



Design for Safety in Buildings and Other Structures

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1. Scope

This *Practice Note* is primarily directed at designers of all building disciplines so that they may understand their own responsibilities and the responsibilities of others in relation to designing for safety. It will also be of interest to owners and clients, project managers, regulators and the like.

This document is intended to be a guide to demonstrating compliance with a designer's responsibilities under the Health and Safety in Employment Act 1992. However, it does not cover all of the health and safety responsibilities that architects, engineers, clients and others have which include, for example, hazard identification and general duties of care when carrying out contract management and site observation/monitoring. For this reason, reference should also be made directly to the health and safety legislation.

It should be noted from the outset that in this document the term "designer" has a wide definition and covers both those who conceptualise and document permanent buildings, structures and plant, and those who determine the programme, sequence and methodology of construction. **Design for safety is not just about architects and engineers.**

2. Background

Within the construction industry there has been an increasing awareness of the role of design in construction safety. Inherently, much design is concerned with safety. Structural engineering, for example, has as its principal concern the ability of materials and structural systems to safely carry loads that might reasonably be expected to be imposed upon them. Architecture and building services design is aimed at ensuring that building occupants have a safe and comfortable environment in which to live, work and play, for example, clean air, protection from excessive noise, and fire safety.

This *Practice Note* seeks to clarify the relative roles and responsibilities that architects, consulting engineers and constructors (contractors and subcontractors) have within the very wide subject of designing for safety. IPENZ, ACENZ and NZIA all represent designers who, at various times, work for either the client (who may be a constructor), preparing working drawings and specifications, or for the builder (during the construction phase), preparing shop drawings and giving advice on temporary works.

Owners, designers and constructors should note that compliance with the Building Code (and associated compliance documents) does not necessarily achieve compliance with the Health and Safety in Employment Act 1992.

Many within the industry have requested a *Practice Note* to define the roles and responsibilities of all designers within the industry.

This document, prepared jointly by IPENZ, ACENZ and NZIA, is intended to provide guidance to all those involved in building design and construction.

3. Definition of Terms, Roles and Responsibilities

For the purposes of this *Practice Note* the work of designers is divided into two categories: permanent works design and temporary works design.

3.1 Permanent works design

3.1.1 Definition of permanent works design

Permanent works design (PWD) typically consists of the preparation of plans and specifications that define what is required in a completed building, structure or plant. These design documents are usually prepared by architects and consulting engineers (structural, mechanical, electrical, process etc). In typical forms of project delivery, these designers are known as the "consultants". However, it is not true to suggest that all PWD is carried out by consultants. Many elements of PWD may be carried out by contractors or subcontractors. This may be the case where a constructor provides "in-house" design services for architecture or engineering, but more commonly occurs in the design of a wide range of proprietary products and systems that are specified on a performance basis (such as precast flooring, aluminium window systems, proprietary cladding systems, fire rated systems, fire sprinklers and process plant).

3.1.2 Obligations of permanent works designers

People who carry out PWD (and those firms or people who employ them) must take all practicable steps to ensure the safety of the end users of the building, structure or plant. The end users include the occupants of the building and those who visit it, service it, clean it and maintain it, once the building or structure is completed. However, it should be understood that people who clean, service or maintain the facility may require specialist training and/or equipment. End users do not include those who construct the building, structure or plant.

End users should be able to expect, for example, that subject to current knowledge:

- the finished structure can safely withstand reasonable loads that may be exerted on it
- the facility may be safely accessed and operated (subject to appropriate training, equipment and maintenance)
- provision has been made for the building or structure to be safely cleaned and maintained (subject to appropriate training, equipment and maintenance)
- materials used in the construction of the facility do not present a hazard to the health of the occupants (subject to specialist training on the subject of hazardous materials for people who



- clean, service or maintain the building)
- the quality of air, light and temperature inside the completed building does not constitute a significant hazard to the health of the occupants
- the occupants are reasonably protected in the case of fire, earthquake or other emergencies to which the facility may be exposed
- if they occupy a partly completed building or a building that is undergoing modification, they will be protected from ongoing construction activities

It can be argued that any design can be built safely. Constructors will argue that some designs are impossible to build without modification. Permanent works designers should always satisfy themselves that their designs are able to be built by a competent builder¹ and that the documentation is clear enough to show the design intent.

