Human Health Risk Assessment of “Wikado” playground

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1. Introduction

On October 10th 2008, the brand new Wikado playground was opened in the city center of Rotterdam (The Netherlands). This unique playground was designed and built by a Dutch architectural firm called 2012architects [24]. It was created from the rejected blades of modern wind turbines and lots of other reused and recycled materials. A Dutch company called NGUP provided the rotor blades from a 15 years old windmill [25]. The scope of this report is to assess possible health risks for playground’s users. Lex van Alphen, shareholder at NGUP, confirmed that the materials used for rotor blades were epoxy resin and glass fibers. Some hardener is generally added to the epoxy resin and the rotor blades provided by NGUP were coated with white paint coating (See **Fig.a)**.

Fig. a. Rotor blades as they were provided by NGUP, coated with white paint.

On the building site the Dutch company maropol [26] used also epoxy resin, glass fibers, for the finishes and the joints of rotor blades. After the cut of rotor blades they were composed in the final new shape. The newborn playground was then coated with a layer of white paint and some colored stripes (See **Fig.b)**. Toxic chemical compounds for playground users can be found in all of these materials. It depends on the type of epoxy resin, hardener and coating which was used.

Fig. b. "Wikado" playground with rotor blades cut connected and placed on site.

2. Normative situation, conceptual model and risk analysis for glass fiber

Rotor blades of wind turbines are normally manufactured with epoxy resin and glass fiber. The resin is infused in the core materials (such as balsa wood, foam) together with the reinforcing media, such as glass fiber. The process is called VARTM, i.e. Vacuum Assisted Resin Transfer Molding. Epoxy has excellent properties and good finish. For these reasons is one of the most favored resin for composites [1]. The European Standard EN 1176-1 (implemented in The Netherlands as NEN-EN 1176-1) is the first part of the international standard for playgrounds. It is called: *Playground equipment and surfacing - Part 1: General safety requirements and test methods*. The chapter 4.1 is about Safety requirements for materials. Subchapter 4.1.5 is about Synthetics. It states that: *If, during maintenance, it is difficult to determine at what point material becomes brittle, manufacturers shall give an indication of the time period after which the part or equipment should be replaced. It should be possible for the operator of the playground to visually identify excessive wear of the gel coat of GRP (glass-reinforced plastics) products intended for sliding before the user becomes exposed to the glass fibers* [2]. Wikado's wind rotor blades are composed by glass fibers; as stated in the directive, it is important to avoid the exposure to the glass fibers for users. Due to bad maintenance or finishing, some parts of Wikado have become already brittle (See **Fig. 2, Fig. 6**). Some part of glass fibers might be sharp and cut. This regard both glass fibers of windmill rotor blades than the one used for the junctions during the Wikado's construction. Maintenance is important and should be regularly done. Following the directive it should be important to give an indication of the time period after which

the part should be replaced. And it should be possible to visually identify excessive wear of the coat before the user becomes exposed to the glass fibers. The norm refers to glass reinforced plastics products intended for sliding. In Wikado (See **Fig. 1, Fig. 2, Fig. 6**) are visible already a couple of parts where the glass fibers are in contact with the user. Those two parts are not exactly a sliding but in one of the two (**Fig. 6**), the user can also slide on it. In the same spot (**Fig. 6**), glass fibers from the rotor blade are exposed to air maybe because users often step on it.

Fig. 1. Interior of a rotor blade where finishes are cut and brittle

Fig. 3. Piece of sharp finish of glass fiber, epoxy and white paint coating

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Fig. 2. Close-up of finishes with epoxy resin, glass fiber and white paint coating (see also Fig. 3). In the right part of this picture is visible the spot where the piece of Fig. 3 was taken off.

This part is in front of the entrance from the street and it has a step height. In the other spot (**Fig. 1, Fig.2**), the fibers and the epoxy are also exposed to air. They are from the finishes made by the workers on Wikado building site. We verified that this part is much cut. It should be smoothed. We took out a small piece of it, very sharp, where are visible the glass fibers, the epoxy resin and

the white paint coating (**Fig. 3**). In the spot of Figure 6 some polystyrene is also detaching from the edge. Glass fiber could also reach the lungs through breathing.
The most frequent health hazards due to glass-fiber exposure are represented by skin lesions, commonly known as fibreglass dermatitis. The basic pathogenetic mechanism of fiberglass dermatitis is represented by penetration of fine, sharp particles into the skin causing mechanical irritation. It is one of the most common occupational irritant contact dermatitis. From a clinical point of view itching (usually very strong) and tingling sensation usually represent the early symptoms. A diffuse eruption of small erythematous patches together with papules of small diameter can be observed in the most of the cases. Other lesion can be present: excoriated folliculitis, paronychia, discoid eczema-like lesions, erythema multiforme-like lesions, lichenification, etc [17]. So glass fiber can represent an occupational human risk for workers who are cutting, shaping smoothing the rotor blades. When the glass fibers are exposed to the users they can be also dangerous for children in the playground. Glass fiber is also suspected to causing cancer and may cause respiratory irritation [18] [19].

Fig. 4. Polystyrene coming out from the edge of the rotor blade

Fig. 5. Edge of the rotor blade with polystyrene

Fig. 6. Close-up edge of the blade already brittle where glass fibers and dry paint coatings are exposed to the users

Human Health Risk assessment is defined as the interaction in between sources (S), pathways (P) and targets (T):

$$R = S \times P \times T$$

Following this it is possible to trace a conceptual model (see **Fig. 10**) with glass fibers representing a Wikado's users health risk. Looking at the probable sources of BPA from epoxy resin in rotor blades used in Wikado's playground is possible to hypothesize a risk for children's health only when, due to wear, usury, the glass fibers are exposed.

