GUIDE 50

Safety aspects — Guidelines for child safety

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

Guides are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft Guides adopted by the responsible Committee or Group are circulated to national bodies for voting. Publication as a Guide requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this Guide may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC Guide 50 was prepared by the Joint ISO/IEC Technical Advisory Group (JTAG) for Child Safety.

It should be used in conjunction with ISO/IEC Guide 51, *Safety aspects — Guidelines for their inclusion in standards*.

This second edition cancels and replaces the first edition (ISO/IEC Guide 50:1987), which has been technically revised.

Annexes A and B of this Guide are for information only.

0 Introduction

0.1 Relevance of child safety

Child safety should be a major concern for society because childhood and adolescent injuries are a major cause of death and disability in many countries. Children are born into an adult world, without experience or appreciation of risk but with a natural desire to explore. Consequently, the potential for injury is particularly great during childhood. Since supervision to the degree that always prevents or controls potentially harmful interactions is neither possible nor practical; additional injury prevention strategies are necessary.

Intervention strategies aimed at protecting children must recognize that children are not little adults. Children's susceptibility to injury and the nature of their injuries differ from those of adults. Such intervention strategies must also recognize the fundamental concept that children do not misuse products or surroundings. Rather, children interact with them in ways that reflect normal child behaviour, which will vary according to the child's age and level of development. Therefore, intervention strategies intended to protect children might differ from those intended to protect adults.

The challenge is to develop products, structures, installations and services (collectively referred to as *products*) in a way in which the potential for injury to children may be minimized. Preventing injuries is everyone's responsibility. Prevention of injuries can be addressed through design and technology, legislation and education.

0.2 Role of standards

Standards can play a key role in injury prevention and control because they have the unique potential

— to draw on technical expertise for design and manufacture,

— to implement solutions through legislation, and

— to educate through provisions for instructions, warnings, illustrations, symbols, etc.

If standards are to fulfil their role in childhood injury prevention and control, standards-writers must consider how children might interact with the products their standards are addressing, regardless of whether or not those products are aimed specifically at children.

NOTE The word “standard” in this Guide is intended to include other ISO/IEC publications, for example Technical Specifications and Guides.

0.3 Structure of the Guide

This Guide consists of three main parts and two annexes as follows.

a) General approach to child safety, including the principles for a systematic way to address hazards (4.1 and 4.2).

b) Specific developmental characteristics of children that place them at particular risk of injury (4.3).

c) Hazards to which children might be exposed during their use of, or interaction with, a product, along with specific suggestions for addressing those hazards (clause 5). These hazards are also listed in ISO/IEC Guide 51 but, here, the focus is on the specific risk to children associated with those hazards.

Annex A provides an overview of hazards, potential injuries and approaches to solutions. However, it is essential that it be read in conjunction with the main body of this Guide as it only gives a few examples of solutions.

Annex B is intended as a checklist for standards-makers to assess their taking into account child safety.

Safety aspects — Guidelines for child safety

1 Scope

This Guide provides a framework for addressing potential sources of unintentional physical harm (hazards) to children from products, processes or services that they use or with which they may come into contact, even if they are not specifically intended for children. The framework aims at minimizing risk of injury to children.

It is primarily intended for those involved in the preparation and revision of standards. However, it has important information that can be useful to, amongst others, designers, architects, manufacturers, service providers, communicators and policy makers.

For children with special needs, additional requirements may be appropriate. This Guide does not claim to address those additional requirements in full. ISO/IEC Guide 71 addresses the needs of persons with disabilities.

A product may include goods, structures, buildings, installations or a combination of these.

No specific guidance is given in this Guide for the prevention or reduction of psychological or moral harm or of intentional injuries.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this Guide. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreement based on this Guide are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC Guide 51:1999, *Safety aspects — Guidelines for their inclusion in standards*

3 Terms and definitions

For the purposes of this Guide, the following terms and definitions apply.

3.1
risk
combination of the probability of occurrence of harm and the severity of that harm

[ISO/IEC Guide 51:1999, definition 3.2]

3.2
harm
physical injury or damage to the health of people or damage to property or the environment

[ISO/IEC Guide 51:1999, definition 3.3]

NOTE In this Guide the word “injury” encompasses damage to health.

3.3
hazard
potential source of harm

[ISO/IEC Guide 51:1999, definition 3.5]

3.4
child
person aged from birth to 14 years

4 General approach to child safety

4.1 General

The safety concepts that distinguish child safety from safety in general are explained in this clause. These concepts are additional to the contents of ISO/IEC Guide 51.

4.2 Risk assessment

Risk assessment is an important step in any injury prevention strategy. The general approach is outlined in ISO/IEC Guide 51. The main questions to ask in a risk assessment process are the following.

a) What can happen?

b) How probable is it?

c) How severe is the resulting injury?

When addressing child safety, the answers to these questions must take into account the following special factors for children:

a) their likelihood of being injured;

b) their interactions with persons and products;

c) their development and behaviour;

d) their lack of knowledge and experience;

e) social/environmental factors.

4.3 Preventing and reducing injury

Injury or disease can result from the transfer of energy (mechanical, thermal, electrical), or exposure to agents (biological, radiation) greater than the body's capacity to withstand. They can be prevented or reduced by intervening in the chain of events leading to or following their occurrence.

Strategies can address the following:

— preventing the harmful event from occurring or reducing exposure to hazard *(primary prevention)*;

— reducing the severity of injuries *(secondary prevention)*;

— reducing the long-term effects of the injury through rescue, treatment or rehabilitation *(tertiary prevention)*.

In addition, strategies can be passive or active. Passive strategies work without the individual having to take any action to be protected. Active strategies require the individual to take some action. Designing safe products generally results in primary prevention; incorporating passive protective strategies generally ensures a greater likelihood of success.

Various sources can be used to identify the potential for injury associated with a product. These include, but are not limited to

— injury statistics,

— detailed information available from injury surveillance systems,

— research studies,

— investigations of case reports, and

— complaint data.

CAUTION — The absence of reported injury does not necessarily mean that there is no hazard.

As injuries to children are closely related to their developmental stage and their exposure to hazards at various ages, it is important to sort child injury data by age group to identify the patterns that emerge. For example, in some countries, burns from oven doors, scalds, poisoning by medicines and household chemicals and drowning have peak rates in children under 5 years of age; injuries associated with falls from playground equipment peak at 5 to 9 years; and injuries associated with falls and impacts related to sports peak at 10 to 14 years.

