**Safety by Design for Electricity Distributors**

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How important is Safety by Design? No engineer will knowingly introduce hazards as part of his/her designs. So, Safety by Design has always been part of an engineer's design process, albeit it was done through a thought process and not necessarily well documented. Nowadays, this approach is no longer acceptable. For example, the Health and Safety in Employment Act requires hazards to be identified and the Electricity Act (S169A) talks about a systematic approach of identification of hazards. Neither acts refer directly to having design information, for example calculations, to be made available during the construction, operation and maintenance of the equipment. The proposed Health and Safety Reform Bill 2014 requires a designer to carry out specific tasks and have information available to support that the design is without risks to health and safety for the live of the equipment.

In addition to the present regulatory requirement with respect to health and safety in the workplace, electricity distributors have to comply with regulatory requirements for public safety. The Electricity Act 1992 Section 61A states that electricity distributors that own or operate an electricity system must implement and maintain public safety management systems.

This all means a sizable challenge for designers in the electricity distribution industry. The paper discusses the resources that are available to New Zealand designers, for example ISO 31000:2009, Risk Management-Principles and Guidelines, to manage their present and future regulatory obligations.
The paper also discusses how designers can use these resources to document their Safety by Design and introduces the concept of a Constructability, Operability, and Maintainability (COM) report. The combination of risk management assessment and the COM report may provide sufficient evidence that the design is safe.

# 1 Introduction

How important is Safety by Design (SbD)? No engineer will knowingly introduce hazards as part of his/her designs. So, SdD has always been part of an engineer's design process, albeit it was done through a thought process and not necessarily well documented. Nowadays, this approach is no longer acceptable. For example, the Health and Safety in Employment Act [1] requires hazards to be identified and the Electricity Act (S169A) talks about a systematic approach of identification of hazards and that regulation may be created around the design, construction, operation, maintenance, and inspection of the electricity supply system (S169A, subsection 2a).

In a report commissioned by the NZ Construction Industry Council in 2006 [2], Mike Cosman, Chief Advisor, of the then Department of Labour has stated the following:

> Safety in Design is the Holy Grail as far as most health and safety professionals are concerned. The higher up the supply chain you can go the easier it is to make changes that benefit everyone downstream. Most site level action is aimed at isolating or minimising the hazard, but the opportunity to eliminate a hazard at the drawing board through good design is one that should be seized with both hands. More importantly the design stage also offers the greatest opportunity to incorporate productivity improvements that can produce time and cost savings.

So let's embrace SbD as the best way to influence safety of assets over their design life. And let's get into the culture of documenting the process and assessment results as if it is second nature. In this way compliance is only a by-product.

As engineers, we are expected to use all means possible to provide safe designs. IPENZ and the Chartered Professional Engineers of New Zealand Act 2002 set the professional standards for engineers. These engineers have their competence regularly assessed, are listed on national registers, and may be subject to disciplinary action by their professional registration authorities. They are bound by the codes of ethics to work within their competence and assessed practice areas.

Having said that, for good order, lets tick off the compliance requirements first. Then we can concentrate on the process and guidelines of a SbD.

# 2 Legislation

## 2.1 Existing legislation

**The Building Act:**

In the civil and structural engineering discipline, there has been a longstanding requirement for designs that need compliance with the Building Act [3]. With this act, designers are required to issue Producer Statements for their designs. IPENZ has a Practice Note (Practice Note 1) [4] and a template of a Producer Statement available on this subject. A Producer Statement is a document prepared by an engineer confirming their professional opinion, based on stated reasonable grounds, that aspects of design of a building achieve compliance with the Building Act, or that elements of construction have been completed in accordance with the approved building consent.

IPENZ has several other documents and practice notes available (refer to section 8).

