ZERO HARM

Health and Safety in Design Minimum Standard

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VERSION 2

NZ TRANSPORT AGENCY WAKA KOTAHI

New Zealand Government

More information

NZ Transport Agency
October 2014

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This document is available on the NZ Transport Agency's website at www.nzta.govt.nz

DOCUMENT MANAGEMENT PLAN

Purpose

This management plan outlines the updating procedures and contact points for the document.

Document information

DOCUMENT NAME	Health and Safety in Design Minimum Standard
DOCUMENT NUMBER	ZH/MS/01
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DOCUMENT OWNER	Manager, Zero Harm – NZ Transport Agency
DOCUMENT SPONSOR	Manager, Zero Harm – NZ Transport Agency

Amendments and review strategy

All corrective action/improvement requests (CAIRs) suggesting changes will be acknowledged by the document owner.

	COMMENTS	FREQUENCY
Amendments (minor revisions)	Updates incorporated immediately they occur.	As required
Review (major revisions)	Amendments fundamentally changing the content or structure of the document will be incorporated as soon as practicable. They may require coordinating with the review team timetable.	Two yearly
Notification	All users that have registered their interest by email to zeroharm@nzta.govt.nz will be advised by email of amendments and updates.	Immediately

Other information (at document owner's discretion)

There will be occasions, depending on the subject matter, when amendments will need to be worked through by the review team before the amendment is actioned. This may cause some variations to the above noted time frames.

RECORD OF AMENDMENT

AMENDMENT NUMBER	DESCRIPTION OF CHANGE	EFFECTIVE DATE	UPDATED BY
2	Zero Harm Industry Group review and update	October 2016	Nick Gluyas

ACKNOWLEDGEMENTS

This document provides Health and Safety in Design minimum standards for the NZ Transport Agency. The original document was produced by an industry working group representing the Association of Consulting Engineers New Zealand (ACENZ) for the Transport Agency State Highway. Subsequent revisions have been led by the Transport Agency's Zero Harm Industry Group

Contact us

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CONTENTS

1. INTRODUCTION

Design evolves as part of an iterative process. Intuitively designers should consider the life cycle of a project: from concept/feasibility to detailed design, constructability and then go onto consider the future use, maintenance and refurbishment/demolition of their project.

This thought process should not stifle innovative design; it's an opportunity for designers to stretch industry boundaries to create practical pragmatic design solutions.

1.1 What is Health and Safety in Design?

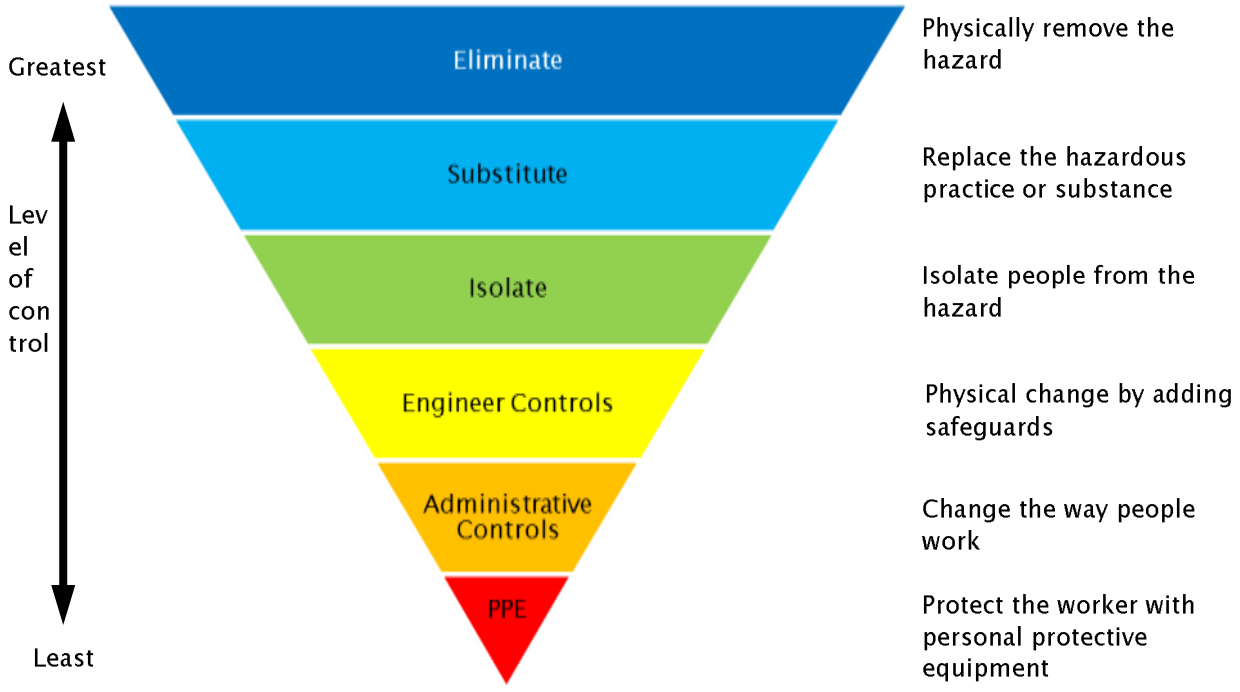
Health and Safety in Design is a process that integrates hazard identification and risk assessment methods early in the design process. The standard considers how to eliminate, substitute, isolate or minimise the risks of death, injury and ill health to those who will construct, operate, maintain, decommission or demolish an asset.

Health and Safety in Design begins in the conceptual and planning phases of a project. The emphasis is on making the right choices about the design as early as possible to enhance the health and safety of the project. These choices may include appropriate methods of construction, on-going maintenance provisions, or materials used.

Most construction health and safety risk mitigation is aimed at isolating, informing or controlling the hazard. The opportunity to consider the life cycle of the project and involve decision makers in the early design stages to eliminate a hazard is invaluable. The earlier you can begin this process in the design stages, the easier it is to make changes that benefit everyone. The design stage offers the greatest opportunity to incorporate improvements that can produce time and cost savings over the life of the asset.

The hierarchy of control sets out the prioritised approaches that can be adopted to managing hazards. The key principle is that *prevention is better than protection*. This means that it is better to eliminate hazards than to try to manage or control them.

The hierarchy of hazard control when considering Health and Safety in Design should be consistent with Sections 5 – 8 of the Health and Safety at Work (General Risk and Workplace Management) Regulations 2016 as described below.



1.2 Why consider Health and Safety in Design?

There are a number of reasons for following a Health and Safety in Design process including:

A. Reducing the risk of directly, or indirectly, causing harm to people throughout the life cycle of an asset
B. Continually challenging and improving designs.
C. Changes made early in the design stage are more cost effective than retrofitted changes (to resolve issues) made during operation and maintenance.
D. Better health and safety outcomes can be achieved by considering and reconciling the interests of different parties involved with an asset.
E. Designers have a duty of care to create safe places to live and work.

1.3 Who is the designer and who should be involved?

The designer (or design team) generally includes anyone who has control or influence over, contributes to, modifies, or has input into the design, construction and use of the infrastructure asset. As such, a person representing the asset owner, designer or contractor including people from communications, planning, commercial and financial teams could be considered to be part of the design team, if they influence design decisions.

Everyone involved in the life cycle of the plant, substance or structure can be involved in health and safety in design. This includes persons conducting a business or undertaking (PCBUs), workers and officers, as well as professionals involved in design such as architects, engineers and industrial designers. They may be involved in design at the outset or at a later stage of the life cycle, for example redesign or modification of existing plant.

Other groups who make design decisions which can affect health or safety include:

- Clients and property developers
- Owners and insurers
- Project managers
- Financiers and purchasers
- Occupational health and safety professionals
- Importers, suppliers and manufacturers
- Plant-hirers, builders, constructors and installers
- Trade and maintenance personnel.

People who have responsibility for designing work processes and systems also have a role in health and safety in design. They include, for example, health and safety officers, managers, human resources personnel, information technology designers and systems engineers and those responsible for designing shift rosters, organisational structures, computer systems, work layout and configuration.

1.4 Who are we protecting?

In undertaking work we must demonstrate that we have taken steps to minimise risks that could affect the health and safety of those who may be affected by the investigation, construction, operation, maintenance, modification, decommissioning and demolition of the project works.