The identification of appropriate countermeasures results from processes of research and evaluation, particularly based on the methods of epidemiology, engineering and biomechanics as well as by the feedback cycle of gradual improvements to design. When choosing preventive measures, it should be recognized that tolerable levels of safety/risk for adults might not be sufficient to protect children. When introducing measures designed to protect adults it is essential to consider any potential effects that might increase risks to children (e.g. passenger side air bags in cars).

4.4 Child development and behaviour

4.4.1 General

Children are not small adults. Inherent characteristics of children, including their stage of development, together with their exposure to hazards, put them at risk of injury in ways different from adults. Developmental stage broadly encompasses children's size, shape, physiology, physical and cognitive ability, emotional development and behaviour. These characteristics change quickly as children develop. Consequently, parents and carers often over- or under-estimate children's abilities at different stages of development, thus resulting in exposure to hazards. This situation is compounded by the fact that much of the environment that surrounds children is designed for adults.

All the childhood characteristics described below need to be considered in determining potential hazards associated with products. It should be kept in mind that these characteristics may act in combination, increasing the child's risk of injury. For example,

— exploratory behaviour might lead a child to climb a ladder,

— limited cognitive skills might prevent the child from recognizing that the ladder might be too high or unstable, and

— limited motor control might result in the child losing grip and falling.

The way children use and interact with these products must be considered as normal childhood behaviour. With regard to children, the term "misuse" is misleading in this respect, and may lead to inappropriate decision-making regarding hazards for children. Survey evidence shows that children regularly use products that were not designed

for them, such as microwave ovens. When a child interacts with a product, it is difficult to make a distinction between play, active learning or intended use. For safety reasons it might not be constructive to attempt to distinguish between such interactions.

While safety considerations should provide an appropriate balance between the risk of injury and freedom for children to explore a stimulating environment and to learn, the goal is to reduce the risk of injury by design until such time as the child has developed an ability to assess risk and take appropriate action.

4.4.2 Children's body size and anthropometric data

Certain characteristics of children's body size and weight distribution make them vulnerable to injury. Their overall mass is smaller, thereby reducing their capacity to absorb injury-causing energy. The following are examples where body size and weight distribution, as compared to adults, are factors in injury.

a) In the case of thermal injuries, a relatively small area of contact can affect a large proportion of their body surface. The large surface area in relation to the small body mass can result in a greater proportion of body fluids being lost from the burnt area.

b) Young children have a large head compared with their body size. Their high centre of gravity increases the likelihood of falls, for example from furniture or structures on which children may be seated, climbing or standing. Children often fall directly onto the head without breaking their fall with their arms.

c) Another effect on the high centre of gravity is that it also increases the risk of falling into pools, buckets, toilets, etc., into which children are bending or reaching, thereby increasing their risk of drowning.

d) The relatively large size of the head means that it requires a much larger space to pass through than the rest of the body. Entrapment can occur when the body passes, feet first, through a gap through which the head cannot pass.

e) Children might be able to insert their fingers, hands or other parts of their body into small openings to access rotating parts, electrical wiring or other hazards.

f) The relatively large mass of the head increases the likelihood and severity of a whiplash injury.

Children’s size in relation to their surroundings makes it necessary to examine their anthropometry, including overall heights as well as body part lengths, widths and circumferences. Anthropometric data should be consulted in order to establish the normal distribution and safety margins.

4.4.3 Motor development

Motor development refers to the maturation process of gross and fine movements. The process includes changes from primary involuntary reflex actions to deliberate, goal-directed actions. Milestone achievements in the process include acquiring the strength and skill to support the head, crouch, sit up, rollover, crawl, stand, climb, rock, walk, run, and the ability to manipulate objects with hands and fingers. Until balance, control and strength have sufficiently developed, children are at risk of falling and getting into unsafe positions from which they cannot escape. The following are examples.

a) When lying, infants can move to the edge of a surface and roll off, but be unable to lift themselves back onto the surface. As a result, they can become wedged in or between products and suffer positioned or compression asphyxia.

b) Standing infants and toddlers can become entangled in cords, ribbons, or window dressings within their reach. When they sit or slump, the cords can tighten around the neck, resulting in strangulation.

c) Climbing infants can get clothing caught in furniture items or protrusions. If they cannot extricate themselves, they can hang.

d) Children fall from heights because they lose their balance or grip.

Understanding what motor skills a child can/cannot accomplish can be an important tool in the design of safer products and also in the design of interventions. For example, access to lift (elevator) platforms can be designed to be out of reach for crawlers, and child-resistance measures can take advantage of the lack of well-developed motor skill.

4.4.4 Physiological development

In addition to body size and motor functions, there are many other physiological functions that develop in children. These include sensory functions, biomechanical properties, reaction time, metabolism and organ development. The following are examples where incomplete physiological development can be a factor in injuries:

— children are vulnerable to poisoning, since medications, chemicals and plants can be toxic to children in smaller amounts than to adults;

— the nature of their skin makes children more vulnerable to thermal injury;

— children's bones are not fully developed, resulting in different responses to mechanical forces.

4.4.5 Cognitive development

Children's stages of cognitive development determine their ability (inability) to assess risk and make informed decisions. Cognitive functions that are not fully developed result in the lack of ability of young children to assess the situation in which they find themselves and save themselves from hazards. In the first year or two of life children appear to have no sense of danger. Thus, whereas normally allowance can be made for hazards that are obvious to the user and are necessary for the function of the product, these hazards might not be so obvious for children. At some stage in early childhood, prior experience and parental/carer teaching begin to influence the child's behaviour. Coping with limited risks is therefore a natural part of children's learning.

Certain behavioural characteristics associated with early childhood also render children at risk of injury. These include the following:

— putting things into their mouths (mouthing), particularly in the first three years of life, exposing them to ingestion and aspiration risks;

— putting things in other body openings, exposing them to impaction and laceration risks;

— natural inquisitiveness and exploring behaviour;

— a relatively small head width, combined with a relatively large head height and length enable children to enter spaces head-first in one orientation, but they are unable to understand how to position their head to exit the space;

— starting to develop individuality at around 2 years, resulting in saying “no” and refusing help, for example when eating;

— assertion of their independence at about 3 to 4 years;

— attraction to taste, smell, design, and colours (e.g. medications).

Since young children explore by mouth, products that are for use by, or likely to be used around, children should not have small easily removable parts. Objects not meant to be put into the mouth, such as erasers or small toys, should not be made to resemble food.