The Building Act has specific requirements for:

- producer statements by a registered engineer (the designer). IPENZ has agreed with the regulator that the term "Registered Engineer" is to be interpreted as a New Zealand Chartered Professional Engineer (CPEng). The certifier may also be the designer, or may take a computer model produced by a drafter and subject this to appropriate structural analysis, or may take responsibility for design work carried out by others.
- dam safety
- fire safety design

**The Health and Safety in Employment Act**

The Health and Safety in Employment Act [5] impacts engineers. IPENZ Practice Note 04 [6] provides awareness for engineers in relation to this act. The act does not state specific requirements around SbD. It talks about 'systematically identify, assess, manage and monitor existing and new hazards', but does not use the word design.

**The Electricity Act**

The Electricity Act [7] requires management of hazards (section 169A) but again has no specific requirements for design of works; this is left to the Electricity (Safety) Regulations (ESR) [8].

There is a reference to design made in the interpretation of 'prescribed electrical work'. Under schedule 1 of the ESR design of 'works' is not 'prescribed electrical work'.

More importantly section 61A requires electricity distributors to implement and maintain a safety management system.

The ESR has many references to design, but caution is required. It makes a distinction between works and electrical installations.

Part 4 of the ESR covers safety of works, which can be used as part of a design checklist.

## 2.2 Proposed legislation

The Health and Safety Reform Bill will create the new Health and Safety at Work Act [9], replacing the Health and Safety in Employment Act 1992. The Government's intention is that the Bill will be passed in 2014, with the new Act coming into force from 1 April 2015. More information can be found on the Ministry of Business, Innovation & Employment website.[1]

The draft act has some very specific requirements on a designer. This is a summary of section 34 of the proposed act:

1. Section 34 applies to a designer who conducts a business or undertaking that designs—
    a) plant that is to be used, or could reasonably be expected to be used, as or at a workplace; or
    b) a substance that is to be used, or could reasonably be expected to be used, at a workplace; or
    c) a structure that is to be used, or could reasonably be expected to be used, as or at a workplace.
2. The designer must, so far as is reasonably practicable, ensure that the plant, substance, or structure is designed to be without risks to the health and safety of

[1] http://www.mbie.govt.nz/what-we-do/workplace-health-and-safety-reform

persons who, at a workplace, use the plant, substance, or structure for a purpose for which it was designed.

3. The designer must carry out, or arrange the carrying out of any calculations, analysis, testing, or examination that may be necessary for the performance of the duty imposed by item 1.
4. The designer must give to each person who is provided with the design for the purpose of giving effect to it adequate information concerning:
    a) each purpose for which the plant, substance, or structure was designed; and
    b) the results of any calculations, analysis, testing, or examination referred to in item 3, including, in relation to a substance, any hazardous properties of the substance identified by testing; and
    c) any conditions necessary to ensure that the plant, substance, or structure is without risks to health and safety when used for a purpose for which it was designed or when carrying out any activity referred to in item 2.
5. The designer, on request, must, so far as is reasonably practicable, give current relevant information on the matters referred to in item 4 to a person who carries out, or is to carry out, any of the activities referred to in item 1.

It will be worthwhile reading the full section 34 of the proposed act.
It is still too early to know what regulations will compliment section 34.

So designers will need to document their designs and safety assessment of their designs. They also need to make this available while the assets are constructed, operated and maintained.

## 3 Safety by Design Process

The main objective of a SbD process is to ensure that the design is such that it does not introduce new hazards during the construction, operation and maintenance.
A secondary objective should be that the process identifies issues around constructability, operability and maintainability. Issues could be that the asset owner suffers high outage cost (customer minutes lost or monetary cost). The most suited process for evaluating the safety of designs is that of a risk management approach.

The deliverables of the SbD process should be a documented risk assessment showing initial and mitigated risk scores and a COM report. More on this COM report later in the paper.