People who may be affected include those who:

- Undertake physical work including site investigations, fabrication, installation and construction
- Are involved in testing and commissioning
- Supply equipment or materials
- Are involved in inspections, operations and maintenance
- Are involved in the modification, alteration, dismantling, decommissioning or demolition of any part of the installed works
- Are not directly involved with the project but who (as third parties) may be exposed to project-related activities during construction, operation, maintenance, decommissioning; and demolition activities. These may include adjacent landowners and tenants, road users, pedestrians and members of the public.

1.5 What are we protecting people from?

We need to protect the individuals and groups listed above from risks that are reasonably foreseeable. We need to incorporate measures that are reasonably practical to protect their health and safety.

1.6 Legal requirements

The Health and Safety at Work Act 2015 (HSWA) requires PCBUs who design substances, plant or structures to take all reasonably practicable steps to protect workers and other persons against harm to their health, safety, and welfare by eliminating or minimising risks arising from work.

PCBUs have a primary duty of care obligations for not only their organisation and workers, but also workers whose activities in carrying out work are influenced or directed by the PCBU, while the workers are carrying out the work. Sections 36 to 43 of the HSWA explain those duties.

Designers, who work for the PCBU, therefore have a duty of care to ensure, so far as reasonably practicable, that their designs are without risk to the health, safety and welfare of workers.

1.6.1 Reasonably practicable

Section 22 of the HSWA defines 'reasonably practicable' as something which is, or was, at a particular time, reasonably able to be done in relation to ensuring health and safety, taking into account and weighing up all relevant matters including

- the likelihood of the hazard or the risk concerned occurring; and
- the degree of harm that might result from the hazard or risk; and
- what the person concerned knows, or ought reasonably to know, about the hazard or the risk; and the ways of eliminating or minimising the risk; and
- the availability and suitability of ways to eliminate or minimise the risk; and
- that after assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with available ways of eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.

The Health and Safety in Design process aims to address the above matters by designing out safety risks where it is reasonably practicable to do so.

It is the PCBU's (e.g. Transport Agency Project Manager) responsibility to endorse the mitigation measures proposed by the Health and Safety in Design process and if required, rule on what is reasonably practicable. Whole of life costing may help with prioritisation of potential risk mitigation options.

1.7 Benefits of a Health and Safety in Design approach

The benefits of embedding Health and Safety in Design principles into the project life cycle include:

A. Taking every opportunity to proactively reduce the risk of death, injury and ill health during the life of an asset
B. Commissioning designs, that so far as is reasonably practicable, do not present a health or safety risk
C. Addressing health and safety even when reviewing the initial options
D. Committing to designing out health and safety risk
E. Creating an environment for honest and open discussion amongst the wider design team
F. Committing to continual improvement and sharing of knowledge

To maximise benefits Health and Safety in Design requirements should be embedded in appropriate policy documents, including but not limited to procurement plans, asset plans, safety management systems and development codes.

2. HEALTH AND SAFETY IN DESIGN SCOPE

Health and Safety in Design minimum standards apply to all those involved in the design process and to all phases of the design. As part of the design process, consideration must be given to safety and ill health throughout the life cycle of the asset. This includes reviewing preferred options, and how the asset can be constructed, operated, maintained, decommissioned or demolished safely.

2.1 Principles of Health and Safety in Design

The key principles that impact achieving Health and Safety in Design are:

Coordinate, communicate and cooperate
Use effective team collaboration to identify project health and safety risks so that all those involved with the asset are safeguarded; understanding the implications of decisions on others.
People with control
People who make decisions affecting the design of project can promote health and safety at the source.
Project lifecycle
Safe design applies to every stage in the project life cycle – from concept through to disposal. It involves eliminating hazards and/or minimising risks as early in the life cycle as possible.
Systematic approach
The application of hazard identification, risk assessment and risk control processes to achieve safe design (e.g. NZTA Z/44).
Safe design knowledge and capability
People with control over design should either demonstrate or acquire the necessary safe design knowledge and capability.
Information transfer
Essential for the safe design approach is the effective communication and documentation of design and risk control information, between those involved in the phases of the asset life cycle.
Lessons repository
Collect learnings and examples from Health and Safety in Design workshops to make good ideas available and therefore collectively help the construction industry be safer.

2.2 Project life cycle

The project life cycle is the process of managing the entire life cycle of an asset from concept, through design and construction, to operation, maintenance and decommission or disposal. As a member of the design team you have various points through this cycle where you can influence the health and safety outcomes of the project e.g. providing investigation information to end user specifications.

Below is a diagram showing the general life cycle of an infrastructure project.

2.3 Responsibilities during the project life cycle

The project team must integrate Health and Safety in Design requirements into their project. The team must also encourage collaboration to improve planning and management and the early identification of hazards. This helps the team focus their efforts on where they can have the most significant impact on health and safety.

Designers have a responsibility to cooperate, communicate and coordinate with others to ensure the health and safety of all those who may be affected by the asset. This includes positively influencing a project through the effective planning and management of risks. The design team must integrate the Health and Safety in Design minimum standard into projects. The team must also encourage collaboration to improve planning and management and the early identification of hazards. This will help the team focus their efforts on where they can have the most significant impact on health and safety.

Vendors and suppliers of equipment and materials also have particular obligations relating to the provision of information about risks associated with their products, and control measures required to keep people safe during the storage, installation, testing, commissioning and use of their product

It is the Transport Agency's (the PCBUs) responsibility to provide information on existing hazards associated with a project, make decisions relating to potential risks, hazards, and the mitigation measures identified by the Health and Safety in Design process (e.g. endorse and accept), and if required, rule on what is reasonably practicable.

The tables found in Appendix C set out the various team responsibilities through the project lifecycle. All parties must recognise the need to consider operation, maintenance, decommissioning and demolition requirements.

2.4 Demolition or decommissioning

Demolition or decommissioning may be a distant prospect at the start of the concept design stage. Alternatively, it may be more immediate if it is temporary works or even the specific reason for the project itself. This will influence the degree to which the design team can viably consider demolition and/or decommissioning aspects.

At the concept design stage, consideration should be given to whether common demolition methods are likely to be adequate. Some projects will have higher risks or complex demolition requirements that need to be taken into account. In those cases, the design considerations need to be more comprehensive and demonstrate that the health and safety risks have been considered. Decommissioning should also be considered, at least in general (high level overview) or in more detail if specific methods are required.

Projects where demolition or decommissioning is the immediate objective will generally be staged or of short duration.

2.5 Road safety audit

The road safety audit process provides an operational, road-user focused view of the likely safety effects/outcomes of design decisions. It is a valuable input to the Health and Safety in Design process. Audit outcomes ideally should be available in time for review workshops.

3. WHEN TO UNDERTAKE HEALTH AND SAFETY IN DESIGN

Health and Safety in Design is a process that should happen all the time, running continuously throughout the project. It should not be watered down to just two discrete meetings that occur at pre-determined hold points in a project programme, albeit review workshops collate the thinking and are a key aspect of a robust process.

A robust Health and Safety in Design process builds a knowledge base in early project phases that can be handed over and built on in subsequent phases. At the Detailed Business Case stage the focus should be concentrated on Hazard ID, flagging key design risks, and suggesting further investigation. At the Pre Implementation phase the focus moves to evaluating the key risks and designing out or around the big issues (e.g. ID and design out where possible). Towards the end of the Pre-Implementation phase the focus shifts towards mitigation measures and eliminating/reducing residual risks and providing quality handover information that can be used to influence the Construction methodology.

Health and Safety in Design review stages should not be seen as rigid, as not all projects will follow the same procurement strategy and some projects may skip some of the development steps. From a Health and Safety in Design perspective, the earlier a review is undertaken the easier and less expensive it is to adopt design changes. It is the responsibility of the asset owner (e.g. Transport Agency Project Manager) and the design manager to plan the Health and Safety in Design process and agree appropriate timings for reviews.