Child behaviour often mimics that of adults and older children. This behaviour can become dangerous when children do not understand the implications of their actions. For example, they may administer medications to their younger siblings, operate locking mechanisms and switch on appliances.

Children cannot necessarily be expected to recognize the difference between a real object and an imitation or model, either of which might be harmful. The use of images for products, which may be associated with toys, such as cartoon characters for hairdryers, lanterns and cigarette lighters, can be misleading and potentially injurious for children.

Reading and communication skills take years to acquire. Warnings and information, including the use of simple methods such as pictograms (symbols), might have no meaning to children.

4.5 Physical and social environment

4.5.1 General

In addition to taking into account child development, it is necessary to consider both the physical and social environment in which a child might use or come into contact with a product. Product safety might be affected by the natural and built environments, climate, language, customs, attitudes and beliefs, knowledge and users' experience.

4.5.2 Physical environment

Specific physical environmental factors related to intended and unintended location of use (such as indoor/outdoor, private/public space, supervised/unsupervised area) and factors such as the effects of weather and terrain must be considered. Interaction with other activities and people, potential for unsupervised activity and the potential for a child to ever be exposed to a particular setting are also relevant. Settings not intended for children, but to which they become exposed or have access (such as the parental workplace and the traffic system), pose greater challenges. Where hazards cannot be controlled, barriers to exposure must be employed.

4.5.3 Social environment

Psychological considerations that might affect intended versus unintended use might also relate to the global geographic location in which the product can potentially be used. The opportunity for global trade requires careful attention to the subtle translations of language and the prevailing customs and attitudes based on cultural/ethnic differences, so that these interpretations of product use do not inadvertently become hazards.

The relationship between parents/carers and children can be expected to vary with geographic, cultural/ethnic and socio-economic differences. Cultural variations of discipline, supervision and safety awareness should be recognized. Although supervision is an important aspect of child safety, it can never replace inherent safety, even when the child is within visual or auditory range of the parent or carer.

As children approach adolescence, peer pressure and risk-taking behaviour can affect the use or consumption of the product. Recreational activities might be associated with higher risk behaviour relating to presumed increased protection from "safety" equipment, aggressive behaviour inherent in the competitive nature of sports, and the greater risk of injury related to attention-seeking behaviour.

5 Hazards relevant for children

5.1 General

In view of the facts presented in the preceding clause, the risks associated with products can be high for children. Product-related hazards and their potential to injure children are discussed below. Examples based on reported injury patterns are provided to help users of this Guide to understand the hazards. It is important to recognize that individual hazards can act in combination to produce injuries that might be different from, or more severe, than those associated with the individual hazards separately.

It is equally important to realize that new hazards can emerge and enter the environment of children due to developing technology and changes in lifestyles, such as working at home (teleworking), and sophisticated medical care at home (e.g. use of gas cylinders and monitoring devices).

In general, accessibility and age groups should be considered in assessing entrapment or entanglement hazards. As a priority, those parts of a product that are accessible should be considered. It might be appropriate to assess gaps and openings beyond the areas accessed during intended use in a less stringent way.

When considering the safety of a product, it is essential to consider the context in which it will be used. For example, if a product is tested in a situation that is not typical of how it will be used in reality, its performance in real life can be different. Equally, when a product is always used in combination with another product, such as a seat used by babies in a bath, or a child restraint used in a car, the performance of both systems in combination should be examined to minimize risk.

A product can cause death or injury at various stages of its life cycle, beyond just its period of intended use. When a product is being disposed of it is essential that it does not cause new hazards. Equally, the ease and frequency of the maintenance of a product can influence the hazard that it presents.

5.2 Mechanical hazards

5.2.1 Hazards from gaps and openings

Accessible gaps and openings can give rise to risks of entrapment or entanglement of the whole or part of the body, and of clothing or accessory entanglement. Entrapment and entanglement are not limited to rigid products, but can also occur in loops of rope or cords. Figure 1 provides an illustration of entrapment and entanglement situations.

Potential injuries include bruises and amputations. If the size of an opening can change, there can be also a crushing or strangulation hazard (see 5.2.9). Heads or bodies can become trapped in situations where the child is incapable of raising its body weight to relieve the pressure. With head entrapment, especially if the child's feet cannot reach a standing surface, there is a high risk of fatal or serious injury.

Strategies to avoid or reduce risks due to gaps and openings include

— avoiding gaps, and

— specifying dimensions for gaps and openings related to the anthropometric data of the growing child.

When addressing the potential for entrapment, the relevant finger accessibility probes, and torso and head test fixtures, defined in existing standards should be used.

Examples

- Entrapment of the head occurs in two different ways
  - — head first, for example through balcony railings, and
  - — feet first, for example through the barriers on bunk beds.
- Body or neck entrapment that can prevent breathing, or crush the child, occurs when the size of gaps changes, for example with electrically operated garage doors or car windows.
- Fingers have been trapped in spring mechanisms, chains on playground swings, folding mechanisms, etc., causing fracture, avulsion or loss of blood supply to the tips.
- Loose cords or ribbons from children's clothing have dropped into V-shaped openings or gaps wide enough for the cord but too narrow for the toggle or knot at the end. When the toggle or knot snags, the child's movement is abruptly stopped. When the cords are in the neckline of a garment, children have been strangled.
- Children have been dragged when waist cords have snagged in vehicle doors, lifts (elevators) and escalators.