The risk assessment approach is well documented in industry guides and standards. A good example of designing using a risk based approach is the EEA Guide to Power System Earthing Practice [10]
Some available methods are:

- Failure Modes and Effects Analysis (FMEA) is a systematic, proactive method for evaluating a design to identify where and how it might fail and to assess the relative impact of different failures, in order to identify the parts of the design that are most in need of change.
- ISO 31000:2009, Risk Management - Principles and Guidelines and ISO 31010:2009, Risk Management – Risk assessment techniques. ISO 31000 replaces AS/NZS 4360:2004.
- Hazard and Operability Analysis (HAZOP) is a structured and systematic technique for system examination and risk management. In particular, HAZOP is often used as an technique for identifying potential hazards in a system and identifying operability

problems. HAZOP is based on a theory that assumes risk events are caused by deviation from design or operability intentions.

- Reliability Centred Maintenance (RCM) is a process to ensure that assets continue to do what their users require in their present operating context. This option could be considered controversial. This technique is designed for maximising reliability, but in doing so, you could argue that you also reduce hazards associated with your assets.
- NZS7901:2008 Electricity & Gas Industries - Safety Management System for Public Safety. This standard is now cited by the ESR section 48 as a means of compliance. This standard is also supported by an EEA handbook, Public Safety Management System toolkit and an audit tool.

NZS 7901 is the most obvious choice for electricity distributors in New Zealand, but any of the options above are suitable, as long as you comply with ESR sections 49 and 50.

The SbD risk assessment should be done initially by the designer, but input from the persons installing, operating, and maintaining the assets is invaluable. Therefore, it is suggested to carry out a combined assessment with installers, operators and maintainers in a combined session. Sometimes, it is recommended to also include equipment suppliers in the process.
Only this way, it can be expected that the assessment is complete.
Another advantage of having all concerned persons together is that an assessment can be done on the constructability, operability, and maintainability (COM) of the assets. Otherwise, it is possible that even though the design is safe, it may be impossible or very expensive (both in cost and SAIDI impact) to maintain the asset.

The result of the process is a documented safety assessment and a COM report. The COM report will be a guide to writing operating and maintenance procedures for the assets. The COM report will also highlight constructability issues that need to be carefully specified in construction contracts (and tender documents).
The value of a COM report is even more important where the design is not done by the asset owner.

When the assessment results in modifications to the design, a re-assessment should be completed.

## 4 Checklist

It is recommended to use a check list for the SbD process, to ensure certain aspects are not overlooked.
Sections 11 and 12 of the EEA handbook for SMS for Public Safety [11] provide some useful information for compiling checklists. Also sections 34, and 39 to 46 of the ESR, even though not compulsory under a safety management system, can still provide useful items for a SbD checklist.
The EEA guide on connection of HV installations is another good source of information.

Other items that could be included in checklists are:

1. Records of unmitigated and mitigated risk scores
2. Any certificates of conformities?
3. Any producer statements?
4. Drawings
5. Specifications
6. Tender documents

7. Commissioning covered?
8. Special tests needed?
9. Foot print measurements for condition monitoring?
10. List of applicable standards
11. Acceptance criteria
12. Any items specifically excluded?
13. Demarcations?
14. Any Hazardous Substances and New Organisms Act issues?
15. Any environmental issues/considerations such as:
    a. Land
    b. Operating (ambient) temperatures
    c. Water
    d. Flora
    e. Fauna
    f. Topography
    g. Geological characteristics
    h. Access
    i. Pollution
    j. Noise
    k. Overheight vehicle loads
    l. Vehicle strike
16. Training
17. Skill levels requirements for construction, operation and maintenance
18. Lead time for equipment
19. Safety during manufacturing of equipment
20. Rating of assets
21. Operations in abnormal conditions
22. Is purchased equipment on a pre-approved list?
23. Checks on constructed according to design?
24. Required manuals
25. As built documentation
26. Planned Maintenance (PM) schedules

## 5 Documentation

Documentation is a requirement of the ESR required safety management system. NZS7901 requires documentation to be legible, identifiable and traceable to the activity, product, or service involved. Also, records shall be stored and maintained in such a way that they are readily retrievable and protected against damage, deterioration, or loss. Their retention times shall be established and recorded.