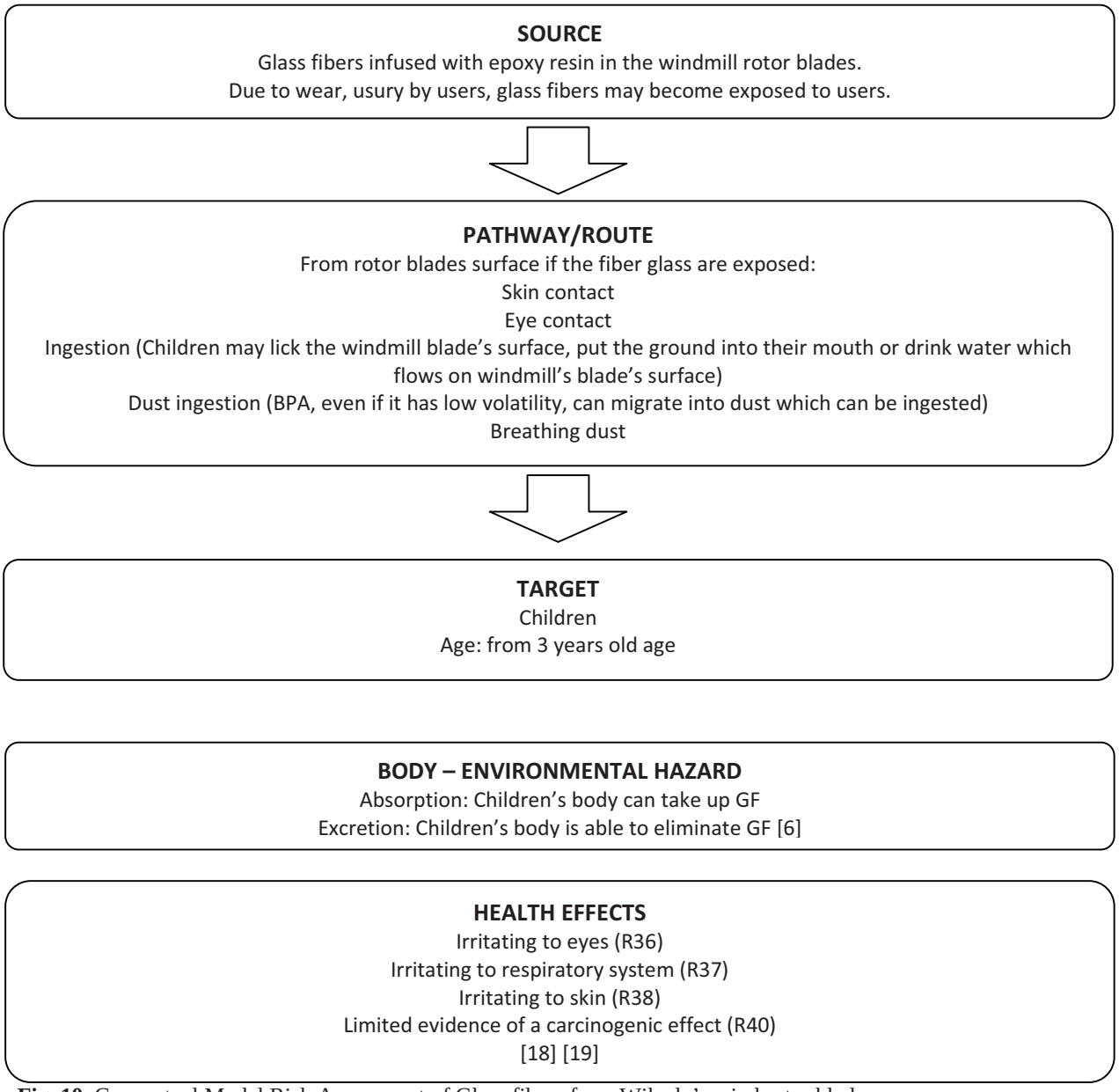

Fig. 10. Conceptual Model Risk Assessment of Glass fibers from Wikado's wind rotor blades

3. Normative situation, conceptual model and risk analysis for epoxy resin

In the same chapter 4 of the European Standard EN 1176-1 for playgrounds, the subchapter 4.1.6 is about dangerous substances. It states: *Dangerous substances shall not be used in playground equipment in such a way that they can cause adverse health effects to the user of the equipment. NOTE: Attention is drawn to the provisions of the Dangerous Substances Directive 76/769/EEC and its successive modifications. Prohibited materials include but are not limited to, asbestos, lead, formaldehyde, coal tar oils, carbolineums and polychlorinated biphenyls (PCBs)* [2]. Directive 76/769/EEC then, states that: *Liquid substances or preparations, which are regarded as dangerous according to the definitions in Article 2 and the criteria in Annex VI, PartII.D to Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances, as last amended by Directive 86/431/EEC, may not be used in: ornamental objects intended to produce light or colour effects by means of different phases, for example in ornamental lamps and ashtrays; tricks, jokes; games for one or more participants, or any object intended to be used as such, even with ornamental aspects* [3]. This point doesn't represent a problem since in Wikado none substance is used in his liquid state. The same Directive states also that: *Substances which appear in Annex I to Directive 67/548/EEC classified as toxic for reproductive purposes category 1 or toxic for reproductive purposes category 2 and labelled with risk phrase R60:"May impair fertility" and/or R61: "May cause harm to the unborn child", and listed as follows: Toxic for reproductive purposes category 1 See List 5 in the Appendix, May not be used in substances and preparations placed on the market for sale to the general public in individual concentration equal to or greater than: either the concentration specified in Annex I to Directive 67/548/EEC, or greater than: the concentration specified in point 6, Table VI, of Annex I to Directive 88/379/EEC where no concentration limit appears in Annex I to Directive 67/548/EEC* [3]. In Annex I to Directive 67/548/EEC is listed a substance with the following chemical name: *bisphenol-A-(epichlorhydrin); epoxy resin (number average molecular weight ≤ 700)* (hereinafter BPA epoxy resin) [4]. This substance even if listed as dangerous substance is not classified as toxic for reproductive purposes category 1 or category 2 so (contrary to what I thought at first) it is allowed. This chemical compound is one of the most used in manufacturing of epoxy resin. Anyway Bisphenol A (hereinafter BPA) is a chemical substance which can be released by BPA epoxy resin and is classified as R62 "Possible risk of impaired fertility" [7].