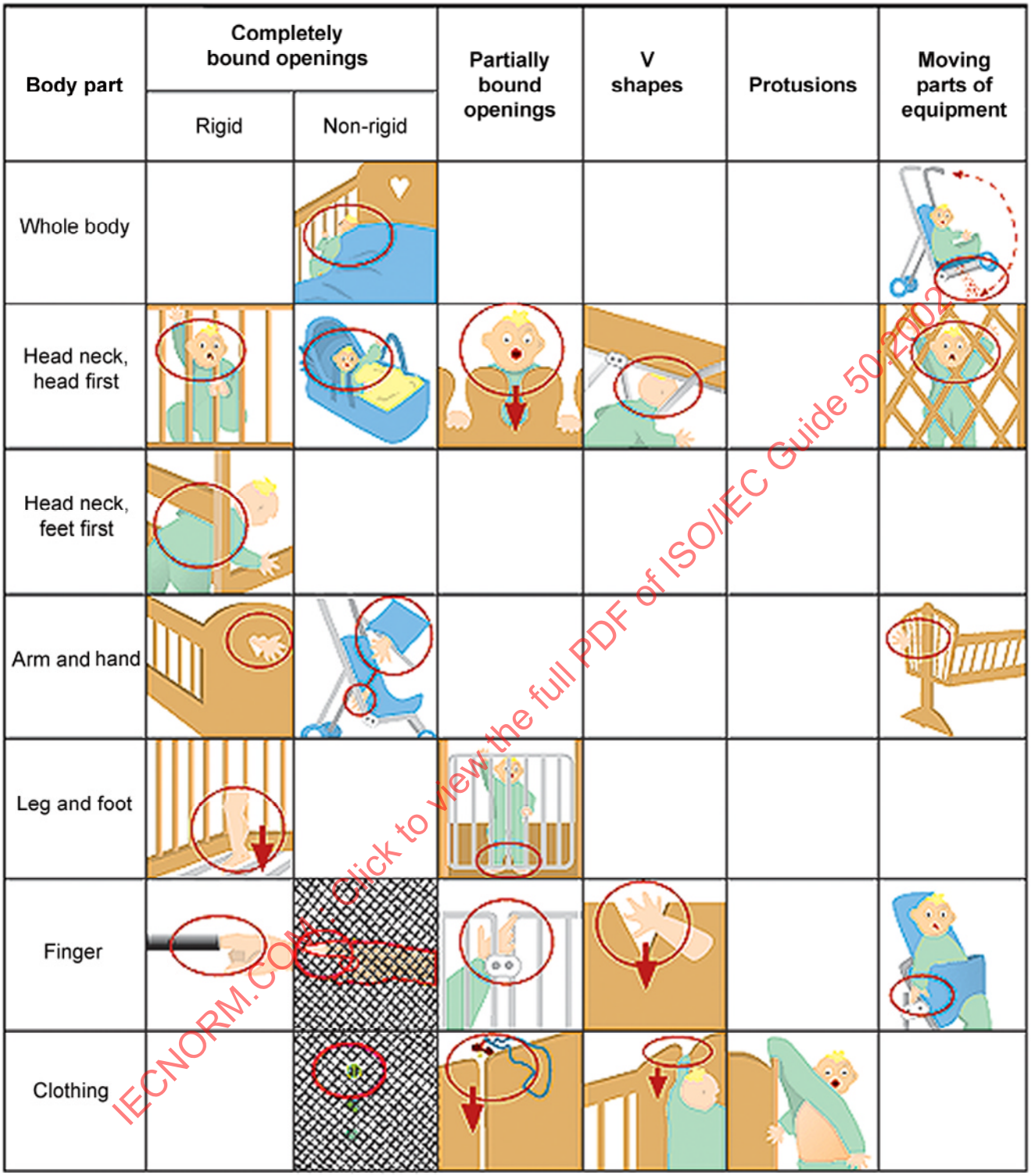

Figure 1 — Examples of entrapment and entanglement in gaps

5.2.2 Hazards from protrusions

Protrusions can create areas for impact or for entanglement for clothing or accessories. The resulting injuries can be strangulation, laceration, puncture or blunt trauma. Loops in cords (clothing) or necklaces, etc., that get caught around a protrusion can cause the child to be strangled.

Strategies to avoid or reduce risks due to protrusions include

— avoiding unnecessary protrusions, and

— making sure that protrusions have a rounded shape and protrude from the surface as little as possible. Test cords, chains or other devices can be used to assess the hazard (see references [12], [14]).

Examples

- Children's clothing, especially cords and hoods, can catch on cot corner posts, posts at the top of slides and on protruding bolts, resulting in strangulation.
- Horizontally protruding poles at about head height in playground equipment have led to head injuries.

5.2.3 Hazards from corners, edges and points (including projectiles)

Contact with hazardous corners, sharp edges and points can result in lacerations or puncture wounds. Projectiles can be particularly hazardous since their paths cannot always be predicted, and because their energy upon impact tends to concentrate in a relatively small area.

Many of the products that children encounter in the domestic and educational environment are intended to be sharp or pointed to meet their functional needs (e.g. knives, needles, kitchen equipment or tools used in the garden or garage).

Sharp edges or hazardous points can arise through the breakage of an object. Glass used in domestic products (drinking vessels, tables, other furniture, etc.) and architectural features (doors, windows, screens, etc.) presents a particular hazard when broken or even when an unbroken edge is exposed.

It is the normal behaviour of young children to put toys and domestic objects in their mouths and to walk and run about when carrying them in this way.

Strategies to avoid or reduce risks due to corners, edges and points include the following:

— avoiding, guarding or curving exposed edges to reduce the risk of laceration;

— using glass that is either difficult to break or that breaks in such a way that the residual pieces are unlikely to cause serious injury (so-called safety glass); in certain high-risk locations in homes and other places where children move freely, materials other than glass should be considered for architectural use;

— restricting access of young children to pointed objects such as pens, pencils and knitting needles;

— restricting access of children to sharp parts of tools by appropriate guarding;

— teaching children to use sharp tools when they are able to do so, under close supervision, with less hazardous versions (such as scissors without pointed blades) being used initially.

Examples

- Facial lacerations, dental or eye injuries can result from collisions with small radius corners of domestic tables or kitchen work surfaces.
- Children falling through tables with surfaces not made from “safety” glass have died from the resulting lacerations to major blood vessels. Collisions with vertical glass that is not “safety” glass in doors or other furniture can also lead to severe lacerations.
- Falling while holding an object in the mouth can lead to penetrating injury to the palate.

5.2.4 Hazards from small objects

Small objects and parts of products as defined in existing standards (see, for example, ISO 8124-1, EN 71-1 and ASTM F 963-96a) present potentially serious hazards, especially to young children.

Apart from the relatively well-known small objects that can enter the airways and trachea, certain rounded (e.g. spherical) shapes present a hazard because they might block the airways at the back of the mouth.

The following hazardous situations can occur:

— objects can be inhaled or inspired, lodging in the trachea or deeper within the airways;

— objects can be ingested, presenting risks of blockage or perforation of the oesophagus, stomach or intestines;

— objects can be inserted into any body orifice, leading to pain, swelling, obstruction or other injury.

Strategies to avoid or reduce risks due to small parts include the following:

— eliminating small parts; in particular, shapes such as spheres and cones should be avoided if possible;

— providing age-appropriate guidance and warnings to consumers of the hazards for younger children;

— applying secondary prevention strategies such as providing continuous air passages, so that if the part is inhaled the child can still breathe;

— training carers in first aid methods in order to minimize the consequences when small objects are inhaled.