This applies to the SbD process and its risk based assessment. For compliance with the proposed Health and Safety at Work Act, the documentation should also extend to the design itself, for example calculations.

## 6 Conclusions

Even though there are no specific design requirements in any present New Zealand acts with respect to electricity distributors, there is still a requirement to ensure designs do not introduce new hazards.

The differences between works and electrical installations, as defined in the Electricity Act, will be blurred by the proposed Health and Safety at Work Act where requirements on designers makes no such distinction.

To best comply with the existing legislation, have a documentation process for SbD. This will assist you in also complying with the proposed legislation.

Ensure that the right persons are involved in the SbD process. A quote by Eleanor Roosevelt comes in mind: 'Learn from the mistakes of others. You cannot live long enough to make them all yourself.'

The COM report is a useful document in identifying hazards, constructability, operability, and maintainability.

## 7 Future

Will we see a similar regime as in the structural design industry which will require electrical designers to issue a Producer Statement for their designs? This could be mandated by the Health and Safety in Work Regulations.
Will we see the requirement that these Producer Statement for works can only be issued by a Chartered Professional Engineer? If this happens, we could see many electrical engineers seeking CPEng status.

We will have to wait for the draft regulations before we will know the answer to these questions.

## 8 Resources

The following websites and organisations provide useful information on the topics discussed in this paper.

- IPENZ http://www.ipenz.org.nz/ipenz/publications/?g=2&CatID=33
- New Zealand Legislation website http://www.legislation.govt.nz/
- EEA website http://www.eea.co.nz/Category?Action=View&Category_id=29
- Cigre, IEC, ISO, IEEE and AS/NZS
- HAZOP:http://www.oshrisk.org/assets/docs/Tools/3%20Conduct%20Risk%20Assessments/HAZOP_Training_Guide.pdf
- RCM: http://standards.sae.org/ja1011_199908/
- HAZAN: http://www.theiet.org/factfiles/health/hsb46b-page.cfm
- HAZOP: http://www.oshrisk.org/assets/docs/Tools/3%20Conduct%20Risk%20Assessments/HAZOP_Training_Guide.pdf
- Safe Work Australia: http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/managing-electrical-risks-in-the-workplace and http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/gm2006principlesofsafedesign

## 9 References


[1] Health and Safety in Employment act 1992, http://www.legislation.govt.nz/act/public/1992/0096/latest/DLM278829.html?src=qs

[2] Safety in Design in Construction, Research Report, April 2006, New Zealand Construction Industry Council. http://www.nzcic.co.nz/Safety_in_Design.pdf

[3] New Zealand legislation, The Building Act 2004. http://www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html?src=qs

[4] IPENZ Practice Note 1. https://www.ipenz.org.nz/ipenz/forms/pdfs/PN01-Guidelines-on-Producer-Statements.pdf

[5] New Zealand legislation, the Health and Safety in Employment Act 1992. http://www.legislation.govt.nz/act/public/1992/0096/latest/DLM278829.html?src=qs

[6] IPENZ Practice Note 04. http://www.ipenz.org.nz/ipenz/forms/pdfs/PN04_Safety.pdf?99682

[7] New Zealand legislation, the Electricity Act 1992. http://www.legislation.govt.nz/act/public/1992/0122/latest/DLM281858.html?src=qs

[8] New Zealand legislation, the Electricity (Safety) Regulations 2010, http://www.legislation.govt.nz/regulation/public/2010/0036/latest/DLM2763501.html?src=qs

[9] New Zealand legislation, the Health and Safety Reform Bill http://www.legislation.govt.nz/bill/government/2014/0192/latest/DLM5976660.html and http://www.business.govt.nz/worksafe/news/releases/2014/health-safety-reform-bill-introduced

[10] EEA Guide to Power System Earthing Practice June 2009, http://www.eea.co.nz/Category?Action=View&Category_id=289

[11] EEA SMS for public Safety – Handbook – July 2011. http://www.eea.co.nz/Section?Action=View&Section_id=451



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