Appendix B: General risks to consider when designing structures, plant or substances

RISK/CONTROL (ALPHABETISED)	EXPLANATION	DESIGN CONSIDERATIONS
Confined spaces	Confined spaces pose a health and safety risk. For further guidance on confined spaces, see WorkSafe's quick guide *Confined Spaces*.	When designing plant or structures that contain a confined space, designers should include: – use of lining materials that are durable, require minimal cleaning and do not react with materials contained in the confined space – mechanical parts that provide for safe and easy maintenance – provision for ventilation of the confined space, such as removable panels – large, practical access points to permit the rescue of people who may become trapped in the confined space. Where it is not reasonably practicable to eliminate confined spaces, the designer should consider designing the area/space: – with a safe means of entry and exit – that does not allow the build-up of hazardous contaminants, or allow dangerous levels of oxygen to occur – where risks to the health and safety of people who enter the space are minimised so far as is reasonably practicable.
Control circuit failure	If the control circuit fails, this may pose a health and safety risk to users. For further guidance on circuit controls, see WorkSafe's guidelines *Safe Use of Machinery*.	A control circuit used to control the plant should be designed to the requirements of the category, performance level or safety integrity level determined by a risk assessment. In particular: – the plant should not start unexpectedly – the plant should not be prevented from stopping if such a command has already been given – no moving part of the plant should fall or be ejected – automatic or manual stopping of moving parts should not be impeded – the protection device should remain fully effective or fail to a condition that does not create a risk.
Emergency stops	An emergency stop is a device installed on or next to plant to bring it to a stop when other control measures fail. It could be a button, grab wire or foot pedal.	Designers should consider the number of emergency stops, features of the plant operation and the location and number of operators who may need to access them throughout the structure or building. Emergency stops do not remove the need for acceptable guarding. The designer should make sure that: – once engaged, the emergency stop controls should remain in place until a risk assessment is done – it is only possible to disengage the emergency stop controls using a deliberate action – the emergency stop control cannot be adversely affected by electrical or electronic circuit malfunction – the emergency stop is not the only method of managing risks – they should be designed as a backup to other control measures – the emergency stop system should be compatible with the operational characteristics of the plant – the emergency stop system should be compatible with the physical characteristics of users – the type of emergency stop design is chosen following the requirements of the category, performance level or safety integrity level determined by a risk assessment – if the plant is designed to be operated by more than one person and more than one emergency stop control is fitted, the designer should make sure that the multiple emergency stop controls are of the 'stop and lock-off' type. This is so the plant cannot be restarted after an emergency stop control has been used unless the emergency stop control is reset.

RISK/CONTROL (ALPHABETISED)	EXPLANATION	DESIGN CONSIDERATIONS
		The emergency stop control should be prominent, clearly and durably marked. Warning devices can include: – audible alarms – motion sensors – lights – rotary flashing lights – air horns – percussion alarms – radio sensing devices. These warning devices may need to be located a multiple places in the building or structure to alert others to the situation.
Energy sources	Designers should consider the possibility of a dangerous situation where the energy source to the plant or structure becomes irregular. This could take the form of a power surge or fluctuation.	Designers should make sure: – plant should default to the 'off position' – plant should not be able to restart automatically after power fluctuations – protective devices should remain fully effective before, during and after power fluctuation. Where electrical equipment has been designed for use within certain voltage limits, only those specific requirements addressing the design requirement should apply. Where plant is powered by an energy source other than electricity, it should be designed to allow the plant to be constructed and equipped to manage, so far as is reasonably practicable, potential risks associated with that particular type of energy.
Entanglement	Some plant carries a risk of entanglement.	Designers should make sure that moving parts of machines are designed in a way that eliminates the need for user intervention. Older plant like radial drills, surface planers and milling machines commonly operate with the rotating tool unguarded. This presents a risk of entanglement should the user or their clothing contact the rotating part. For modern metal-working machines, designers should consider these things: – incorporating protective guards that surround the cutter – providing lubricant and swarf removal that could eliminate the need for user invention – ensuring plant is computer controlled where possible. For older woodworking machinery, designers should consider: – using powered feed equipment to provide a safe distance between the user and the revolving cutters or blades – fitting barriers like mesh guards or tunnel guards for close-contact plant like grain augers or tree-limb mulchers. Older style machines should be protected by the use of physical barriers, pressure sensitive mats or presence sensing devices. Operator controls for plant capable of entanglement should be able to bring the plant quickly to a complete stop. The braking system on the plant should, so far as is reasonably practicable, prevent further movement once the plant has stopped.
Fire and explosion	Certain types of plant, substances or structures contain or create the risk of fire, explosion or overheating.	A designer must, so far as is reasonably practicable, ensure the plant or structure is designed without risk. They must also manage risks posed by the plant itself. Risks may arise from gases, liquids, dusts, vapours or other substances produced, stored or used in the plant or structure, or other plant or structures in the vicinity.