Examples

- Objects that can change in size, shape or texture when mixed with saliva can occlude the airway.
- Button batteries can cause an obstruction, leak, corrode or lead to localized harmful electrochemical reactions when inserted into a body orifice, such as the nose, or when swallowed.
- Small magnets, when swallowed, can attract each other and damage the small intestine.
- Children as old as 12 years have choked on small objects combined with or resembling food.
- Flexible objects such as whole or broken latex balloons have lodged in the airway.
- Pen caps are often held in the mouth by older children and, because of their shape, can be inhaled.
- Foods containing inedible products, such as toys, have resulted in inhalation or ingestion of small parts while eating.

5.2.5 Hazards from non-permeable enclosures

Enclosures that do not allow air to pass constitute a suffocation risk, in particular to young children. During play, they might either hide themselves completely in the product or put it over their face or head. Products that might contribute to the risk include

— a sheet of flexible material that can take the shape of the face and thus cover nose and mouth, or

— an enclosed space.

Strategies to avoid or reduce risks due to non-permeable enclosures include

— limiting the size of flexible materials (e.g. the opening of plastic bags),

— providing ventilation holes in the material, and

— using material with less flexibility.

Examples

- Suffocation and irreversible brain injury can occur when children place plastic bags over their head or face.
- Children have suffocated when trapped in toy chests, old refrigerators, portable insulated boxes and vehicle boots (trunks) because of an absence of ventilation holes and the inability of the child to open the cover/door.

5.2.6 Hazards from inadequate stability

A product that is not sufficiently stable might fall over, injuring a child who is in, on, or near it. The nature of the injury can vary depending on the function of the product. For example,

— scalds from hot liquids when cookers tip over,

— crush injuries from heavy items of furniture, and

— burns from fire caused by unstable free-standing lamps.

Strategies to avoid or reduce the risks due to inadequate stability include

— designing products with such features (centre of gravity position, mass, position of contact points with the supporting surface) that they can withstand any foreseeable destabilizing loads, and

— limiting the effects of products falling over (e.g. spill-resistant mugs).

Examples

- Wheeled furniture, such as television stands, cause a risk when children pull or push them.
- Pedestal tables can fall over when hook-on chairs are attached.
- Open dishwasher or oven doors can cause hazardous situations when used as a climbing aid.
- Certain types of petroleum stoves are unstable, which is especially dangerous because of the presence of fuel and flames inside.

5.2.7 Hazards from inadequate structural integrity

Inadequate structural integrity can result in fractures, internal injuries and laceration. It can also lead to product breakage and thereby to the release of small parts or access to other hazards. A product might fail during its lifetime because of inadequate maintenance. Maintenance is important for many products. Some products are intended to be assembled or installed, either

— every time they are used (e.g. folding pushchairs), or

— only once (e.g. wardrobes, bicycles, or features of the built environment such as fences).

The safety of a self-assembly product depends on the design of the product, the adequacy of the instructions and the skill of the person assembling it. Products that are assembled every time they are used often include locking mechanisms that can be accessible to children who might release the locks, or might fail to secure them correctly.

Strategies to avoid or reduce risks due to inadequate structural integrity include the following:

— making sure that if a product looks as if a child can sit, stand or climb on it, the product is actually able to carry the weight; products should be capable of being overloaded without collapsing; test methods should reflect reasonable foreseeable use during the life of the product;

— designing products to minimize the need for maintenance; if maintenance is required, adequate instructions should be provided;

— making incomplete or incorrect assembly, including the use of locking mechanisms, virtually impossible or manifestly obvious; if incorrectly assembled, the product should be unusable (see also 5.10);

— making sure that locking mechanisms resulting in the collapse of the product cannot be operated by children.

Examples

- Glass-topped coffee tables, which children perceived as being strong, have broken when children have stood on them, causing fatal lacerations.
- Playground equipment can fail because of poor inspection or maintenance. Fatalities have occurred when swings have broken.
- Pushchairs have collapsed with the child inside because of inadequate locking, resulting in the amputation of fingertips.

5.2.8 Hazardous heights

Falls from a height can result in internal injuries (brain and other internal organs) and fractures, particularly of arms and legs. The kind and degree of injury depends on the height of the fall, hazards encountered during the fall, and the nature of the surface on which the child lands.

Strategies to avoid or reduce risks due to hazardous height include the following:

— designing barriers to prevent climbing activity;

— removing the potential for children to climb by design, by using vertical rather than horizontal design elements (removing footholds);

— building in guards at the top and bottom of stairs when a house is constructed;

— incorporating window guards and locking mechanisms in new buildings and designing standards to require retrofittings for older dwellings;

— preventing the fall (e.g. where appropriate, using structures of such a size that children can achieve a secure grip; providing adequate guarding);

— reducing the consequences of a fall (e.g. by reducing potential fall heights, designing and installing product to avoid contact with hazards if a child does fall, or providing energy-absorbing surfacing material);

— reducing the consequences of falls combined with movement in sports or leisure activities by designing appropriate safety equipment and environments, and by revising rules.

Examples

- In the home, the most serious falls occur from accessible openings (windows and doors) and down the stairs.
- Balcony railings that allow a child to pass beneath or climb over them can result in fatal falls.
- In playgrounds children might fall when using equipment not suitable for their ability.
- Fractures associated with sport and leisure activities increase as children age and participate in activities where falls result from a combination of a fall and movement (collision).

5.2.9 Hazards from moving and rotating objects

Impact with moving objects can cause crushing, internal injuries, fractures, etc. The injury severity is related to the mass and velocity of the object. For this reason, it is not surprising that motor vehicle injuries, including injury to passengers and pedestrians, cause more deaths than any other type of unintentional injury. Some efforts to reduce the likelihood of vehicular death and injury have focused on secondary interventions like better restraint systems and air bags. Primary prevention efforts should not be overlooked. These include, but are not limited to, designing roadways for safer routing of traffic, reducing speed in areas where children are expected, providing better lighting, and creating protected pathways for pedestrians and cyclists.

Contact with moving and rotating objects (e.g. fan blades, food chopper blades and hinged mechanisms) can cause lacerations, traumatic amputations and other serious injuries. Such contact can also entangle or trap hair, clothing, or accessories, as for example in escalators, ski tows, lifts (elevators) and bus doors, resulting in strangulation, scalping or dragging.