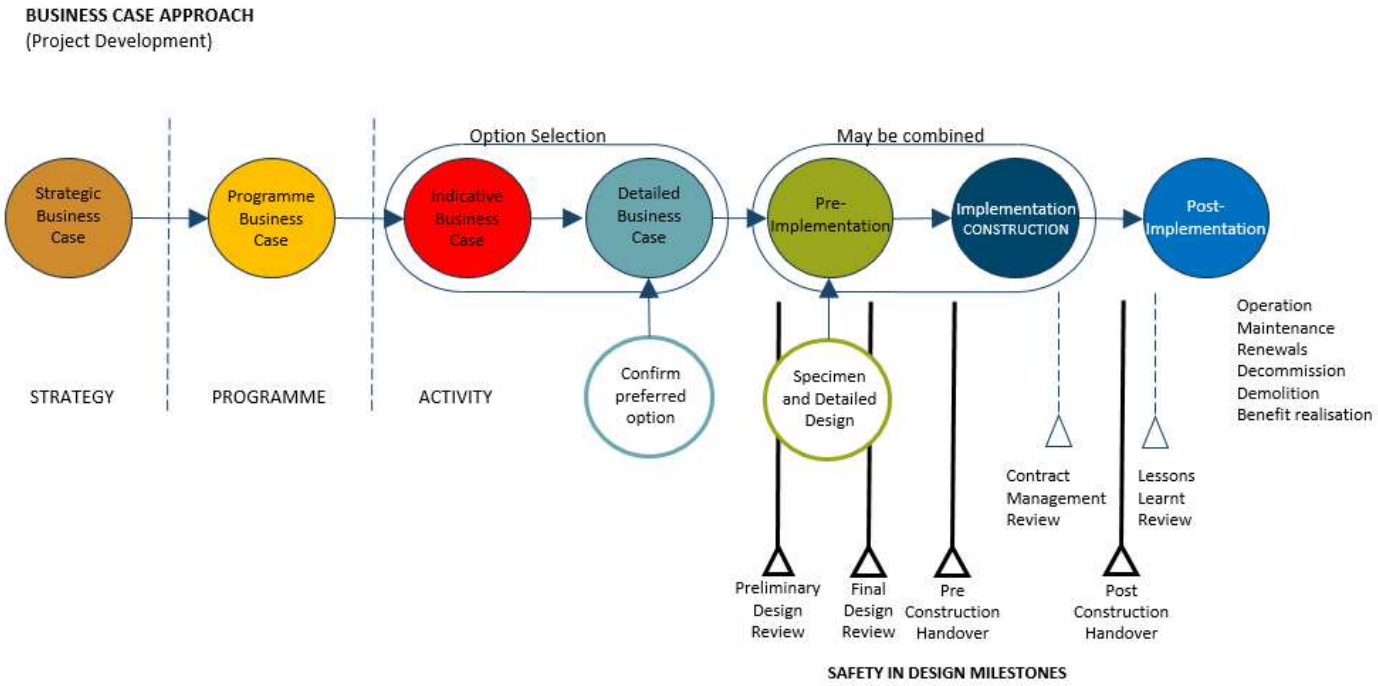
To identify issues early, it is recommended that reviews are carried out at two stages (minimum) during the project development cycle.

The first review stage should be early in the Pre-Implementation phase to either inform (or review) the preferred option before it proceeds onto final detailing. The second review stage should be during the final detail design phase as soon as enough information is available for discussion, and not too far along that it is difficult to make design changes (e.g. between 40-60% complete). A Health and Safety in Design review carried out at the very end of the final detail design phase should be avoided as it is often too late and impractical to make significant design changes.

The principles of Health and Safety in Design apply to all procurement models. However, for some models (such as the Design and Construct, Public-Private Partnerships and/or Alliancing), additional and more complex Health and Safety in Design requirements may apply to the specimen design, pre-tender, tender (potentially multiple designs to review) and post-award stages. The client should outline the specific process to be followed for any particular project at the start of the project development cycle.

The number of review meetings undertaken at each stage will depend on the projects complexity. Large multi-disciplined projects that are complex (e.g. significant structures, tunnelling, etc.) may need to be broken into a number of discipline or area specific reviews. Simple projects that involve common construction and maintenance techniques may only require brief reviews at each stage.

The following diagram gives an indication of where specific review meetings could be held.



3.1 Concept design review stage

At the commencement of the concept design phase, the design team leader must understand the scope and design requirements of the project. They should review the project brief to ensure they understand the preliminary health and safety risks of the project. The design team leader must also make sure they have the right documents, standards, procedures and people in place to follow the Health and Safety in Design process. Appendix A contains a checklist that can be used to help manage this process.

The design team leader should also understand and agree with the Health and Safety in Design process from the onset of the project. They should establish the number of reviews required and at what point in the concept design the reviews should take place.

As the concept design is developed, thought should be given to any surrounding hazards e.g. working over/near water, at depth or height, land contamination and adjacent construction sites (see Appendix B for prompt words). This information, together with any existing information such as historical or general background and design requirements, should form a base for the first Health and Safety in Design review.

Concept design reviews can be carried out in a number of ways including:

A. design review meetings
B. conversations with appropriate teams members
C. constructor input/constructability workshops
D. Health and Safety in Design workshops.

An agenda template for a Health and Safety in Design workshop can be found in Appendix C.

To achieve a successful outcome, the design team leader should:

A. Create an honest and open environment to enable coordination, communication and cooperation.
B. Ensure the right people are invited to the review. This should include representatives from the PCBU (Transport Agency), maintenance and operations staff, and decommissioning staff – not just the designer and contractor. It should also include people with appropriately experience for their area of contribution.
C. Visit the site at least once and provide photographs of the site at the review.
D. Engage a facilitator (if required) and ensure they are given an appropriate amount of time to prepare.
E. Ensure all the appropriate drawings and design information is available to the attendees well in advance.
F. Direct attendees to lessons recorded on the Transport Agency's Zero Harm website http://www.nzta.govt.nz/safety/zero-harm/
G. Ensure the Health and Safety in Design review is carried out appropriately using a systematic approach.
H. Actions are recorded and managed.
I. Documentation is completed at concept design stage and made available for the detail design.

Output from the Health and Safety in Design reviews should inform decision making regarding which design option to progress, materials to be used, or which construction methodologies are appropriate.

There are a number of ways to present the outputs from the reviews. These may include:

A. file notes
B. spreadsheets/risk registers
C. minutes of meetings
D. hazard identification drawings (e.g. residual risks shown on drawings with clouds so field workers can understand any issues without needing the risk register.
E. designers risk assessment
F. lessons learned uploaded to the Zero Harm website http://www.nzta.govt.nz/safety/zero-harm/

3.2 Detail design review stage

Once the detail design stage commences all prior Health and Safety in Design documentation should be reviewed to ensure it is complete and understood. The design team leader should agree the number of Health and Safety in Design reviews required during the detail design phase and at what point they should take place. Again, the reviews can take many forms and at various stages through the project design lifecycle. Appendix D contains a checklist can be used to help manage this process.

A Health and Safety in Design review focused on construction hazards, maintenance and operational hazards, renewal hazards and demolition hazards should be carried out at least once during the detail design stage. However, as design is an iterative process, it will usually involve refinement or changes as a result of further discussions and considerations. Therefore it is important to review the risks and hazards identified to ensure items are closed out and ensure any new hazards that are introduced or identified are managed appropriately. For larger projects this may occur though a number of workshops or design meetings.

The design team leader should:

A. Ensure the right people are invited to the review.
B. Carry out a site visit where possible, with a constructor (or team member) and a maintenance contractor (or operations team member) with the appropriate experience.
C. Provide the facilitator (if required) an appropriate amount of time to prepare.
D. Ensure all the appropriate drawings and design information and previous risk assessments are available to the attendees well in advance of the review.
E. Direct attendees to lessons recorded on the Transport Agency's Zero Harm website http://www.nzta.govt.nz/safety/zero-harm/
F. Ensure the Health and Safety in Design review is carried out appropriately using a systematic approach (see Section 6).
G. Ensure remaining actions are closed, updated or recorded and managed.
H. Ensure Health and Safety in Design documentation is completed and made available the contractor, the asset owner and the maintenance contractor.