In Wikado it is very probable that BPA epoxy resin was used in the manufacturing of rotor blades and in the finishing during the construction of the playground. Notwithstanding the failure of manufacturer to disclose the ingredients of the epoxy resins used, research indicates that most of epoxy resins used in combination with glass fibers for wind turbines are BPA epoxy resin [16]. It is also very probable that the epoxy resin used for the finishes on Wikado's building sites is BPA epoxy resin. That's because many epoxy based high performance resin are made from BPA. In Wikado, BPA exposure from epoxy resin of rotor blades to the users should not be an important risk. Studies about how much BPA can migrate from epoxy resin from a windmill rotor blades do not exist. What is known is that BPA can migrate from BPA epoxy resin and that BPA can metabolized back from some epoxy resin products [5]. Epoxy resins are used as plastic coatings in the food-packing industry. A layer of epoxy resin is normally added on the inner surface of cans in order to avoid metal oxidation. It is documented that a significant proportion of unreacted epoxy compounds like BPA can be recovered from food packed in containers with

these plastics because polymerization of epoxy resin reactions may not be fully complete. BPA is a starting material for the synthesis of polycarbonate and epoxy resins and it has been detected as well as in canned food, in autoclavable flasks, baby bottles and other food materials and containers [8]. Because is suspected of damaging infertility or the unborn child [7], BPA was banned by the EU in Polycarbonate baby bottles by 1 March 2011 [6]. A recent study states that for infants fed with PC baby bottles the mean dose rates and the highest exposure dose rate ($1.6*10^{-6}$ $mg/kg_{bw}/d$) was far below the tolerable daily intake (hereinafter 'TDI') of $5*10^{-5}$ $mg/kg_{bw}/d$ [6]. However, it is of the same order of magnitude as recently reported concentrations that caused low-dose health effects in rodents($2.5*10^{-6}$ $mg/kg_{bw}/d$) [20]. This demonstrates why EU decision to ban polycarbonate from baby bottle, was as a precautionary principle. The leaching of BPA has been related to the temperature, heating time, type of food in the container, hydrolysis, photolysis and also amminolysis [8] [9] [10] [11] [12].
As we said, Human Health Risk assessment is defined as the interaction in between sources, pathways and targets:

$$R = S \times P \times T$$

Following this it is possible to trace a conceptual model (see **Fig 11**) with BPA as a Wikado's users health risk. Looking at the probable sources of BPA from epoxy resin in rotor blades used in Wikado playground is possible to hypothesize a very low risk for children's health. As we said the separation of BPA from epoxy resin can happens through hydrolysis, aminolysis, photolysis, increase of temperature, heating time [8] [9] [10] [11] [12].
Since the playground is outside, rainwater makes possible hydrolysis of epoxy resin and epoxy coating. Hydrolysis literally means reaction with water. It is a chemical process in which a molecule is cleaved into two parts by the addition of a molecule of water. It is the type of reaction that is used to break down certain polymers [13] [14]. BPA for instance can be detached from epoxy resin through hydrolysis. Hydrolysis can also take place where the drinking water, coming out from the fountain on the top of one of the towers, flows on the rotor blades. When I went there a toy bucket was placed on the edge of the blade, collecting the water flowing down from the blade's surface. The water in the bucket can be drink by a child. Outdoor conditions make possible photolysis as well. Photolysis literally means reaction with light. It is a chemical process in which a molecule is cleaved into two or more parts resulting from absorption of light (or a photochemical process in which such cleavage is an essential part) [14]. BPA can be detached by epoxy resins through photolysis caused by UV rays from the sun.
BPA has low volatility [15] so, once detached it should deposit to the surfaces and to the ground around the playground. Wind can blown it away. When a coating is already present on rotor blades surfaces, since its function is to protect the epoxy resin from degradation during the windmill's life, it would keep also the BPA behind its layer. But if for instance the coating is epoxy based (there are several in the wind turbine industry), its degradation might lead to BPA migration from the coating itself [5]. It is very important to know if other dangerous substances are present in the coating and if they can migrate out from it. In chapter 4.1.1 of European Standard EN 1176-1 for playgrounds is stated: *Special attention should be given to surface coatings to avoid potential toxic hazards* [2]. Playground users (who are mainly children) are the Targets. They can be in contact with BPA through different pathway. One of these is the "Hand to mouth" behavior: children may put their hands to mouth after having touched the windmill surfaces and the ground. They could also directly lick the surface or eat part of the ground.

Another pathway is possible if they drink water which flowed on windmill's blades first. Even if BPA has a low volatility [15] it can move through the air and be carried by the wind. So children could also breathe it if for instance they lay down for a while on the rotor blade.