Strategies to avoid or reduce risks due to moving and rotating parts include the following:

— keeping children and the product apart;

— limiting the kinetic energy (e.g. speed);

— providing adequate means of stopping the motion of the product;

— providing adequate means of absorbing the energy if an impact occurs;

— designing the product in such a way that the moving or rotating part is outside the reach of the child by, for example, enclosing or guarding it;

— ensuring that distances between moving parts are large or small enough to prevent injuries; the distances should be based on anthropometric data;

— incorporating safety locks or other safety measures that the child is unable to defeat.

Examples

- Children have been scalped when their hair has caught and been drawn into farm machinery with rotating parts.
- Some kitchen appliances incorporate moving and rotating parts. Finger lacerations and amputations have been associated with grinders, mixers and similar devices.
- Children's feet and hands have been trapped in moving playground equipment, such as roundabouts.
- Escalators and lifts (elevators) have trapped children's fingers, hands, feet, clothing and accessories.
- Inadequately guarded spokes of bicycles wheels cause numerous foot injuries to young children being carried as passengers.
- Hinged doors cause many injuries to children, especially at the hinge side of the door.

5.2.10 Hazards from noise

Hazards due to noise are well documented in the literature. Injuries occur when the sensitive hearing organs within the ear are exposed to a sound pressure level that is too high. Injuries that damage hearing are often irreversible.

Young children are more sensitive to hearing loss than adults. Hearing damage is difficult to detect in children because they may not recognize nor be able to report their problem. It is often detected only when the child shows serious difficulties in hearing or has language or social problems.

Exposure can be divided into two major groups, as follows.

a) Peak or impulse noise

   — Examples of such sources are gunshots, air bag deployment, explosives, clicking sounds, etc.

   — Peak noises can cause immediate damage to the ear.

b) Continuous noise

   — Examples of such sources are music, beeping products, motor noises, etc. Most products emitting sound will be in this category. Continuous noise will cause injuries after a certain amount of time. The risk assessment needs to take into account both sound pressure level and exposure time.

The distance between the noise source and the ear also has to be taken into account when determining risks.

Strategies to avoid or reduce risks due to noise include

— lowering the peak noise level that a product may emit,

— automatically resetting to low volume when the product is switched on,

— muffling noise,

— labelling volume controls clearly, and

— informing or warning children about the hazard.

Examples

Peak or impulse noise

- The child is exposed to explosives such as toys using caps and/or firecrackers. The child is exposed to clicking noises close to the ear.

Continuous noise

- Infants are exposed to squeeze noises, beeping, rattling noises, musical boxes, alarms, etc. The infant is usually not able to operate the toy him or herself. Third persons, such as siblings or carers, usually determine the distance between the noise source and the infant's ear and also in some cases the sound pressure level.
- Children use noise-producing products without realizing the hazards to themselves and to other children.
- Older children expose themselves to noise, for example in discos and vehicles.
- Products with earphones or where the noise source is close to the ear can be particularly hazardous.

5.2.11 Drowning hazards

Immersion in water can lead to drowning or near drowning. Young children are very vulnerable to drowning due to their inability to swim. Even short periods of lack of air can cause brain damage. Also, a shallow layer of water can be fatal if the child's facial area is covered.

Strategies to avoid or reduce the risk of drowning include the following:

— creating barriers to minimize children's access to water in and around the home, such as garden ponds, swimming-pools, washing machines and bath tubs;

— closing cisterns, wells and other water storage places with lids, etc.;

— educating carers to ensure that babies and young children are never left alone while in the bath (including in a bath seat), pool, or near any body of water;

— designing water environments with a view for easy supervision;

— designing alerting systems, such as alarms, as a back-up to barriers;

— teaching children to swim at an early age;

— ensuring that children wear appropriate buoyancy aids or life-jackets during water sports.

Examples

- Children have drowned when they tried to walk across pool covers and fell into puddles of accumulated water, or when they reached garden ponds where the water/land border was concealed by plants.
- Young children trying to mimic their carer have tried to do the laundry and fallen into a top-loading washing machine.
- Children have been trapped under opaque pool covers.
- Children have drowned in buckets.

5.2.12 Hazards from suction

Suction cups on products such as toy arrows or darts have caused bruises when applied to body parts. When eyes are involved, the injury can be very severe and lead to blindness. If suction or adhesion by some other means (e.g. capillary attraction) involves the nose/mouth, asphyxia can occur.

Children have been drowned when their hair or body part has become drawn into whirlpool/spa drains. They have been disembowelled when caught in an squatting/sitting position over swimming pool drains.

Strategies to avoid or reduce risks due to suction include

— creating barriers to separate the suction force,

— minimizing actual and potential suction forces,

— designing suction cups that are minimally concave or too small to be placed over the nose/mouth, and

— minimizing by design solutions the likelihood that a vacuum or other mechanism of adhesion can occur.

Examples

- Young children have suffocated when hollow, dome-shaped or half-spherical toys have adhered tightly over the nose/mouth.
- Children have placed suction cups over parts of the body.

5.3 Thermal hazards

5.3.1 Flammability and burning characteristics

Fire is among the leading causes of unintentional injury or death. Flammable materials can ignite when exposed to open flames, high temperatures, sparks, or by spontaneous combustion. The rate of burn and the propensity to self-extinguish are factors affecting whether the fire will spread or be contained.

Strategies to avoid or reduce risks due to flammability and burning materials include the following:

— selecting non-flammable materials or reducing the flammability of materials; however, flame-retardant additives can pose new problems due to their chemical properties (see also 5.4);

— incorporating child-resistant features to reduce the likelihood of fire where flammable materials must be used, and providing adequate instructions for use, handling and disposal.

Examples

- Loose garments carry a much greater risk of catching fire than close-fitting garments.
- Older children, especially boys, experiment with lighting fires using flammable liquids. When spilled on their clothing, severe burns can result if they are close to an ignition source.
- Infants will not physically be able to escape a house fire by themselves. Older children might be mobile, but will not be able to evaluate a situation and know what steps to take to minimize injury. Young children sometimes hide to “protect” themselves from house fires, making it difficult for rescue services to find them.
- Children are known to play with matches and lighters.

5.3.2 Hazards from hot and cold surfaces

Contact with hot or cold surfaces can result in thermal injuries. Surfaces can become hot or cold because of internal components (e.g. engines, batteries, coolants) or because of external exposure to the sun or cold. The thermal absorptive/reflective characteristics of materials determine the surface temperatures. Some surfaces are intended to be hot (e.g. electric hobs) or cold (e.g. freezers). Children are more likely to touch hot/cold surfaces because of their limited ability to recognize the associated injury potential. Products and appliances that are hot or cold, without giving any indication of being so, present a particular problem.