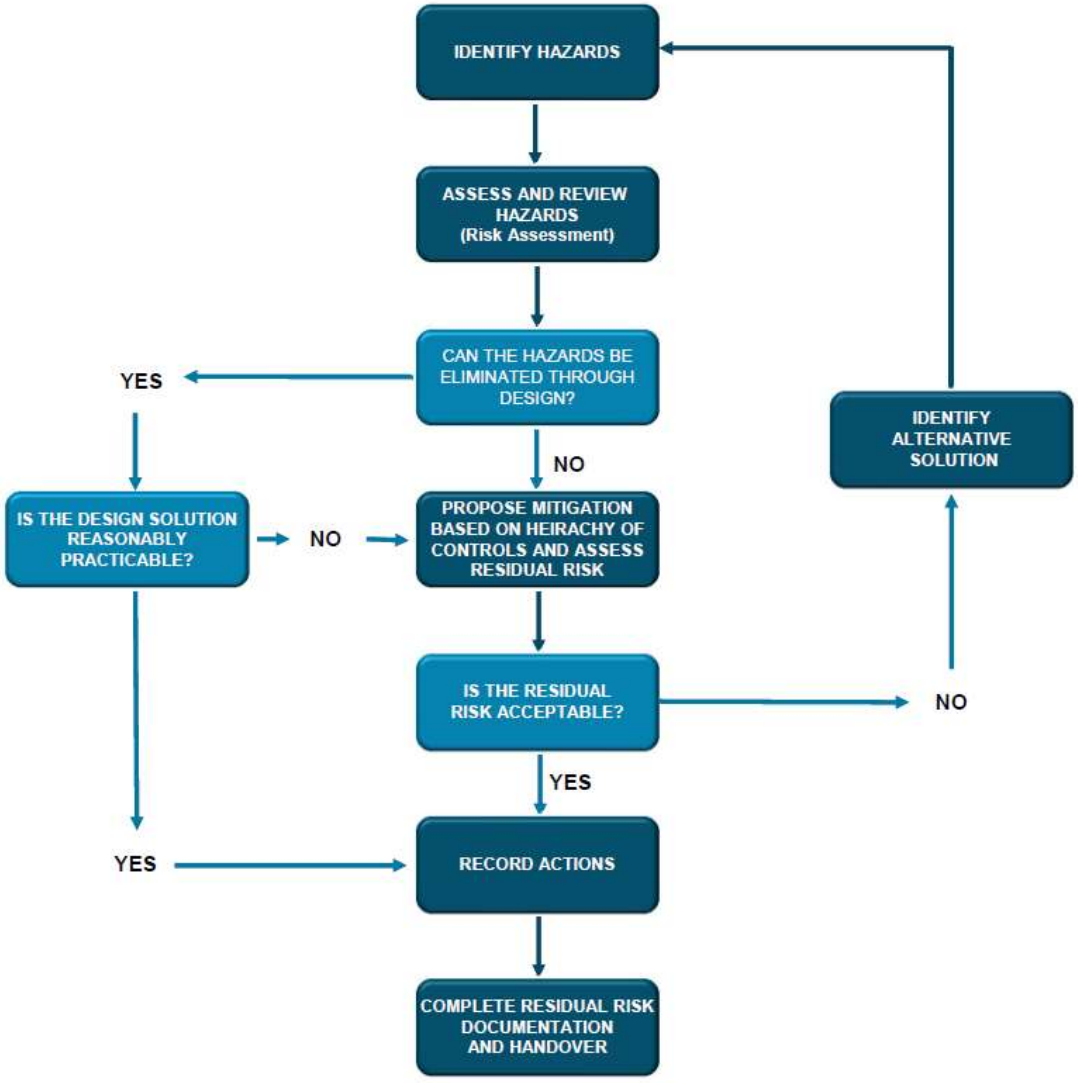
Again, handover documentation can take various forms; the key is clear and effective communication. The people on the ground doing the job every day must be included in this process. These are the people who have to construct, maintain, renew and operate the asset. These resources should not be overlooked but embraced and used to the fullest potential.

Designers should take the opportunity to visit similar projects to get an understanding as to what plant may be used during construction, how the site will look once it is operating, and how maintenance activities will be undertaken.

4. HOW TO CARRY OUT A HEALTH AND SAFETY IN DESIGN REVIEW

4.1 Reviews

A review should be a systematic process of establishing the context, identifying, analysing, evaluating and communicating the risks. The reviews are undertaken during design in order to eliminate, substitute, isolate or control foreseeable risks which may occur in the construction or subsequent phases of the project life cycle.



A guideline to Health and Safety in Design review methodology and guide words can be found in Appendix H.

4.2 Hazard identification

This phase involves the project team identifying and listing all the hazards that might cause harm during the lifecycle of the infrastructure being created. Hazards could relate to existing site conditions (e.g. underground services), construction challenges introduced by the project (e.g. working at height), or ongoing maintenance, operation and demolition challenges (e.g. working in confined spaces). As discussed in 3, the Hazard Identification phase should be considered from the earliest design phase and updated and refined as the project progresses.

4.3 Assessment and review of hazards

This step involves a risk assessment of the identified hazards to determine their relative importance (i.e. assessed risk). The process involves the review team (usually in a Risk Workshop) assessing the consequence of the effects of a hazard and the likelihood of those hazard effects occurring (e.g. the consequence of an underground service strike and the likelihood of it happening).

As discussed in Section 3, it is critically important that this phase draws on the knowledge of stakeholders in the project. It allows the people on the ground doing the job every day – the people that construct, maintain, renew and operate the asset to input into the design and to offer their knowledge and expertise in identification and management of the health and safety risks associated with the design.

Section 5 discusses the specific responsibilities of the review team undertaking the risk assessment.

4.4 Mitigation

The mitigation stage focuses on eliminating hazards through smart design. If the review team cannot identify a reasonably practical way of designing the hazard out, then they use the 'hierarchy of controls' philosophy described in Section 1.1 to identify the highest level of control that helps treat the hazard and reduce the risk (e.g. providing railing to prevent falls if working at height cannot be eliminated).

4.5 Residual risk assessment

The residual risk assessment phase follows the same process as described by section 4.3, however, it assumes that the proposed mitigation strategy has been implemented. Some organisations refer to residual risk as 'current' risk (the risk you are left with) and others refer to it as 'target' risk (the risk level you want to achieve after your treatments). For the purposes of this minimum standard, 'current' and 'target' risk should be considered to be the same as 'residual' risk. Residual (treated) risk should always be less than the original assessed risk.

Following the residual risk assessment the review team (including the Transport Agency) must agree whether the hazard has been treated to an acceptable level, or whether further mitigation is required. The residual risk assessment should be considered an iterative process that reviews and reanalyses the control measures and the subsequent mitigated risk until the hazard has been treated to an acceptable level.

If the hazard cannot be treated to an acceptable level and the residual risk remains unacceptably high, then an alternative design solution must be sought.