Appendix B: General risks to consider when designing structures, plant or substances

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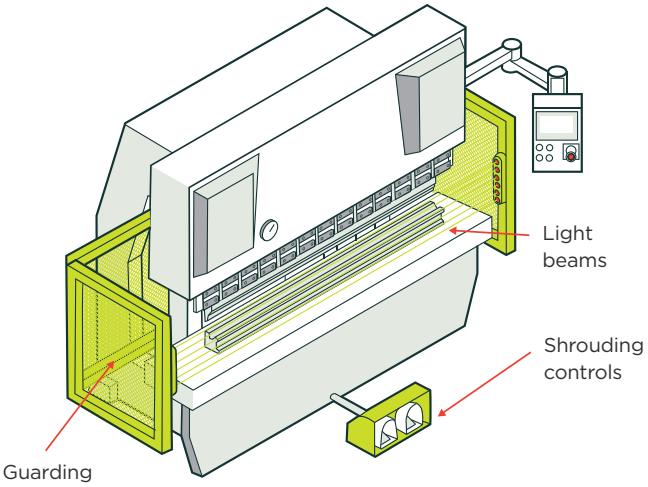
Fire and explosion	Certain types of plant, substances or structures contain or create the risk of fire, explosion or overheating.	A designer must, so far as is reasonably practicable, ensure the plant or structure is designed without risk. They must also manage risks posed by the plant itself. Risks may arise from gases, liquids, dusts, vapours or other substances produced, stored or used in the plant or structure, or other plant or structures in the vicinity.

RISK/CONTROL (ALPHABETISED)	EXPLANATION	DESIGN CONSIDERATIONS
Guarding	The designer should ensure, so far as is reasonably practicable, that guarding will prevent access to the danger point of the plant.	The guarding should be a permanently fixed barrier or an interlocked physical barrier. If neither of these options is reasonably practicable, the guarding should be a physical barrier that can only be altered or removed using a tool. If this option is not practicable, a presence-sensing safeguarding system should be used. The designer should also make sure that: – the guarding can be removed to allow maintenance and cleaning of the plant. The location of plant inside the structure is an important consideration here. – the guarding can only be removed when the plant is not in normal operation – if the guarding is removed, the plant cannot be restarted unless the guarding is replaced. The mechanisms and operator controls forming part of a machine guard should be of failsafe design. The guarding should not: – weaken the structure of the plant – cause discomfort to users – introduce new hazards like pinch points, rough edges or sharp corners. The designer should review the regulatory requirements for guarding at each phase of the design development. The guard should be designed considering: – the placement of the guard (eg to allow the user to observe the operation) – removal or ejection of work pieces – lubrication – inspection – the physical characteristics of users – adjustment and – repair of machine parts. Where some form of physical barrier is provided to prevent access to dangerous parts, the size and position of the barrier should take into account the physical characteristics of likely users. The illustration shows an example of good guard design on a press brake.  When choosing a guard, designers should consider the environment it will be used in. Physical barrier guarding should be: – constructed from material strong enough to resist normal wear and shock – able to withstand long use with a minimum of maintenance – made from corrosion-resistant materials, if it is likely to be exposed to corrosion.