Strategies to avoid or reduce risks due to hot and cold surfaces include the following:

— providing automatic shut-offs and timers in appliances that are inherently heat-generating;

— using materials that are less likely to absorb heat/cold in products that could be exposed to the environment (e.g. playground equipment, swimming pool deck surfaces, doors, child car seats and outdoor furniture); appropriate installation and use of the product, supported by adequate instructions, can reduce injuries;

— reducing contact burns from hot/cold surfaces by the reduction/increase of surface temperatures, the addition of barriers, or the addition of a visual indicator of changing temperature (although an indicator will have no meaning to young children);

— avoiding drawing the attention of children to the hot surface;

— making sure that a surface that needs to be hot for functional reasons cools down quickly after use.

Examples

- Playground slides facing the sun or not located in shade can become hot enough to cause contact injuries.
- Heated appliances, such as ceramic hobs on cookers, continue to be hot after being switched off although this might not be obvious to a child.
- The light in an oven might make it more attractive to young children.
- Young children are naturally attracted to the glowing red bars of electric heaters. Guarding has to be adequate to prevent small hands reaching the hot element.
- Young children have been injured by licking very cold railings, metal parts of child carriers (back packs) and frozen food removed from the freezer.

5.3.3 Hazards from hot and cold fluids

Hot fluids can result in scalds. Children are particularly at risk of being scalded in the kitchen/dining areas because of their inclination to explore.

Strategies to avoid or reduce risks due to hot or cold fluids include

— using spill-resistant tea and coffee cups,

— increasing the stability of containers like kettles and coffee pots,

— adding protective lids,

— limiting the amount of hot liquid available,

— presetting the temperature of hot water heaters to a safe level,

— using thermostatic mixer-taps that control the temperature of the water emerging from the tap, and

— instructing consumers about the scald potential of hot tap water.

Examples

- Hot beverage mugs can easily be overturned.
- Children pull on hanging objects, such as table linens and appliance cords hanging over tables and work surfaces, pulling containers of hot liquids over themselves.
- Babies grab at cups being handled by adult carers.
- Bathtub scalds occur because children fall into tubs with hot water or they, or their siblings, turn on hot water when unsupervised. A child is unlikely to get out without adult intervention.

5.3.4 Hazards from open flames

While open flames are an obvious hazard to adults, they may be an attraction to children. Historically, children as young as 2 years of age have started fires and been injured as a result of their playing with matches or lighters. This play behaviour might be associated with attraction to the flame or lighter, or with an attempt to imitate adult behaviour. Because children playing with fire are likely to have the flame close to their body, the resulting injury can be severe.

Strategies to avoid or reduce risks due to open flames include the following:

— incorporating child-resistant features into the design of cigarette lighters and other sources of ignition, for example, by requiring a designated sequence or combination of steps (see ISO 9994);

— avoiding designing lighters and other sources of ignition with appearances that are attractive to children (e.g. resembling familiar cartoon characters or toys); conversely, toys or sweet containers that resemble lighters could give children the idea that a lighter is something intended for children;

— using physical barriers to the flames of domestic fireplaces; the barriers should prevent a child from reaching or tossing an item into the fire, as well as embers being thrown out from the fire; wood-burning stoves need guarding because their exterior surfaces can become very hot;

— labelling candles to remind users to keep lit candles away from flammable materials, including furnishings and bedding, and not to leave them unattended when lit.

Examples

- Young children are attracted to the glow and flames of barbecues and open fires.
- An aerosol can may leave a trail of flammable solvent upon spraying; near open flames this can ignite back and cause an explosion of the can.
- Cigarette lighters are often easily available to children, and are potential sources of fires.

5.3.5 Hazards from melting behaviour

Some solid products, such as some plastics, soften when heated while others may liquefy. Any skin contact with softened solids or hot liquids is likely to result in severe injuries because the skin contact area and time will necessarily be extended. Adults might be aware of the hazard associated with these types of changes but children might not.

Strategies to avoid or reduce risks due to melting behaviour include the containment of materials that can melt or soften, or the use of alternative materials.

Examples

- Molten candle wax can burn a child or cause him or her to drop the lit candle.
- Synthetic fabrics used in tents can melt when burning, dropping onto occupants.
- Clothing made from synthetic fabrics can melt and adhere to the skin if ignited.

5.3.6 Hyperthermia and hypothermia hazards

Overheating (rise of core temperature) can arise when a child is in a hot environment (e.g. a room or a car). This is a factor that has been associated with sudden infant death syndrome. Combinations of the room temperature and products that cause heat build-up (e.g. duvets or electric blankets for infants) constitute a hazard.

A lowering of body temperature can arise from being trapped in a cold storage room or being unable to gain or regain access to the home in very cold climates.

Strategies to avoid or reduce risks due to hyperthermia and hypothermia include

— using devices to limit room temperature, and

— providing overheating warnings on blankets and similar products.

Example

- Children left in cars in hot sunshine have died from hyperthermia.

5.4 Chemical hazards

Exposure to hazardous chemicals can be acute or occur over a long period. This can occur throughout the life of a product, and also after that product has been disposed of. The potential harm includes poisoning, external and internal chemical burns, allergic reactions, chronic illnesses and cancer, chemical pneumonia and disturbance of reproductive capacity.

The approach to minimizing risk of harm should take into account the fact that long-term effects might not be known.

Strategies to avoid or reduce risks due to hazardous chemicals include the following:

— limiting the amount of chemical available in single or repeated exposures;

— using physical barriers, such as child-resistant closures, on appropriate containers or safe storage facilities;

— substituting non- or less-toxic chemicals;

— using materials which produce less toxic gases when ignited, keeping in mind that carbon monoxide is often released when organic materials burn;

— prohibiting suspected or known mutagens and carcinogens;

— avoiding known allergens and corrosives;

— avoiding chemicals with an appearance, taste and smell attractive to children;

— providing product information, including ingredients, first aid measures, manufacturer identification and contact information;

— providing warnings that are relevant and adequate;

— providing information on safe storage and disposal.

Examples

- House fires often generate toxic emissions that result in deaths.
- Children frequently need medical attention after swallowing or inhaling household chemicals, medications or pesticides.
- Children have suffered chemical burns due to contact with, or ingestion of, strong cleaning products and batteries.
- Latex and nickel in contact with the skin may result in an allergic reaction.
- Long-term exposures to certain heavy metals can produce adverse health effects.