4.6 Recording of actions and handover

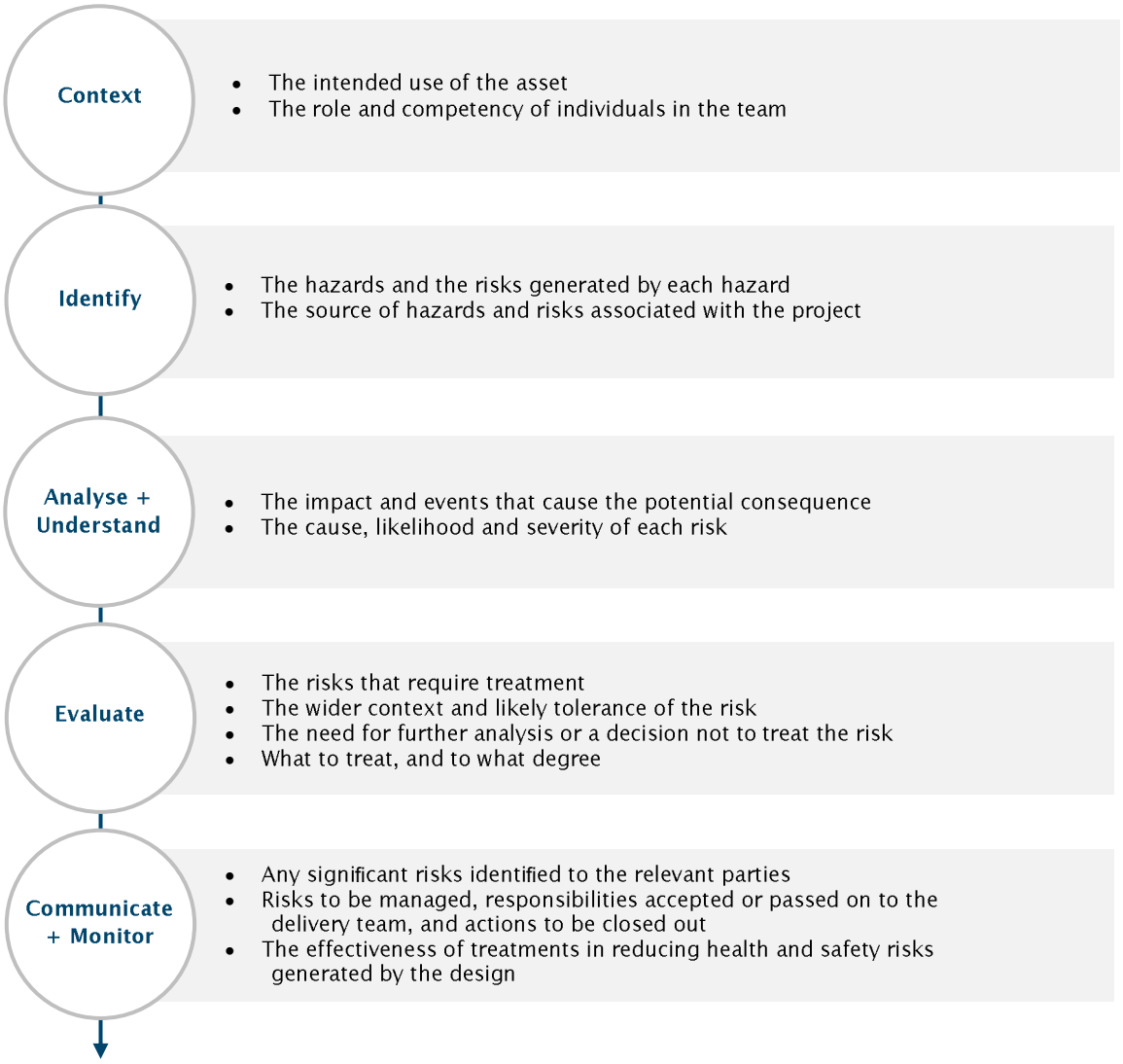
The recording of actions and handover is the most critical aspect of the Health and Safety in Design process. It is the phase where the residual risks that need to be managed need to be communicated to the contractor and end-users.

Section 5.3 describes how actions should be recorded and handed over at the end of each design phase. Health and Safety in Design Risk Registers should be used to record actions, assign responsibilities, track completion and note close out. A Health and Safety in Design report also constitutes an appropriate method of formally handing over SID deliverables.

Irrespective of the form of the handover information it is important for the Transport Agency to sign off and accept the residual risks noted in the register.

5. RESPONSIBILITY OF THE REVIEW TEAM

The role of the review team is to:



5.1 General requirements

The Health and Safety in Design review should be conducted in accordance with an appropriate methodology and tools for the project. SA/SNZ HB89:2013 provides guidance on risk assessment techniques. The methodology adopted must comply with the Z/44 minimum standard for all Transport Agency projects. This is to ensure consistency of output and ease of incorporation of handover material.

It should be made clear at the onset of a review that the focus **is on safety and ill health, not project risks**. Any general project risks identified should be noted and addressed in a risk workshop/meeting.

The chosen review methodology should be structured, systematic and thorough. As with any design record, the scope, purpose and the design basis upon which the review is conducted need to be clearly documented. This is so that the state of knowledge at the time of the review is defined.

The client project manager, operations and maintenance representatives, design leads and contractor representative should be invited to the review. Collaboration with the various team members will likely deliver more successful design reviews.

5.2 Facilitation

The facilitator should be an independent, suitably experienced person – they may be an employee of the design consultant or someone else. Guidelines for facilitators can be found in Appendix I.

5.3 Health and Safety in Design records and handover

The extent of the records/report will depend on the objectives and scope of the review. The review process should be documented together with the results of the assessment. Risks should be expressed in understandable terms, and the units in which the level of risk is expressed should be clear e.g. SA/SNZ HB89:2013, NZTA Z/44.

The results of the review, such as information on any residual risks, should be supplied with the project deliverables in an appropriate form at the end of each design phase.

In order for the project team to understand the risks that have been mitigated and/or remain to be addressed, a copy of the above information should be communicated to all team members at the end of the assessment.

The review documentation should include:

A. The design documentation
B. The objectives of the review
C. The methodology employed
D. The dates, timing and participants
E. A record of all risks identified (even where no further actions or recommendations are made). This may include drawings with clouds and annotation identifying residual risks.
F. Responsibility for specific actions and for management of the overall outcomes
G. Identification of specific actions and residual hazards to be managed by various team members.
H. An attendance sheet with position descriptions and role in the team.

The two key handover points are prior to the start of construction and immediately after construction at handover to the asset owner.

5.3.1 Pre-construction handover

The appropriate form of documentation, as discussed previously, should be included within the tender documentation. This will allow the contractor to appropriately manage health and safety risks during construction.

A pre-start meeting is a good opportunity to discuss the Health and Safety in Design documentation so that remaining health and safety risks are managed appropriately, and any design assumptions, specified materials, and methodologies can be understood.

Any feedback and lessons learned should be carried out and circulated back to the design team leader, client project manager and the Transport Agency's Zero Harm Team to ensure that future designs are improved and that lessons are recorded.

These learnings should be reviewed and outcomes shared with the organisations involved.

5.3.2 Post-construction handover

On many projects adjustments to the design may continue during the construction phase. These aspects need to be captured in the post construction handover report.

The Transport Agency has checklists to aid the hand over process from capital project delivery into the operations and maintenance phase (e.g. the PSF 3g Capital Project Handover Checklist). At practical completion appropriate Health and Safety in Design information highlighting the residual operations and maintenance risks should be handed over with the asset owner's manual, as-builts, RAMM, etc.

The handover report for the operations and maintenance teams is unlikely to need all the items that were communicated at pre-construction handover, as a number of the risks will likely relate to construction activities.

Appendix A: References

The list of industry codes of practice and guides listed below are not comprehensive. Designers need to identify the specific regulations relevant to the work in which their project will be constructed.

- Health and Safety at Work Act 2015 (HSWA)
- Electricity Act and Electricity (Safety) Regulations HSNO Regulations
- NZ Utilities Access Act and associated NZUAG Code of Practice
- UK CDM ACoP
- DoL Safe Working in Confined Space
- DoL Best practice guidelines for working at height in New Zealand, April 2012
- AS2685-2009- Safe Working in Confined Spaces
- AS/NZS ISO 31000:2009, Risk Management Principles and Guidelines
- AS/NZS ISO 31010:2009, Risk Management Assessment Techniques
- Design for Safety in Buildings and Other Structures [IPENZ/ACENZ/NZIA 2006]
- NZTA Minimum Standard Z/44 – Risk Management
- Managing Hazards to Prevent Major Industrial Accidents
- Guide to Best Practice for Safer Construction
- Code of practice for temporary traffic management (COPTTM): Part 8 of the Traffic Control Devices Manual (TCD)
- MBIE Approved code of practice for load-lifting rigging 5th edition 2012
- Health and Safety Executive (HSE) – UK www.hse.gov.uk
- Safe Work Australia Code of Practice – Safe Design of Structures www.safeworkaustralia.gov.au
- Crossrail Healthy by Design guide http://www.cbhscheme.com/Documents/Healthy_by_Design_Version_3

Appendix B: Definition of terms

For the purpose of this document the following definitions apply:

- HSiD/HSID – Health and Safety in Design
- Entire lifecycle – the construction, maintenance, decommissioning, and demolition of the asset
- MBIE – Ministry of Business, Innovation and Employment
- COPTTM – Code of Practice for Temporary Traffic Management
- CDM – Construction design and management
- DOL – Department of Labour
- COP – Code of Practice
- HSWA – Health and Safety at Work Act 2015