RISK/CONTROL (ALPHABETISED)	EXPLANATION	DESIGN CONSIDERATIONS
		When an enclosure is used to prevent access to mechanical, chemical and electrical hazards there may be an opportunity to control other risks. For example, risks associated with exposure to dust may be controlled by replacing a mesh guard with a sheet metal guard (ie enclosure) however; the accumulation of dust within the guard should not create another hazard. Where there is a risk of jamming or blocking moving parts, the designer should document the work procedures, devices and tools to clear the plant in a way that minimises the risk. This information should be passed on to the manufacturer and supplier. The designer should carry out safety integrity testing for presence-sensing safeguarding systems to check that a safety function will perform as intended. A risk assessment determines the safety integrity requirements – the higher the level of safety integrity, the lower the likelihood of failure which can cause harm. If applicable, the designer should specify (in the information provided to the manufacturer) the safe systems of work for using and maintaining the guarding and the maintenance of the components being guarded.
Hazardous substances and substances hazardous to health	Hazardous substances may create health and safety risks for people who handle them.	Plant should be designed and manufactured to control the release of hazardous exposures. This includes controlling hazardous waste and airborne substances. Extraction ventilation for a structure or for plant should be designed to maximise the capture and containment of the airborne contaminant and ensure it is carried away from the workers rather than toward the workers.
Lighting	Lighting should be provided to enable safe use of plant and provide a safe work environment in, or on a structure. Poor lighting can lead to poor visibility, user fatigue, difficulty performing tasks, and wrong decisions and accidents.	Lighting may be internally or externally installed. Emergency lighting should use its own power supply and not be subject to power cuts. If external lighting is needed to ensure the safety of workers at or near the plant, the designer should provide written information to the installer and the end user. Designers should consider control panel lighting when designing plant. Designers should, by applying appropriate Standards, look into lighting requirements for plant use and maintenance including: – the direction and intensity of lighting – the contrast between background and local illumination – the colour of the light source – control of reflection, glare and shadows – the use of colour and finishes on reflecting surfaces – adaptation of the worker to the light levels – distribution of light in the space and on surfaces – the use of light with suitable colour characteristics.
Lightning	Lightning strikes pose a risk of severe burns or death.	Plant or structures potentially exposed to lightning strikes while being used, or worked in or on should incorporate a system for conducting resultant electrical charges to earth.
Manual tasks	Manual tasks can pose a risk to workers' health and safety.	Designers should: – make sure that the plant and layout of the structure is designed to eliminate, so far as is reasonably practicable, the need for any hazardous manual tasks to be carried out – take reasonable steps to provide information on hazardous manual tasks associated with plant. For example, this information may be in user manuals and manufacturer's instructions. It should be in plain English and include pictures or drawings where possible while also maintaining the accuracy and quality of the technical information.

RISK/CONTROL (ALPHABETISED)	EXPLANATION	DESIGN CONSIDERATIONS
		Designers should consider: – characteristics of the plant such as weight, size, shape and stability – layout of the structure and work areas in terms of accessibility and movement of people, plant and vehicles – vertical and horizontal reach distances of future users – conditions in which the plant will be used, serviced, maintained and repaired – if the plant is suited to the physical characteristics of users including body size and shape – if the plant could create poor working positions or awkward postures – if the operator will need to carry out repetitive actions – if the operator will be required to work at the same task for long periods – sight lines of users. Designers should consider the following methods to minimise risks associated with manual tasks: – modular components designed to be dismantled so they can easily be carried or repaired – attachments like handles or designated lifting points to make lifting easier – wheels to make moving easier – using lightweight materials – managing weight of products, substances or components (eg packing substances only in 10 kg bags rather than 25 kg bags).
Mechanical or structural failure during use	Parts of plant and structures should be able to withstand typical stresses during intended use and reasonably foreseeable misuse.	Materials used to make the plant and structure should suit the specified working environment. While deciding which materials to use, designers should consider the possible effects of fatigue, ageing, corrosion and abrasion. The design specification should indicate: – the type and frequency of inspection and maintenance required to keep the plant or structure in a safe condition – the parts subjected to wear – the criteria for determining replacement of these parts. Where risk of rupture or disintegration of parts of plant or structure remains after control measures are taken, the parts should be designed, so far as is reasonably practicable, to be mounted, positioned or guarded so if they rupture their fragments will not put the user or others at risk. Designers should consider whether it is appropriate to design plant such that if one part of the plant disintegrates or fails, the entire plant should stop (or continue, whatever is safer) so that it does not pose any additional risk over and above the failed part. Rigid and flexible hoses and pipes carrying fluids like gases or liquids, particularly those under high pressure, should be able to withstand foreseen stresses and be firmly attached and protected against them. Where material to be processed is automatically fed to moving parts of the plant, the design should include a way to avoid risks to the user and others which may arise from the material being ejected or being blocked in the moving parts of the plant. This may include: – allowing the moving parts to reach normal working condition before material comes into contact with the moving parts and – co-ordinating the feed movement of the material and the moving parts of the plant including on start-up and shut-down, regardless of whether the use is intentional or unintentional. For further information, see the *ILO Code of Practice* (Occupational Safety and Health).