5.5 Electric shock hazards

Electric shock can result in injury or death. Because children cannot "see" or comprehend the hazard, it is particularly insidious.

Strategies to avoid or reduce the risk due to electric shock include the following:

— protecting against access to live parts; the positioning and size of openings that children can access is important;

— using effective methods of isolation (including shutter mechanisms, switches or other barriers) if, for the functioning of the product, it is necessary that openings be easily accessible, as in the case of socket outlets;

— making toys and child-appealing products battery-operated, or operated at *safety extra low voltage* (SELV); however, it has to be recognized that these approaches can introduce other significant hazards.

Hazards, other than electric shock, which may result from the use of electricity, are dealt with in other clauses of this Guide, for example 5.2.9 (Hazards from moving and rotating objects) and 5.3 (Thermal hazards).

Examples

- Hairdryers whose appearance (e.g. in the shape of ducks) make them appealing to children might lead to children taking them into the bath.
- Plug-in night-lights with attractive shapes might cause children to regard socket outlets as harmless.

5.6 Radiation hazards

5.6.1 **Ionizing radiation** (i.e. radioactivity)

Access to ionizing radiation by children needs to be, and usually is, very strictly controlled. The chronic effects of naturally occurring ionizing radiation, such as from radon gas found in certain geological areas, can be minimized through local house design measures supported by regulations.

5.6.2 Ultraviolet radiation

Exposure to ultraviolet radiation from the sun is the most common exposure to radiation. In the short term this can result in sunburn. Prolonged exposure can cause skin cancer later in life.

Strategies to avoid or reduce risks due to exposure to ultraviolet radiation include the following:

— getting this message across by health promotion; adult carers should ensure that shade is provided in environments where children play;

— recommending clothing made of fabrics that have a high sun-protection factor (SPF); however, it should be noted that some fabrics offer little protection when wet or stretched;

— discouraging the use of imitation sunglasses with inadequate protective function for children (see 5.9);

— building safety devices into products that produce ultraviolet radiation, such as tanning beds, to prevent unintentional prolonged exposure to the radiation; clear warnings should be given stating that these products are not to be used by children.

5.6.3 High intensity or concentrated light

It is a normal human reaction to move away from excessive heat or to shield one's eyes from bright light. However, babies may be physically incapable of taking either of these protective actions.

Periodic light (i.e. regular flashing or flickering light) can have effects on children with epilepsy.

Examples

- Excessive exposure to sunlight can cause sunburn, skin cancer and eye damage. The use of protective clothing, sunscreens and sunglasses can reduce these injuries.
- High intensity, focused visible light, including laser beams (pens), can very rapidly result in skin and eye injuries.
- Some children are highly susceptible to the flickering light that is sometimes associated with television pictures or computer games. Convulsions have resulted. The adverse effect can be made worse by poor ambient lighting.

5.7 Biological hazards

Microorganisms such as viruses and bacteria can cause illness in all people, but it is known that very young children do not have adequate resistance/immunity. This hazard typically does not generate acute injury but illness is included in the definition of harm (see 3.2).

Biological contaminants (e.g. moulds) might be present in toys, prams, etc.

Strategies to avoid or reduce the risk due to exposure to biological contaminants include

— designing products to facilitate their cleaning-out, including, where necessary, comprehensive cleaning instructions, and

— designing hot water ducts so as to avoid growth of *Legionella*.

Examples

- Toys have been found to contain fluids (e.g. water) which were contaminated.
- Crevices or odd shapes in products restrict accessibility for cleaning.
- *Legionella* bacteria have spread through inadequately heated water systems (e.g. whirlpools, showers) especially affecting children and the elderly who have limited general resistance.

5.8 Explosion hazards

The hazard of explosions is determined by the flammability and burning characteristics of products. In addition, pressure build-up can cause explosions. Explosive mixtures of substances can be formed intentionally (fireworks,

cap guns), or unintentionally (gas leakage, gasoline vapour, etc.). The exposure of children is particularly relevant in the first type of product. Adolescents have a desire to experiment with all kinds of products, including fireworks.

Strategies to avoid or reduce the risks due to explosions include the following:

— limiting (as far as is possible) children's access to explosive materials;

— when this cannot be achieved, creating distance between the explosion and the child;

— limiting in fireworks the amount of burning material flying off and the distance traversed by the particles;

— packaging products, such as toy caps, to minimize the risk of spontaneous explosion;

— keeping the maximum sound level of toy caps at a safe value at short distances (see also 5.2.10), because the distance from the explosion to a child's ear will often be small;

— ensuring, by the design of any explosive product with which children might come into contact, that the timing of the explosion is set as exactly as possible and that the possibility of particles flying away is minimized;

— using protective equipment, such as face guards and gloves with appropriate performance requirements, when children do intentionally handle materials that may explode, for example during school chemistry lessons.

Fireworks cannot be expected to be safe for children without supervision. Some countries ban the sale of fireworks to the public (with few exceptions) and require that only licensed adults conduct firework displays.

Examples

- Fireworks that are not adequately made can give rise to early or delayed detonation. The specific risk for children is that they tend to experiment more and to use the cheaper types of fireworks.
- Explosions are often accompanied by ejected particles and by light flashes that can damage the eyes.
- Exploding fireworks can cause scattering of hot and burning particles that can give rise to skin burns.
- The noise that explosions make can be very damaging to a child's ears. A particular risk to children exists because their arms are short and because they use certain explosive products (cap guns) during play.
- Toughened glassware can spontaneously shatter due to thermal shocks. In addition, it is not always clear which vessels may be used on open flames or in microwave ovens.
- Batteries and aerosol packages exposed to heat or thrown into fires can explode.
- Pressure cookers can explode if the overpressure valve does not work properly.
- Batteries inserted with the wrong polarity can cause explosions.

5.9 Inadequate protective function

Some products, such as helmets, sunglasses, lifejackets, 'safety' gates and barriers, are intended to reduce the likelihood of death and injury or to minimize the severity of injuries. It is important that such products do actually provide acceptable levels of protection. A problem can arise when products which resemble protective devices but which provide no protection are also available. These products are often toys, for example toy helmets or toy sunglasses.

Sometimes protective devices are designed for segments of the population excluding children. When these devices operate, they can present a hazard to infants and children. For example, infants and young children have been injured or killed when passenger air bags have deployed while a child was in the passenger seat.

Sometimes protective devices can create problems by being used in circumstances that were not foreseen. For example, children have left on their bicycle helmets when they stopped to play at a playground. Playground