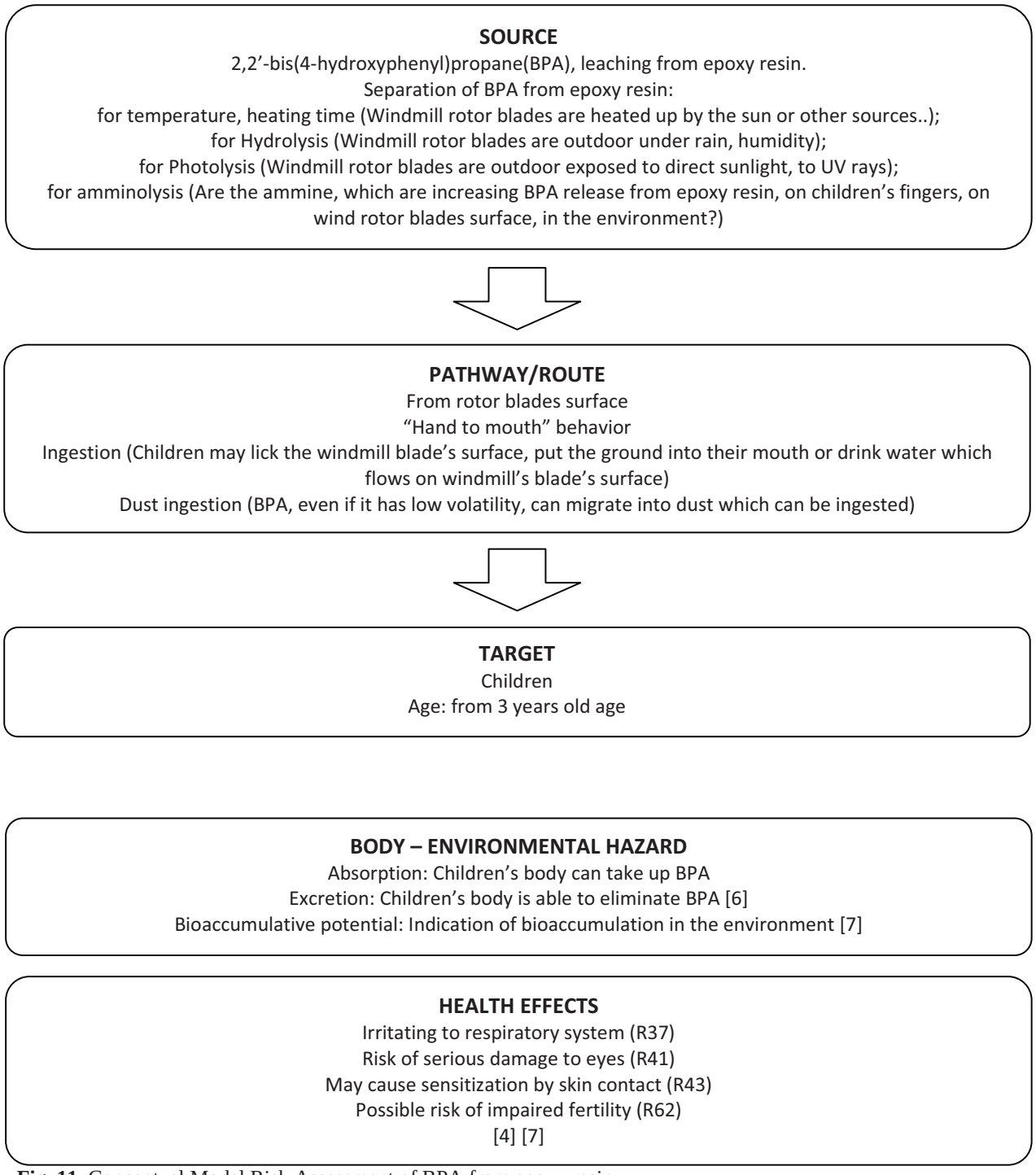

Fig. 11. Conceptual Model Risk Assessment of BPA from epoxy resin

In a recent study has been measured the occurrence of BPA in indoor dust from two locations in the United States [21]. BPA's sources of human exposure in indoor environment are: canned and packaged food products, indoor air and dust ingestion. Sources of BPA which is in dust and air can be various like: PVC cords and pipes; synthetic leather; boxes, containers, compact discs and various objects made by Polycarbonate (hereinafter PC); plastic electrical plugs and phenol resins [22]. In the two locations of the United States BPA was found in 95% of the dust samples. The median values for BPA intake by way of the ingestion of dust by adults and toddlers were calculated to be 0.35 and 5.63 ng/kg body weight/day [21]. Even if these estimated exposure doses of BPA through dust ingestion are below the TDI of $5*10^{-5}$ mg/kg$_{bw}$/d (50 ng//kg$_{bw}$/d) [6], they are of the same order of magnitude as the recently reported low concentrations that induced health effects in laboratory animal studies (2.5 ng//kg$_{bw}$/d) [20].
Wikado is outside, and the inner parts of rotor blades are much ventilated through the several holes on it. Air and wind can blown away the dust containing BPA. The coating should decrease the BPA migration and keep it in the epoxy. It is difficult to estimate of much BPA could migrate from the rotor blade and how much BPA can reach the target through dust ingestion. If we compare WIkado's case with the indoor cases of studies in the US, the main difference is that Wikado is outdoor. A hypothesis based consideration is that I would not suggest to people in general (and even more for children) to stay regularly for several hours per day during a period of time of months inside a rotor blades without many opening and coating. This is because the sources of BPA in the US apartments were mostly plastic small objects. In a standard 1.5 megawatt wind turbine there are approximately 10 tones of epoxy in its rotor blades made from 6.6 tonnes of phenol [23]. Great part of this can be BPA. It will take a lot of time to migrate all from the epoxy but potentially it can.