RISK/CONTROL (ALPHABETISED)	EXPLANATION	DESIGN CONSIDERATIONS
Noise	Designers should design plant and structures so that noise emission is as low as is reasonably practicable.	To manage the risks associated with noise emission, the designer should consider: – preventing or reducing the impact between machine parts – replacing metal parts with quieter plastic parts – combining machine guards with acoustic treatment – enclosing noisy machine parts – selecting power transmission which permits the quietest speed regulation – isolating vibration-related noise sources within machines – using effective seals for machine doors – machines with effective cooling flanges which reduce the need for air jet cooling – quieter types of fans or placing mufflers in the ducts of ventilation systems – quiet electric motors and transmissions – reducing velocity of air or liquids in pipes – maximum 5 metres per second – ventilation ducts with fan inlet mufflers and other mufflers to prevent noise transfer in the duct between noisy and quiet rooms – locating noisy plant outside a structure, or if within a structure at a position that minimises noise reflection from walls, ceiling and floors.
Operator controls	Operator controls can pose a risk if they are difficult to use or access.	Designers should design plant operator controls so they are: – identified on the plant to indicate how to use them – located in an accessible place on the plant – located or guarded to prevent accidental activation – able to be locked into the ‘off’ position to enable the disconnection of all motive power. Control devices should be designed: – so the plant is fail-safe to the category, performance level and safety integrity level determined by a risk assessment – to be located within easy access of the user – with extra emergency stops which can be used from other parts of the plant – so they are clearly visible, identifiable and suitably marked – to clearly indicate the function of the control and control operations are as indicated – using symbols and written instructions – so they can be easily read and understood by all users or potential users (including those with poor vision). This includes dials, screens and gauges – so the control moves consistent with established convention – so the desired effect can only occur by intentionally operating a control – to withstand normal use, undue forces and environmental conditions – to be outside danger zones – to be located or guarded to prevent unintentional activation – so they can be locked in the ‘off’ position to isolate the power and – to be readily accessible for maintenance. It should only be possible to start plant by deliberately moving or operating a control provided for that purpose, including after a stoppage. Each item of plant should be designed to include a control which completely stops the plant or its relevant components safely.

RISK/CONTROL (ALPHABETISED)	EXPLANATION	DESIGN CONSIDERATIONS
Plant combinations	Plant that is designed to work in combination with other plant can pose a health and safety risk if not used correctly.	Plant arranged to work in combination with other plant should be designed so when the stop controls, including the emergency stop control, are activated, all the plant being used is stopped simultaneously. Where production lines are separated into zones, designers should indicate to the user that the stop controls will only work for that zone. Separate zones should be clear and intrusions into adjoining zones should be made as difficult as possible. Designers should provide information and instructions about combined plant to the manufacturer.
Powered mobile plant	Powered mobile plant includes tractors, forklifts, quad bikes and other plant that is commonly used to transport people or materials.	There are various risk controls that may need to be considered in their design. These may include: – roll over protective structures (ROPS) – falling object protective structures (FOPS) – seat belts – reversing alarms that can be easily heard above background noise. For more information on powered mobile plant, see WorkSafe's guidance *Keep safe around moving plant*.
Radiation – Electro-magnetic	Electro-magnetic radiation can pose a health and safety risk. It may occur at workplaces that perform: – forging – annealing – tempering – brazing or soldering – sealing of plastics – glue drying – curing particle boards and panels – heating fabrics and paper – cooking with a microwave. Pregnant women and people with metallic implants or cardiac pacemakers may be at particular risk from electro-magnetic radiation. Plant that produces a magnetic field may include: – devices – appliances – equipment containing wires that carry a direct current. Technologies that use magnetic fields may include: – aluminium production – electrolytic processes – magnet production – nuclear magnetic resonance imaging – spectroscopy. Low frequency radiation is man-made, low frequency electromagnetic fields.	Designers should consider the effects of plant that generates electro-magnetic radiation. Control measures to minimise exposure to electro-magnetic radiation may include: – shielding – interlocking doors on industrial microwave ovens – installing remote operator controls when stray radiation could be produced from an induction or dielectric heater.