The commercial decisions made by owners and/or by consultants on behalf of owners (that is, whether they wish to minimise capital or operational costs) will have an effect on the way a building is operated and maintained following construction. For example, the selection of cladding systems will determine the frequency of maintenance, and decisions regarding the inclusion of a building maintenance unit (BMU) will determine how the exterior of a building is cleaned and maintained. A building could incorporate a full perimeter walkway or BMU for window cleaning (high capital cost) or the client may prefer to clean using a cherry picker or abseil system (higher operational costs). Architects and engineers have a role in assisting owners to understand the health and safety implications of such decisions.

As part of their ongoing obligations under the Health and Safety in Employment Act 1992, and as a duty of care, permanent works designers will often, on behalf of the client, specify that the constructor must act responsibly with respect to issues of health and safety during construction. Competent, safety-conscious contractors in charge of the site will develop safety protocols that include safety plans and risk analysis of every task on site to mitigate (isolate, minimise or eliminate) potential hazards.

The permanent works designer may also identify work areas that have particular constraints or programme requirements but leave responsibility to the constructor to decide how they wish to work within those constraints.

3.2 Temporary works design

3.2.1 Definition of temporary works design

Temporary works design (TWD) typically consists of the preparation of programmes, methodology statements and “falsework” design that define the method and sequence in which the building or structure is to be built. In this context, falsework refers to all staging, temporary propping and bracing, scaffolding and access,

¹ That is, that there is at least one method and sequence that can be followed to construct the design.

shop drawing, shoring, cramage, site access and the like. TWD and documentation is usually the responsibility of, and is carried out by, the constructor (that is, the staff of the contractor and subcontractors). Individuals involved in TWD include site supervisors, construction managers, foremen, site engineers and programmers. On many smaller projects, TWD is not committed to paper but exists only in the mind of the site supervisor. It should be noted that some elements of falsework (most notably access provided by scaffolding) have specialist codes of practice and require certification before they may be used.

It is not uncommon for selected elements of TWD to be carried out by consulting engineers or other third party designers at the request of a contractor or subcontractor. These elements may require complex analysis, depending on the construction sequence that the builder has decided upon. This work is sometimes carried out by the project’s consultants but more commonly by an independent third party consulting engineer.

3.2.2 Obligations of temporary works designers

The constructor is responsible for managing health and safety risks during the construction phase. As such, the constructor must take all practicable steps during preparation of TWD to ensure the safety of all workers on the construction site and others who may be affected by the works. This includes, for example, consideration of the following potential hazards:

- working at height
- working in confined spaces
- excavations
- hazardous materials
- hazardous elements (sharp, heavy, unstable)
- temporary stresses
- temporary stability
- temporary ventilation and extract
- electrical safety
- temporary access and escape
- welding safety
- acoustic safety
- cramage
- control of public access
- inter-trade work sequences and handover
- safety of users during partial occupation or work in an already occupied area
- commissioning and testing safety

It is not uncommon for buildings undergoing refurbishment to be partially occupied by tenants or owners. Similarly, portions of new buildings may be occupied before the total project is completed. In these cases, both the TWD, and to a significant extent the PWD, must address the staged nature of the project, and in particular address the health and safety of the occupants as well as the construction workers. This will generally be achieved by separating the occupants from the construction site and its effects. In these cases the permanent and temporary works designers must work together to ensure, for example, that the quality of light, ventilation



and noise levels is able to be maintained at compliance levels, and that access to facilities and emergency egress is available at all times. In this type of project, these issues often require significant co-operation and understanding between consultants, constructors, building owners and relevant authorities.

In complex projects, such as those involving industrial plant, the separation between PWD and TWD can become blurred. In such cases, relative responsibilities should be defined at the commencement of design.

Competent contractors, aware of their obligations, will work within safety systems that include task analysis for every significant task on site to mitigate (isolate, minimise or eliminate) potential hazards.