Appendix C: Design team responsibilities

Concept Design

Asset Owner/Project Manager

Provide H&S knowledge of the project area/asset including all known hazards

Provide all known investigation information to the designer

Highlight any operational and maintenance needs of the project

Clarify the intended use of the asset

Endorse the mitigation measures identified in the reviews

Design Team Leader

Understand if the project includes bespoke construction requirements, materials or departures from standard

Critically assess the design to ensure health and safety issues are identified and solutions integrated into final concept design

Consider appropriate materials and construction methodologies

Manage and organise Health and Safety in Design reviews

Provide full information about any risks associated with the design

Ensure all Health and Safety in Design information is issued to the design team for the next stage of work

Ensure all Health and Safety in Design reviews are completed before design progresses to the next stage

Construction Contractor

Ensure appropriate resources experienced in the techniques likely to be required to construct the design are made available for Health and Safety in Design reviews

Proactively highlight all construction hazards and risks of the design

Share knowledge/experience regarding construction methodology, materials and planning requirements

Detail Design (and/or Demolition)

Asset Owner/Project Manager

Highlight any operational and maintenance needs of the project

Highlight any changes to the project/asset requirements, scope and likely usage

Evaluate the mitigation measures identified in the reviews

Design Team Leader

Pro-actively address new risks emerging through the design process

Complete previous Health and Safety in Design actions

Manage and organise Health and Safety in Design reviews

Provide full Health and Safety in Design information about any risks associated with the design

Ensure all Health and Safety in Design information is issued to the relevant party (design team and/or the construction contractor) for the next stage of work including any untreated hazards identified

Ensure all Health and Safety in Design reviews are completed before proceeding to construction

Construction Contractor

Ensure appropriate resources experienced in the techniques required to construct the design (or undertake the demolition) are made available for Health and Safety in Design reviews

Pro-actively highlight and address new risks emerging through the design process

Share knowledge/experience regarding construction methodology, materials and planning requirements

Plan, manage and coordinate construction work to ensure hazards are identified and risks are properly controlled

Everyone

Cooperate, coordinate and communicate with all other team members

Ensure you can competently carry out your responsibilities; seek training and advice where required

Actively participate in Health and Safety in Design reviews

Complete any actions allocated to you in the Health and Safety in Design reviews

Pre-construction Handover

Asset Owner/Project Manager

Attend the pre-construction meeting, providing input where required

Highlight any operational and maintenance needs of the project including all known hazards related to the project area/asset

Evaluate the mitigation measures identified in the review

Design Team Leader

Attend the pre-construction meeting, providing input where required

Highlight any design assumptions or changes made in relation to Health and Safety in Design

Highlight items to be included in O&M Manual

Ensure all Health and Safety in Design information including any untreated hazards identified are issued to the relevant party (contractor and the asset owner)

Construction Contractor

Review the Health and Safety in Design information received regarding for completeness (construction risks) and issue to the appropriate people/parties

Ensure the construction team is competent to carry out the work they are engaged to do in a safe manner and with the correct equipment

Plan, manage and coordinate construction work, and any design work during construction, to ensure hazards are identified and risks are properly controlled

Ensure all relevant information passed on to the construction teams during site meetings/tool box talks etc.

Ensure all relevant information is included in H&S plans, As-built and O&M manuals

Maintenance, Renewal and Operation

Asset Owner/Project Manager

Highlight any operational and maintenance needs of the project including all known hazards related to the project area/asset

Agree O&M manual content

Confirm intended use

Evaluate the mitigation measures identified in the review

Design Team Leader

Provide full Health and Safety in Design information about any maintenance and operation risks associated with the design

Ensure all Health and Safety in Design information is issued to the maintenance contractor and the asset owner

Highlight any maintenance and operation assumptions in relation to Health and Safety in Design

Ensure all Health and Safety in Design information is issued to the construction contractor, maintenance contractor and the asset owner

Maintenance Contractor

Review the Health and Safety in Design information received for completeness (maintenance and operation risks)

Ensure the maintenance work contractors can be done in a safe manner

Ensure all relevant information is identified for inclusion in H&S plans, As-built and O&M manuals

Everyone

Cooperate, coordinate and communicate with all other team members

Ensure you can competently carry out your responsibilities; seek training and advice where required

Actively participate in Health and Safety in Design reviews

Complete any actions allocated to you in the Health and Safety in Design reviews

Appendix D: Concept design checklist

The following checklist can be used on projects as a prompt to manage the Health and Safety in Design process through concept design.

	Key Elements	Y/N	Comments / Justifications
1	Is there a clear scope of works, do you understand the design requirements and intended end use?		
2	Have you reviewed the project brief to understand the preliminary health and safety hazards?		
3	Do you have all the relevant design documents and standards to carry out the design?		
4	Has the frequency of the Health and Safety in Design reviews been determined and at what stages?		
5	Have the key people who should attend the Health and Safety in Design reviews been identified (member from each Team), do you need a facilitator?		
6	Have you included a contractor representative and an operational/maintenance representative in the review team?		
7	Have you carried out a site visit to identify existing hazards?		
8	Have you carried out a Health and Safety in Design Review? Are there construction hazards that need to be addressed? Are there operational hazards that need to be addressed? Are there maintenance hazards that need to be addressed? Are there demolition hazards that need to be addressed?		
9	Have you applied the hierarchy of hazard control? (eliminate, isolate and minimise)		
10	Have all actions been allocated to people and/or closed? Have you recorded risks and who owns them? Is there a process for capturing treatment actions, progress, closure and reporting?		
11	Are there any outstanding unacceptable residual risks?		
12	Are there factors outside of your control? (e.g. risks to be accepted or tolerated)		
13	Have you circulated all the outputs from the Health and Safety in Design review to the project team?		
14	Have you collated all the Health and Safety in Design outputs for the next phase?		
15	Have you agreed the next review date?		

Appendix E: Review prompt words

Prompt Words
Noise
Manual Handling
Vibration
Heat
Hyperbaric Atmosphere
Chemical – Cement, silica, dust, solvents, hydrocarbons, asbestos
Biological – Contaminated water or soil
Working at height or depth
Working over/near water
Adjacent construction sites and land use
Underground excavations and works – tunnelling, trenching, etc.
Ground conditions
Services and utilities
Confined spaces
Heavy Lifting – including working under suspended loads
Temporary Works
Working in and around mobile plant – site traffic
Demolition
Emergency requirements
Existing structures
Existing information – as-builts, historical, etc.
Prescribed methods of working/construction
Existing and future operational and maintenance issues
Live Traffic – vehicles/cycles/pedestrians
Natural Hazards – wind, rain, snow, flooding, seismic activity, etc.
Competence

Appendix F: Workshop agenda template

HEALTH AND SAFETY IN DESIGN WORKSHOP AGENDA

Date:

Venue:

Attendees:

Apologies:

1. **Introductions**
   - Setting the scene
2. **The process**
   - Systematic approach Hierarchy of Control
3. **Key hazards and risks**
   - Agree and discuss
4. **Health and Safety in Design review**
   - Work through the project lifecycle to assess each risk, propose mitigation using the hierarchy of control, assess the residual risk and assign actions
5. **Conclusions and wrap up**
6. **Next meeting**

Appendix G: Detail design checklist

The following checklist can be used on projects as a prompt to manage the Health and Safety in Design process through detail design.

	Key Elements	Y/N	Comments / Justifications
1	Is the scope of works clear, do you understand the design requirements, assumptions made, standards used and intended end use?		
2	Have you received and reviewed the previous Health and Safety in Design documentation? Is it complete?		
3	Has the frequency of the Health and Safety in Design reviews been determined and at what stages?		
4	Have the key people who should attend the Health and Safety in Design reviews been identified (member from each		
5	Have you included a contractor representative and an operational/maintenance representative in the review team?		
6	Have you carried out a site visit, with the relevant people to review the existing hazards and proposed design?		
7	Have you carried out a Health and Safety in Design Review? Are there construction hazards that need to be addressed? Are there operational hazards that need to be addressed? Are there maintenance hazards that need to be addressed? Are there demolition hazards that need to be addressed?		
8	Have you applied the hierarchy of hazard control? (Eliminate, isolate and minimise)		
9	Have all actions been allocated to people and/or closed? Have you recorded risks and who owns them? Is there a process for capturing treatment actions, progress, closure and reporting?		
10	Are there any outstanding unacceptable residual risks? Have they been communicated?		
11	Are there factors outside of your control? (e.g. risks to be accepted or tolerated)		
12	Have you circulated all the outputs from the Health and Safety in Design review to the project team? How will you check they have been closed before handover?		
13	Have you communicated all the Health and Safety in Design outputs for the tender documentation?		
14	Have you carried out a handover?		