4. Conclusions

The main risks for human health of Wikado's users are the glass fibers and BPA or other additives leaching out from the epoxy resin or the coating. About glass fiber, a non non-toxic coating can solve the problem and avoid health risks for users. As suggested in the Norm the coating has to be checked regularly in order to prevent any exposure to the glass fiber by users. Some coatings can contain dangerous substances (like most of the coating from the wind turbines industries). In this case the coating should be removed by workers (wearing the proper equipments to avoid occupation human health risk) and a new non-toxic coating has to be spread. Another solution is to cover the old coating with a new one which has to be non-toxic and able to be impermeable both to the dangerous substances which may leach out from the coating and to the ones which may migrate from the epoxy resin. If the windmill rotor blades provided are without coating, the non-toxic coating which has to be spread on it has to be impermeable only to the dangerous substances which can leach out from the epoxy resin.
Answering to a question made by Jos de Krieger from 2012architecten, it is difficult to say if a playground like Wikado should be built again or not. This is mainly because (due to the failure of manufacturer to disclose the ingredients) we are still not completely sure about all the materials and additives contained in the wind turbines. In my opinion 2012architecten next time should make a deal (maybe writing it in the contract) with providers to have any information requested about the materials delivered.

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LIST OF ANNEXES:

1 - Nederlands Normalisatie-instituut, Pages 1, 2, 3, 15, 16, 17 of Nederlandse norm NEN-EN 1176-1 of june 2008. Playground equipment and surfacing - Part 1: General safety requirements and test methods.

2 - Sigma-Aldrich Company Ltd. (Revision Date 24.07.2010). Page 1 of Bisphenol A. *Safety Data Sheet*.

3 - Sigma-Aldrich Company Ltd. (Revision Date 15.12.2010). Page 1 of Glass, oxide, chemicals this category encompasses the various chemical substances manufactured in the production of inorganic glasses. *Safety Data Sheet*.

4 - Healthy Building Network (July 2009), Bisphenol A in Building Materials: High Performance Paint Coatings. *Global Health and Safety Initiative.* http://www.healthybuilding.net/news/090722bpa_in_building_materials.html

5 - Answer to a question from Jos de Krieger, 2012architecten.

ANNEXE I

Nederlands Normalisatie-instituut, Pages 1, 2, 3, 15, 16, 17 of Nederlandse norm NEN-EN 1176-1 of june 2008. Playground equipment and surfacing - Part 1: General safety requirements and test methods.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1176-1

May 2008

ICS 97.200.40

Supersedes EN 1176-1:1998

English Version

Playground equipment and surfacing - Part 1: General safety requirements and test methods

Equipements et sols d'aires de jeux - Partie 1 : Exigences de sécurité et méthodes d'essai générales

Spielplatzgeräte und Spielplatzböden - Teil 1: Allgemeine sicherheitstechnische Anforderungen und Prüfverfahren

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Ref. No. EN 1176-1:2008: E

Contents

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4 Safety requirements

4.1 Materials

4.1.1 General

Materials shall conform to 4.1.2 to 4.1.5.

Materials shall be selected and protected such that the structural integrity of the equipment manufactured from them is not affected before the next relevant maintenance inspection.

NOTE 1 EN 1176-7 gives recommendations on maintenance inspections.

Materials should be manufactured in a workmanlike manner.

NOTE 2 The provisions relating to certain materials in this standard do not imply that other equivalent materials are unsuitable in the manufacture of children's playground equipment.

The selection of materials and their use should be in accordance with appropriate European Standards.

Special attention should be given to surface coatings to avoid potential toxic hazards.

The choice of materials should be appropriate where extreme climatic or atmospheric conditions are to be expected.

Where very low or very high temperatures can be anticipated care should be taken on material selection to avoid possible hazards through direct skin contact.

In the choice of a material or substance for playground equipment, consideration should be given to the eventual disposal of the material or substance having regard to any possible environmental toxic hazard.

4.1.2 Flammability

To avoid the risk of fire and associated hazards, materials known to produce surface flash shall not be used. Particular attention should be given to newly developed products whose properties might not be fully known.

NOTE 1 Requirements for adequate exits to ensure escape in cases of fire are given in 4.2.3.

NOTE 2 Attention is drawn to national and local building regulations regarding flammability for equipment installed both indoors and outdoors.

4.1.3 Timber and associated products

Timber parts shall be designed in such a way that precipitation can drain off freely and water accumulation shall be avoided.

In cases of ground contact, one or more of the following methods shall be used:

a) use of timber species with sufficient natural resistance in accordance with classes 1 and 2 of the natural resistance classification given in EN 350-2:1994, 4.2.2;

b) construction methods, e.g. post shoe;

c) use of timber treated with wood preservatives in accordance with EN 351-1:2007, Figure A.1 and in accordance with EN 335-2:2006, use class 4.

Consideration should also be given to other factors which can be unsuitable, such as splintering, poisoning etc.

All components made of timber and associated products, other than those species conforming to a), that affect the stability of the structure and are in constant contact with the ground shall be treated in accordance with c).

When selecting metal fastenings, consideration should be given to the species of timber and chemical treatments used as some will accelerate corrosion of metals if there is contact between them.

Plywood shall be in accordance with EN 636 and shall be weatherproofed.

4.1.4 Metals

Metal parts should be protected against atmospheric conditions and cathodic corrosion.

Metals that produce toxic oxides that scale or flake shall be protected by a non-toxic coating.

