided to Client	<ol style="list-style-type: none"> 1. Prepare, check and issue final record drawings to the client 2. Provide Client with up-to-date operating manuals and maintenance specifications 3. Provide the Client and all interested parties with a final list of names and contact details. Included in the list should be all the members of the professional team, Contractors and Subcontractors 		
3. Client perception of performance	<ol style="list-style-type: none"> 1. Obtain feedback from the Client and other professional team members regarding their perception of the following: <ol style="list-style-type: none"> 1.1. The alignment between the original scope of the project and the final delivered project 1.2. The Consultant's contribution towards adding value to the project 1.3. The Consultant's ability and quality of resources to undertake projects of a similar nature 1.4. The quality, accuracy and on-time production of documentation 2. Analyse the feedback received in 1 above to ensure that corrective action is taken in respect of areas of under-performance. 		