RISK/CONTROL (ALPHABETISED)	EXPLANATION	DESIGN CONSIDERATIONS
Radiation – Ionising	The use and assessment of these is covered by the Radiation Safety Act 2016 and regulations. For more information on ionising radiation, see the Ministry of Health's Radiation Safety page: www.health.govt.nz/our-work/radiation-safety	Designers should design plant: – to eliminate, so far as is reasonably practicable, personal exposure to radiation – so that external ionising radiation does not affect people working with or near the plant – so that ionising radiation levels are not higher than what is necessary to use the plant, even in an emergency – so that ionising radiation levels do not exceed relevant exposure limits set by the Radiation Safety Act 2016 and Radiation Safety Regulations 2016.
Radiation (non-ionising) – Lasers	Lasers are devices that produce optical radiation with unique properties. They have varying power and applications. High power laser devices can present a hazard over considerable distances from the source. Exposure to some higher powered lasers may cause skin burns and eye damage.	Designers of plant with laser equipment should make sure that: – laser equipment on plant is designed to prevent harm – laser equipment on plant is protected so that users are not exposed to direct radiation, radiation produced by reflection or diffusion or secondary radiation – visual equipment used for observation or adjustment of laser equipment on plant does not create health and safety risks. Designers should consult with manufacturers, suppliers, owners and end users to make sure that the correct strength of laser is used and the housing of the laser unit is designed according to safe design principles. The designer should make sure that written information on how to use laser products safely is provided to the relevant PCBUs and workers. **Designers of lasers and plant with lasers should provide information about how to use the lasers safely. This could be a label with both the classification details and the warnings-for-use relevant to that classification. The warning labels relevant to that classification should be permanently attached to the housing of the plant in a highly visible position.**
Radiation – Ultraviolet	Excessive exposure to ultraviolet (UV) radiation from the sun can cause sunburn, lasting skin damage, premature skin aging and an increased risk of developing skin cancer. Exposure also increases the risk of ultraviolet induced damage to the lens and cornea of the eye. Exposure can also come from artificial sources like germicidal lamps and quartz-halogen lights, UV curing of printing inks and some forms of welding.	Designers should consider ultraviolet light risks associated with the plant, and in structures they are designing. For example, a designer of mobile plant should safeguard the driver from exposure to ultraviolet radiation from the sun by incorporating an effective canopy into the design. They should make sure that UV radiation created by the plant is not released to prevent exposure to other workers in the structure.
Risk of being trapped	Becoming trapped in plant poses a risk or injury or even death to users.	Where there is a risk of a person becoming trapped or enclosed within the plant, designers should incorporate control measures in the design to allow the plant to come to an immediate stop or prevent the plant being activated while a person is in that position. For mobile plant, the risk of the user being trapped if the plant overturns can be minimised with rollover protection structures.
Software	If software is difficult to use, it can lead to health and safety risks for users.	Designers should investigate any potential Standards they may need to reference when designing software for plant. Designers considering the use of interactive software for the user to control the plant should make sure the software is as easy-to-use, and with as few manual task risks as possible. See *Manual Tasks* for more information about user interaction with plant, structures and substances.

RISK/CONTROL (ALPHABETISED)	EXPLANATION	DESIGN CONSIDERATIONS
Stability	Unstable plant can cause a risk to health and safety. It can topple, parts can fall off or it can unexpectedly move and result in crush or impact injuries.	Designers should design plant to be stable under all expected conditions. Detailed written instructions should be provided by the designer to the relevant PCBUs. Detailed written erection, modification and dismantling procedures should be provided to the manufacturer by the designer. Stability testing requirements for the plant can be developed and specified at the design phase and verified after manufacture.
Static electricity	Static electricity may cause an electric shock to a person, as well as unintended combustion where flammable fumes are present.	Plant and structures should be designed to prevent or limit the discharge of electrostatic charges. To manage health and safety risks arising from static electricity, designers can incorporate control measures into their design such as spark detection and suppression systems.
Vibration	Vibration can be transmitted to the whole body and through the hands and arms when using plant, or working in structures. This can lead to muscle damage and other injuries and health problems.	Plant should be designed to manage risks resulting from vibration. Three approaches to control vibration are: – eliminating vibration happening in the first place – minimising vibration – isolating the vibration from the person. Ways that designers could minimise health and safety risks that may arise from vibration are: – designing commercial vehicles to have suspended cabs – designing in vibration isolation (eg the use of rubber blocks or mounts on an engine) – tool design that isolates the handles from the percussive action – incorporating an electric drive into the design – eliminating or reducing the need for people to work on or access parts of a structure where vibration occurs.
Warning devices		If the plant design includes an emergency warning device the designer should position the device on the plant to make sure the device will work to best effect. Warning devices can include: – audible alarms – motion sensors – lights – rotary flashing lights – air horns – percussion alarms – radio sensing devices.