3.3 Design Document Guidelines

These definitions of PWD and TWD marry well with the New Zealand Construction Industry Council's *Design Document Guidelines*. The document lists five design phases:

1. concept design
2. preliminary design
3. developed design
4. detailed design
5. construction design

Essentially, phases one to four are concerned solely with PWD and the deliverables that are provided by the consultants. Phase five is more concerned with TWD and the deliverables provided by the constructor. The early involvement of a constructor (for example, in design and build projects) can assist him or her in meeting TWD health and safety obligations.

4. Related Documents

Document	Source
Health and Safety in Employment Act 2002	Obtain a hard copy from Bennett's Government Bookshop, visit www.legislation.govt.nz or visit www.osh.govt.nz/law/hse.shtml
Building Act 2004 and New Zealand Building Code	Obtain a hard copy from Bennett's Government Bookshop, visit www.legislation.govt.nz or visit www.building.dbh.govt.nz
<i>Design Documentation Guidelines</i> New Zealand Construction Industry Council	Available as a printed copy or download from www.acenz.org.nz/publications.htm
<i>Guidelines for the Prevention of Falls</i> <i>Guidelines for the Provision of Facilities and General Safety in the Construction Industry</i> <i>Approved Code of Practice for the Safe Erection and use of Scaffolding</i> Workplace Health and Safety, Department of Labour	Search by topic or by publication at www.osh.govt.nz/order/catalogue/index.shtml
AS/NZS 4488:1997 Industrial Rope Access Systems	Purchase from Standards New Zealand, phone 04 498 5991 or visit www.standards.org.nz/purchase-standards/Default.htm
Electrical Regulations	Available from the Electrical Workers Registration Board website www.ewrb.govt.nz/content/teaching-guidelines/electricians/section5.html or visit www.standards.org.nz/purchase-standards/Default.htm



5. Design for Safety Examples by Discipline

Note that these are examples – the list is not exhaustive. Many examples may cross disciplines. Note that “design” may be expressed by drawing, trade specification, performance specification, construction programme or sequence, methodology statement and the like.

Architecture

Permanent Works Design	Temporary Works Design
General	
A specification requirement for the constructor to comply with relevant legislation	Programming of work
Noting any specific or known hazards, eg the presence of asbestos	Site access
	Working area
	Location of site office, hazard board etc
Glazing	
Glass type and thickness	Handling of pre-cut glass
Mullion size	Handling of large framed assemblies
Safety glass	Access for reglazing in case of breakage
Restraint points and access for cleaning	Safety precautions below glazing operations
Flooring	
Non-slip	Handling of large pavers
Acoustic insulation	Ventilation during gluing
Wall cladding	
Spans and fixings to resist wind loads	Safe and suitable access to the workforce
Anchorage points for rope access systems	
Access for cleaning and maintenance	
General weathertightness issues to prevent the growth of fungi and subsequent health issues	
Roof cladding	
Spans and fixings to resist wind loads	Temporary barriers
Barriers or anchorage points for access to and maintenance of both the building fabric and rooftop mechanical plant installations	Restraint from falling during erection
Restraint from falling through roof lights and over roof edges	Safety mesh

Structure

Permanent Works Design	Temporary Works Design
Foundations/geotechnical	
Foundations sized to safely carry self-weight and imposed loads	Temporary shoring
Slope stability	Temporary batter angles
Underpinning	Width of excavation for safe access
	Safe access to inspect piles



Frame and floors

Frame sized to safely carry self-weight and imposed vertical and lateral loads

Anchorage points for permanent barriers and fall restraint

Determination of construction sequence for unusual structures:

- complex bridges
- post-tensioned structures
- hung structures
- partial demolition of existing structure

Temporary falsework and formwork to safely carry construction loads

Back propping

Temporary bracing (for wind, earthquake, soil pressures etc)

Safe access and restraint for working at heights

Temporary barriers

Protection from hazardous objects, trip hazards etc

Protection from hazardous materials and processes (concrete burns, cutting etc)

Safe lifting and transport of materials on site

Cranage, storage of materials

External walls

Support framing sized to safely carry self-weight and imposed load

Anchorage points for future cleaning and maintenance

Handling of materials and pre-fabricated sub-assemblies

Safe access for construction, scaffolding etc

Temporary barriers, restraint from falling

Roofs

Support structures, framing and cladding sized to safely carry self-weight and imposed loads

Permanent barriers and anchorage points or systems for future access, cleaning and maintenance