Appendix H: Review methodology and templates

Methodology

A guideline for a successful Health and Safety in Design Reviews methodology is as follows:

- Understand the intended use of the project, including existing hazards and risks. Understand the external and internal parameters of the project to be reviewed.
  - Hazard means the potential for an agent, activity or process to cause injury, illness or damage to people, property, or the environment.
  - Risk is a measure of the severity of the consequence of a hazard and the likelihood of its occurrence.
- Identify the sources of the hazard or risk, areas of impact, events, control measures and their causes and potential consequences.
- Analyse the cause and source of the hazard or risk and likelihood of the consequences that can occur. Determine the likelihood and consequence of the risk to produce a level of risk.
  - Likelihood is an assessment of the chance of the risk issue occurring and resulting in the determined potential consequence.
  - Consequence is the worst possible (but credible) extent of harm to people, property or the environment, resulting from an incident due to a hazard.
- Evaluate the hazard or risk treatment and the priority of this treatment (e.g. eliminate, substitute, isolate, control) as far as reasonably practical.
- Reassess the residual risk in terms of severity and likelihood and therefore level of risk.
  - Severity is a quantification of the potential consequence of an incident due to a hazard.
  - Assign responsibility for implementation of proposed treatment option to the appropriate person attending the risk assessment.
  - Document the assessment.
  - Follow up to confirm recommended controls are implemented.
  - Communicate treatment option and any residual risks.

Communication is a key to Health and Safety in Design. Therefore, documentation of any findings or alterations should be made clear to ensure that others can follow the design plans or modifications.

Ensure that all information, concerning actions taken to address health and safety, is adequately recorded and transferred from the planning/design phases and that those involved at later lifecycle phases have access to information about any residual risks that may affect their health and safety.

A review table/spreadsheet can be used to assess the severity of the risks. Residual level of risks of low should be targeted. Where the level of risk is medium or high, control measures need to be implemented, as far as reasonably practicable, to enable the risk to be eliminated or minimised. Where risks cannot be reduced to low the end-user should be informed.

Guide words for a Health and Safety in Design review

Site Layout	Surrounding environment, site clearance, access (within and to site), traffic circulation, size, storage space, limitations, contamination, existing infrastructure/structures.
Access/egress	No. of entry/egress points, caught, trapped, emergency egress, obstructions, lighting, external impacts, people and equipment, frequency of movements.
Interfaces external to the project	Public safety, traffic, adjacent property, services, external fire, day/night/ weekend, emergency services, noise, dust, pollution, vibration, departures from standard details or practice.
Natural Hazards	Extreme weather, lightning, dust, temperature, ground, water, snow, ice, noise, earthquake, floods, high wind.
Site Caused Environment	Vapour/dust, effluent/waste, noise, flooding, asbestos.
Position / Location	Too high, too low, too far, misaligned, wrong position.
Heights / Depths	Working at heights/depth, falls, striking by falling objects, scaffolding (space to fit).
Load / Force / Energy	High, excess, low, insufficient, additional loads, dynamics, temporary weakness, fragile, tension, compression, PE, inertia, movement, fluid flows.
Movement Direction	Stability/instability, compression, physical damage, vibration, friction, slip, rotation, up, downwards, reverse, expansion, tension, rollover.
Toxicity / Safety	PPE, chemicals, safety showers, eye wash, barriers/guards, lead/asbestos, oil, handling, precautions, ventilation, gases, pressure venting, overflows (provision), materials.
Utilities/Services	Vapour/dust, effluent/waste, noise, seepage, heat/cold, electricity, flooding, outages, proximity.
Electrical	Underground, overhead, heating, proximity, spacing, clearances, isolation for maintenance access
Eliminate / Combine	Movements, mobile plant, lifting, exertion, sequence, timing, simplify
Ergonomics	Posture, manual handling, RSI, discomfort, fatigue, stress, effect on PPE, visibility, slips, trips
Fire / Explosion	Prevention/detection, suppression/protection, emergency procedures, sparks/earthing
Moving Plant & Machinery	Internal, external, above, below, reversing, visibility.
Confined Spaces	Access, egress, emergency procedures
Timing	Too late, early, short, long, sequence, extended delays
Demolition	Ease, issues, documentation, asbestos, sequencing.

Appendix I: Facilitation guidelines

Preparation

At least two weeks before the Health and Safety in Design review the facilitator should meet with the Design Team Leader or other appropriate person and establish the following:

- Appropriate attendees – Asset Owners, Designers, Constructors, Maintainers, Operators etc.
- Project scope – the boundary for the assessment.
- Basis for review – general arrangement drawings; sections where possible; for brown field sites a site inspection at the start of the session can help to identify hazards.
- Areas for assessment – break down the scope into discrete items or areas for review. They should be small enough to easily review and discuss.
- Agenda – plan a logical path through the project; allow a reasonable time for each area; send the agenda to the attendees.
- Prepare a set of prompt works, phrases and open questions.
- Recording methodology – refer to Section 6.4.

Review

A guideline to facilitating the Health and Safety in Design Review is as follows:

- Set the scene of the review, explaining the purpose and objectives.
- Use a predetermined set of guides or prompts to assist in the identification of hazards associated with each item (similar to those in Appendix E).
- Optional – brainstorm the list of prompt words to engage participants and create a safe environment.
- For each area break down the scope into discrete items, activities or areas for review.
- Invite the group to consider what actions need to be taken in this area during construction, operation, maintenance and demolition.
- Review these actions and look for any associated hazards.
- When discussion slows, use a predetermined set of guides, prompts or open questions to assist in the identification of hazards associated with each item (Appendix E).
- Manage the risk assessment process to ensure all hazards are identified, analysed and evaluated in a systematic approach.
- Manage the group dynamics by being aware of the participants and ensure everyone has the chance to be heard.
- Be prepared to take control of a discussion if it starts to go off topic, not all issues will be concluded in the workshop. Ask the individuals to follow up on their discussion outside of the workshop and report back to the group.
- Take regular breaks if it is a long workshop.
- Wrap up the workshop by thanking people for their participation, highlight the next steps and ask for any final thoughts.
- After the workshop the records should be documented and communicated to the teams.

Appendix J: Example Design Register

The following risk register provides an example that is consistent with the principles of the Z/44 Risk Management process and has been used on a number of Transport Agency projects.

TRANSPORT AGENCY

MacKays to Peka Peka

Safety in Design Risk Assessment Register

Project Name: MacKay's to Peka Peka Alliance

Sector: Sector 330-350: Leinster Ave to Wharemauku

Author (Role): Nathanael Sterling, SID Facilitator, and Doug Stirrat (Zone Design Manager)

Approved By:

Revision: 3

Job No: 3320901

Date: 16 October 2014

Stage of Design / Project: Concept Confirmation

RISKS ASSOCIATED WITH DESIGN ELEMENTS				Risk Matrix			PROPOSED MITIGATION MEASURES	Risk Matrix					RESIDUAL RISK	
Discipline	Ref	Cause & Outcome	Existing controls (current design or current environment)	Likelihood	Consequence	Risk Rating	Control Hierarchy: 1) Elimination 2) Substitution 3) Engineering 4) Administrative 5) Personnel Protective Equipment	Likelihood	Consequence	Risk Rating	Status	Action Owner (Discipline Level)	Residual Risk	Client / Asset Owner Acceptance / Comment
1 Construction Phase - Process of Building the Asset														
Stormwater	1.01	Deep excavations, risk of fatality in excavation through engulfment of water or soft soil due to high water table and weak soils (Services and Stormwater)	Confined space procedures. Trenching and deep excavation guidelines	Unlikely	Permanent Injury	Extreme	Remove need to access deep trenches through design and/or construction methods.	Rare	Permanent Injury	High	Live	Construction Team	Constructors. Deep trench at wastewater pipe south of Wharemauku Stream could not be removed. Residual construction risk. Detailed construction methodology to be developed.	