4.1.5 Synthetics

If, during maintenance, it is difficult to determine at what point material becomes brittle, manufacturers shall give an indication of the time period after which the part or equipment should be replaced.

It should be possible for the operator of the playground to visually identify excessive wear of the gelcoat of GRP (glass-reinforced plastics) products intended for sliding before the user becomes exposed to the glass fibres.

NOTE This can be achieved for example by the use of different coloured layers in the sliding surface.

Consideration should also be given to degradation of structural components through ultraviolet influences.

4.1.6 Dangerous substances

Dangerous substances shall not be used in playground equipment in such a way that they can cause adverse health effects to the user of the equipment.

NOTE Attention is drawn to the provisions of the Dangerous Substances Directive 76/769/EEC and its successive modifications. Prohibited materials include but are not limited to, asbestos, lead, formaldehyde, coal tar oils, carbolineums and polychlorinated biphenyls (PCBs).

4.2 Design and manufacture

4.2.1 General

Equipment where the primary play function is augmented by a secondary motion, e.g. rocking and/or rotating, shall conform to the additional parts of EN 1176 relating to both play functions, as appropriate, unless the equipment is specifically covered in just one of the additional parts of EN 1176.

The dimensions and degree of difficulty of the equipment should be suitable for the intended user group. The equipment should be designed so that the risk involved in play is apparent and foreseeable by the child.

NOTE For additional safety of equipment that is easily accessible, specific requirements have been included for the following:

— protection against falling:

  — guardrails (4.2.4.3);

  — barriers (4.2.4.4);

— steep elements (4.2.9.4);

— easily accessible playground equipment (4.2.9.5).

Except when intended for water play, all parts of playground equipment should be designed so that they do not accumulate water.

4.2.2 Structural integrity

For playground equipment, the structural integrity for the worst case of the intended combinations shall be proved.

Structural integrity, including stability of the equipment shall be assessed by one of the following:

a) calculation, in accordance with Annexes A and B;

b) physical testing, in accordance with Annex C; or

c) combination of a) and b).

When calculations are carried out in accordance with Annex B no limit states shall be exceeded at combinations of loads as given in B.2.

When tested in accordance with Annex C, the equipment shall not show any cracks, damage or excessive permanent deformation (see C.1.2).

For some equipment, these specific calculations or tests are not always appropriate, but the structural integrity shall be at least equivalent

Each structure shall resist both the permanent and variable loads acting on equipment and parts of equipment as described in Annex C.

When playground equipment relies on one post for its stability, the construction should be carried out in order to:

— minimize rotting or corrosion in parts relevant for stability;

— allow for controlling degradation and the need for decommission;

— be used without collapse within the foreseen inspection period when maintained correctly.

NOTE 1 No allowance for accidental loads, i.e. loads produced by fire, collision by vehicles or earthquake, need be made for playground equipment.

NOTE 2 The loads associated with fatigue are in general much smaller than the loads in combination with the appropriate load factors when calculated in accordance with B.2. Therefore playground equipment in general need not be verified for fatigue.

Structural parts shall resist the worst case loading condition.

NOTE 3 To achieve this, it may be necessary to remove that part of the user load causing favourable effects, as shown in Figure 7.

ANNEXE II

Sigma-Aldrich Company Ltd. (Revision Date 24.07.2010). Page 1 of Bisphenol A. *Safety Data Sheet*.

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006
Version 4.0 Revision Date 24.07.2010
Print Date 04.03.2011

1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

Product name	:	Bisphenol A
Product Number	:	239658
Brand	:	Aldrich
Company	:	Sigma-Aldrich Company Ltd. The Old Brickyard NEW ROAD, GILLINGHAM Dorset SP8 4XT UNITED KINGDOM
Telephone	:	+441747833000
Fax	:	+441747833313
Emergency Phone #	:	+44 (0)1747 833100
E-mail address	:	eurtechserv@sial.com

2. HAZARDS IDENTIFICATION

Classification of the substance or mixture

According to Regulation (EC) No1272/2008
Serious eye damage (Category 1)
Skin sensitization (Category 1)
Reproductive toxicity (Category 2)

According to European Directive 67/548/EEC as amended.
May cause sensitization by skin contact. Possible risk of impaired fertility. Irritating to respiratory system. Risk of serious damage to eyes.

Label elements

Pictogram

Signal word Danger

Hazard statement(s)

H317	May cause an allergic skin reaction.
H318	Causes serious eye damage.
H361	Suspected of damaging fertility or the unborn child.

Precautionary statement(s)

P280	Wear protective gloves/ eye protection/ face protection.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Hazard symbol(s)

Xn	Harmful

R-phrase(s)

R37	Irritating to respiratory system.
R41	Risk of serious damage to eyes.
R43	May cause sensitization by skin contact.
R62	Possible risk of impaired fertility.

ANNEXE III

Sigma-Aldrich Company Ltd. (Revision Date 15.12.2010). Page 1 of Glass, oxide, chemicals this category encompasses the various chemical substances manufactured in the production of inorganic glasses. *Safety Data Sheet*.

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006
Version 4.0 Revision Date 15.12.2010
Print Date 06.06.2011

1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1 Product identifiers

Product name : Glass, oxide, chemicals this category encompasses the various chemical substances manufactured in the production of inorganic glasses. for purposes of this category, 'glass' is defined as an amorphous, inorganic, transparent, translucent or opaque ma

Product Number : Z255890
Brand : Aldrich
CAS-No. : 65997-17-3

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Company Ltd.
The Old Brickyard
NEW ROAD, GILLINGHAM
Dorset
SP8 4XT
UNITED KINGDOM

Telephone : +44 (0)1747 833000
Fax : +44 (0)1747 833313
E-mail address : eurtechserv@sial.com

1.4 Emergency telephone number

Emergency Phone # : +44 (0)1747 833100

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No 1272/2008 [EU-GHS/CLP]
Skin irritation (Category 2)
Eye irritation (Category 2)
Carcinogenicity (Category 2)
Specific target organ toxicity - single exposure (Category 3)

Classification according to EU Directives 67/548/EEC or 1999/45/EC
Irritating to eyes, respiratory system and skin. Limited evidence of a carcinogenic effect.