Temporary support

Safe construction access

Temporary barriers, restraint from falling

Handling of materials and pre-fabricated sub-assemblies

Pre-fabrication at ground level

Mechanical Services

Permanent Works Design

Temporary Works Design

Equipment in all locations

Located in a compliant plant room or location

Physical safety is considered, viz:

- noise
- access for repair and maintenance
- replacement

Permanent fixing, seismic bracing

Electrical isolation and interlocking

Maintenance guidelines

Factory testing and related activities

Delivery, lifting and installation

Pre-commissioning and commissioning activities

Temporary utility supplies

Pipe work and tanks

Permanent fixing, seismic bracing, vibration expansion and contraction, and water hammer control

Sanitary systems to meet regulations

Remediation work in confined spaces

Lifting and installation

Pressure testing procedures

Safety related to disinfection of pipework and systems before bringing into service



Pressurised systems and fuel systems	
Compliance with approved documents	Pressure testing procedures
Located in a compliant plant room or location	Handling of hazardous materials
Fire control	
Hazardous materials can be safely handled	
Ducted air systems	
Clean, filtered air	Handling cut sheet metal
Protection from contaminants, Legionnaires disease etc	Delivery, lifting and installation
Permanent fixing, seismic bracing	
Fire isolation and smoke handling	
Compliance with Building Code and specific design	Temporary works fire protection
Control systems	
Normal system operation must be safe in all modes	Pre-occupation and commissioning activity
Clearly document functional descriptions including interlocks, overrides and remote operation capability	Building occupation and systems operation before completion
Safety in maintenance and replacement modes must be clearly communicated	

Acoustics

Permanent Works Design	Temporary Works Design
OSH noise	
Protection and shielding of occupants and users from internal and external noise sources	Protection of public/off-site personnel from construction noise by use of temporary barriers
Maintenance guidelines	Signage and clear operating procedures to reduce worker exposure to explosive noise such as explosive powered fastener devices
	Protection from noise (use of hearing protection)
Heavy objects	
Danger from handling heavy objects such as moveable suspended acoustic reflectors/orchestra shells in auditoria or operable walls	Handling of heavier materials required for sound insulation, eg glass, plasterboard (particularly for ceilings), concrete
Children struggling to operate heavy sealed acoustic doorsets in schools	Handling heavy objects at height, eg positioning/installing loudspeakers at high level in auditoria, positioning/installing acoustic reflectors
Hazardous materials	
	Handling of materials used for absorption or cavity insulation which can cause skin irritations, eg fibreglass, MDF dust



Fire Engineering

Permanent Works Design	Temporary Works Design
Fire alarm systems operation	
Design and specification of fire protection systems for compliance with Building Code etc	Installation of temporary fire alerting system during construction
Review of proprietary design, confirmation of correct coverage and location	Installation of temporary detection system during construction
Review of commissioning including confirmation that sounders, sprinklers etc are operational	Temporary on-site communication system to notify Fire Service
	Impairment of fire protection systems during alteration while building is occupied by end users
Means of escape	
Design and specification of means of escape, evacuation procedures	Temporary evacuation procedures and unambiguous signage to exits
	Adequate number and capacity of escape routes, clear of debris, trip hazards
	No locks on escape routes
	Temporary emergency lighting (hazard and project specific)
	Temporary fire protection to escape routes to suit fire hazards (project specific) but especially stairs in multi-storey buildings
	Safety of occupants during construction with full or partial occupation or while permanent works incomplete
Passive fire protection	
Appropriate fire resistance to suit fire load	Appropriate fire resistance to suit temporary fire load
Agreement on suitable systems (correct use of materials, performance, durability etc)	Construction procedures to ensure integrity of fire separations at handover
Protection of structure as required	Control of fire spread to neighbouring buildings during construction
Integrity of fire separations	
Fire protection systems installation	
Performance specification sprinklers, alarms etc	Appropriate construction methods for working at height (alarm and sprinkler installation)
Site management of fire hazards	
	Accumulation of higher fire load than designed for the completed building
	Exposure of combustible materials to heat and ignition sources
	Hot work permits and specific hazards
	Temporary fire suppression: extinguishers and hose reels (hazard and project specific)

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