Appendix K: Health and Safety in Design issues – examples

Health Related Examples

Example one

Issue: Manual Handling

Solution Examples:

- Non slip surfaces on floors
- Allowing space for mechanical devices to be used instead of, or to assist with, manual handling
- Prefabrication based on the size/weight that one person can safely manage

Example two

Issue: Fatigue

Solutions:

Fatigue Risk Management Programmes that adopt comprehensive risk based approaches, evaluate fatigue risk and potential impact on staff and operational and strategic objectives and, agree preventative actions for the risks identified

Example three

Issue: Airborne Contaminants

Solution Examples:

- Selecting paints and finishes that emit less VOCs
- Cast-in crack inducers in concrete (to eliminate scabbing to achieve a bonding surface)
- Cast-in joint formers (to eliminate saw-cutting joints)
- Cast-in ducting for services (to eliminate chasing out concrete later)
- Cast-on anchors and fittings instead of drill and fix to install later
- Ventilation controls in asphalt pavers
- Specify low chrome cement
- Design to use bulk supply pumped concrete
- Plan enabling works with welfare facilities installed at project start
- Specify adhesives that have non-volatile solvents
- Specify concrete products with pre-cast fixings
- Off-site timber treatment (under controlled conditions)

Example four

Issue: Noise

Solution Examples:

- Cast-in crack inducers in concrete (to eliminate scabbing to achieve a bonding surface)
- Cast-in joint formers (to eliminate saw-cutting joints)
- Cast-in ducting for services
- Cast-on anchors for anchors instead of drill and fix to install an anchor
- Minimise noise intensity in enclosed spaces e.g. inside box girders, concrete structures, box culverts, manholes, cofferdams
- Design in noise barriers and acoustical treatments
- Specify hydraulic piling
- Specify self compacting concrete
- Specify crack-inducers
- Cast in brick ties, instead of shot-firing
- Specify concrete products with pre-cast fixings
- Specify built in ducting
- Specify dry lean concrete
- Design for the use of tools with noise attenuation fittings
- Design for the use of remote control compaction

Example five

Issue: Vibration

Solution Examples:

- Specify self-compacting concrete and fill
- Pile cropping – excess concrete at the top of each pile is trimmed away to the final cut-off level using hand power tools. Before pile cages are installed, foam rubber sleeves, similar to pipe lagging, are placed over the reinforcing bars above cut-off level. This prevents them from bonding with the concrete. At cut-down, when the pile is finally exposed, a 50cm diameter horizontal hole is drilled into the concrete at the cut-off level and to a depth just over half the diameter of the pile. A standard hydraulic splitter is then inserted into the hole and triggered, causing the pile to split neatly, and in a controlled fashion at exactly the right level. The unwanted top of the pile can be lifted away using a lifting eye cast into the top surface of the pile. “Exposure to hand-arm vibration is reduced by 90-95% compared to conventional methods”
- Laying kerb stones – vacuum lifters attached to plant and the re-design of kerbs to reduce material weight and density, but not at the detriment of performance

Example six

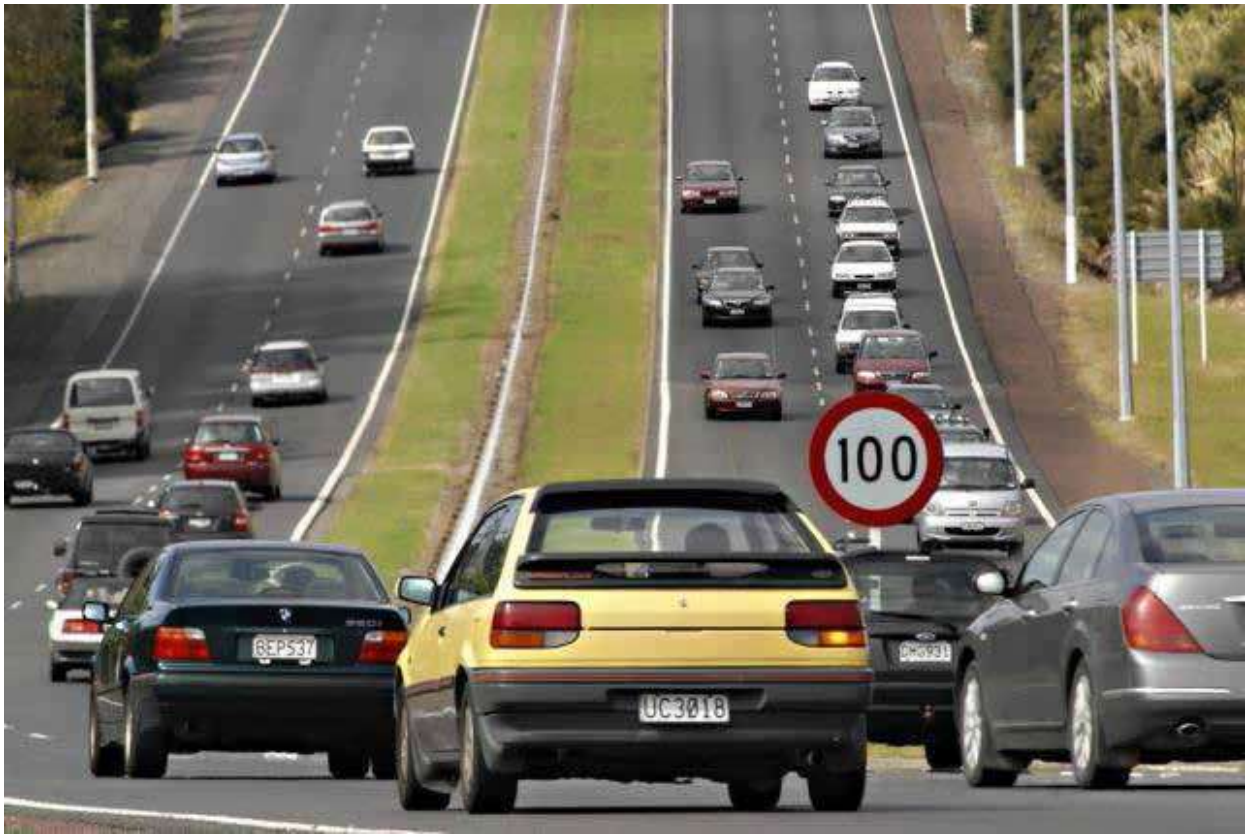
Issue: General

Solution Examples:

- Adequate and well positioned lighting
- Thermal comfort
- Workplace space and layout to prevent manual handling issues and allowing use of mechanical aids
- Non slip fatigue flooring

Safety Related Examples

Example one



Issue: Median grass – dangerous to mow, weed-eat and/or spray around wire rope barriers. Issue leads to lane closures and traffic congestion. Light pole maintenance is also an operational hazard.

Solution: Sealed or artificially grassed medians. Install LED lighting, requiring less maintenance.

Example two

Issue: Poorly located vegetation around barriers requires maintenance to prevent it becoming a road safety hazard. This leads to shoulder closures and a less safe workplace.

Solution: Use appropriate low level, low maintenance planting in locations where access is poor.

Example three

Issue: Working at height grass above retaining walls is difficult and dangerous to mow.

Solution: Use appropriate ground cover such as low maintenance planting and/or provide a handrail. E.g.

Example four

Issue: Manhole covers in traffic lanes can be extremely dangerous to road users, and maintenance access requires lane closures.

Solution: Provide manhole access in berm or shoulder areas and use buried junction chambers under traffic lanes.

Example five

Issue: Standard light pole access panel is not on road side. In this case this means a cherry picker is required for inspections, creating a fall from height and working over water hazard.

Solution: Consider operational access as part of the design.

Example six

Issue: Light pole plinth design creates an easy access point for graffiti vandals. To clean the graffiti, a motorway lane closure is required to establish a safe work platform (e.g. scissor lift).

Solution: Consider operational issues (e.g. graffiti removal) as part of the design.

Example seven

Issue: Property, designation and maintenance boundaries have the potential to adversely impact on design decisions and design criteria.

Solution: Consider the merits of maximising available land during construction (e.g. temporary occupation) to avoid constraining construction methodology. Also consider the merits of minimising the amount of land that needs to maintained long term e.g. construct a noise wall rather than a bund so the land behind can be disposed.