2.2 Label elements

Labelling according Regulation (EC) No 1272/2008 [CLP]

Pictogram

Signal word Warning

Hazard statement(s)

H315	Causes skin irritation.
H319	Causes serious eye irritation.
H335	May cause respiratory irritation.
H351	Suspected of causing cancer.

Precautionary statement(s)

P261	Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
P281	Use personal protective equipment as required.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Supplemental Hazard Statements none

According to European Directive 67/548/EEC as amended.

Hazard symbol(s)

R-phrase(s)

R36/37/38	Irritating to eyes, respiratory system and skin.
R40	Limited evidence of a carcinogenic effect.

S-phrase(s)

S26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S36	Wear suitable protective clothing.
S45	In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

2.3 Other hazards - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Formula : O2Si
Molecular Weight : 60.08 g/mol

Component		Concentration
Glass, oxide, chemicals this category encompasses the various chemical substances manufactured in the production of inorganic glasse		
CAS-No. EC-No.	65997-17-3 266-046-0	-

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

ANNEXE IV

Healthy Building Network (July 2009), Bisphenol A in Building Materials: High Performance Paint Coatings. *Global Health and Safety Initiative.*
http://www.healthybuilding.net/news/090722bpa_in_building_materials.html

Bisphenol A in Building Materials: High Performance Paint Coatings

It is impossible to turn one's attention to recent news on environmental health issues without reading about the health concerns associated with bisphenol A (BPA) in baby bottles and/or food can liners. Few, however, are as aware that BPA is a chemical component of epoxy resins used in a wide range of building materials, including high performance coatings (paints, floor sealers, and other protective coatings), adhesives and fillers (caulk, grout, mortar, and putty), fiberglass binders, and cement additives. Epoxy resins are also in some wind energy applications, generators and other electronic equipment, industrial tooling applications, and materials used in the art, aerospace and marine industries.

Policymakers, purchasers, and scientists are just beginning to get an understanding of the toxicity and exposure concerns associated with BPA in building materials made from epoxy resins and the alternatives that exist to replace BPA. This fact sheet provides information about the chemical components of epoxy resins, with a focus on high performance paint coatings. Based on studies looking at occupational exposure to BPA in epoxy paint, purchasers should look for alternatives that meet their performance needs that are BPA-free, as well as those that contain low VOCs and other toxicants.

Epoxy Resins

Epoxy resins are used in many high performance paint coatings (those that are durable, anticorrosive, and/or that can withstand chemical spills and repeated scrubbing).

A wide range of chemicals may be used to manufacture epoxy resin. Identifying all of the chemicals in an epoxy resin is a difficult and uncertain task.

Material Data Safety Sheets (MSDS) and Technical Data Sheets (TDS) are notoriously inconsistent in their level of detail and generally fail to reveal proprietary blends and processes.

Notwithstanding the failure of manufacturers to disclose the ingredients of the epoxy resins used in high performance paint coatings, research indicates that many epoxy-based high performance paint coatings are made from bisphenol A diglicidyl ether, otherwise known as BADGE. BADGE, in turn, is made from two primary chemicals: bisphenol A (BPA) and epichlorohydrin. Both of these chemicals pose significant occupational hazards. They are intermediary chemicals only—used in the manufacture of the resin but not intentionally included in the final product. This fact sheet only deals with health and exposure risks associated with BPA and not epichlorohydrin. (Detailed information about the health concerns associated with epichlorohydrin can be found at http://www.healthybuilding.net/healthcare/Alter

native%20Resin%20Binders.pdf.)

Bisphenol A

Bisphenol A (BPA) (CAS number 80-05-7). More than 6 billion pounds of BPA are produced globally annually.[1] It is a chemical compound much in the news recently. Scientists have generally studied and raised concerns about BPA found in food can liners made from epoxy resin and baby and water bottles made from polycarbonate plastic (bisphenol A is the primary compound of this plastic), because these applications are likely to be sources of BPA exposure in the general public. It is also a component of dental sealants, some medical and dental devices, and thermal paper receipts.

Recent biomonitoring studies have raised concerns about widespread human exposure to BPA—a National Health and Nutrition Examination Survey (NHANES) study found that more than 90% of people in a representative sample of the general population have BPA residues in their urine.[2] For vulnerable populations, the exposures raise greater concerns. Scientists looking at exposure to BPA in premature infants treated in the neonatal intensive care unit (NICU) found those patients undergoing intensive therapies to have urinary BPA concentrations one order of magnitude higher than the general population.[3] Whether or not the levels of exposure are sufficient to raise health concerns is a matter of considerable debate.

The primary endpoints of concern for BPA in animal studies are reproductive (prostate cancer) and neurodevelopmental (alterations in behavior).[4]

In addition, in limited human studies, scientists have raised concerns about miscarriages and other birth defects.[5] Other effects that are emerging of concern are alterations in fat metabolism (an endocrine effect).

Health impacts

Cancer

Recent animal studies link early-life BPA exposure to increased risk of prostate6 and breast cancer.[7]

Studies have also found that BPA may interfere with chemotherapeutic treatment for both prostate and breast cancer.8 9 BPA has also been shown to cause normal but "at risk" breast tissue to express genes that are only found in highly aggressive and often fatal breast cancers.10 The levels of exposure in these studies are within the range of exposures that are already occurring in the general population.

Non-cancer

BPA is an endocrine disrupting chemical, which means it can interfere with hormone communication among cells controlling metabolism, development, growth, reproduction and behavior. BPA can alter the expression of multiple genes.[11] In animal studies, low levels of BPA exposure alter prostate gland and urinary tract development.[12] Animal studies also indicate that BPA interferes with brain development,[13] and can affect fat metabolism, potentially increasing risk of diabetes and obesity.[14]

Additionally, in low dose animal studies, BPA accelerates the onset of puberty in female mice,[15] decreases sperm quantity and/or quality, is linked to obesity,[16] and may change reproductive hormone levels.[17] Emerging science indicates that BPA exposure also may increase the risk of cardiovascular disease and diabetes in

humans.[18]

Based primarily on animal studies and the few limited studies conducted on humans, the National Toxicology Program's (NTP) Center for Environmental Risks to Human Reproduction (CERHR) concluded that there was sufficient evidence to raise concern about BPA's effects on the development of the brain, behavior and prostate gland in humans and the reproductive systems of human newborns and fetuses.[19]

Much of the current debate centers on the extent to which the results from numerous animal studies are relevant to humans, since BPA is generally believed to be rapidly metabolized and excreted after oral exposures. Moreover, some people have expressed concern that subcutaneous administration of BPA used in many animal studies might not be relevant to understanding the effect via oral exposure of humans. Follow up studies in neonatal mice, however, have shown that the route of exposure has no effect on blood BPA levels.[20] A recent study in humans also has challenged the assumption that BPA is rapidly metabolized.[21] Further, the active, non-metabolized form (the most toxic form) of BPA has been identified in the blood of pregnant women[22] and in amniotic fluid, indicating fetal exposures.[23]

Occupational exposures

Little information is available on the level of direct exposure of workers to BPA in occupational settings, however two factors make this an issue of significant concern. One is that scientific work referred to above indicates that BPA may have harmful effects at levels of exposure that are already occurring in the general population.

Furthermore studies of products made from BPA, including those used in epoxy resins, indicate that workers using those secondary products metabolize or breakdown the secondary products back into BPA (see BADGE section below). OSHA has not yet established regulatory levels for occupational exposure.[24]

User exposures

Theoretically, BPA is consumed entirely in the production of epoxy resins and does not show up in the final product so should not be a user exposure problem. However, there is some indication that this is not the case, but rather some epoxy resin products produced from BPA can be metabolized back into BPA (see BADGE section below).

What do we know about BPA-based epoxy resins like BADGE?

Many high performance paint coatings use epoxy resins made from Bisphenol A diglycidyl ether or BADGE (CAS No. 1675-54-3), a resin manufactured by reacting BPA and epichlorohydrin.

Health impacts

Cancer

BADGE is not classifiable as a human carcinogen by the International Agency for Research on Cancer (IARC), which means IARC did not have enough data to make a determination about BADGE's carcinogenicity.[25]

Non-cancer

In a DOW Chemical company's product safety sheet for BADGE, the overview states, "[b]roadly speaking, direct contact with these materials should be avoided.

Although BADGE is not acutely irritating to the skin, it is capable of causing skin sensitization in some individuals."26 BADGE's most significant direct impacts may be on non-human environmental health. DOW chemical acknowledged that BADGE is moderately toxic to aquatic organisms and has a moderate bioconcentration potential. Additionally, DOW's product safety data sheet for BADGE states that "[i]f a BADGE-based material does reach soil and/or surface water, it can pose a flammability and health concern."[27]

Conversion to BPA

The most significant concerns about BADGE may not be the direct health impacts of BADGE itself, but rather its metabolic breakdown products. A Japanese study of workers spraying BADGE in an epoxy resin factory at least three hours per day found that BADGE may break down to BPA in the human body and further that the bisphenol A may disrupt secretion of sex hormones in men and suggested that the "[c]linical significance of the endocrine disrupting effects of bisphenol A should be further investigated in male workers."[28] A subsequent study of workers applying paint consisting of 10-30% BADGE reported significantly higher urinary levels of total BPA and alterations in sex hormones in painters than nonpainter controls. Other confounding factors make it hard to determine the clinical significance of this study.[29]

Occupational exposures

BADGE has a low vapor pressure,30 so inhalation from vapors from standing liquid in occupational settings is not likely to be of concern. However, appliers of epoxy coatings may be exposed by inhalation of aerosol mist as indicated in the previous study and should use appropriate respiratory protection. One National Institute for Occupation Safety and Health (NIOSH) investigation found BADGE could cause dermatitis after direct contact with 2-bisphenol-A type epoxy resins (including Cas. No. 25085-99-8).[31] Another study showed that BADGE was absorbed through the skin and metabolized to BPA.[32] These occupational studies raise concerns that could apply to workers undertaking field application of epoxy resins, as well as other building occupants.

User exposure

The low vapor pressure minimizes the likelihood of exposure for occupants of rooms with epoxy products to BADGE through vapor inhalation.

However, as with other semi-volatile compounds in building materials, such as phthalates, there is a potential for exposure to BADGE through migration of dust from products over time. Except for its use in dental sealants, we are not aware of any studies of potential exposure to BADGE or of contact dermatitis occurring in users of consumer products containing cured resin.

Conclusion

While the NTP raised only minimal concern for worker exposures and reproductive toxicity, early indications from the research are that workers spraying paints containing epoxy resins are exposed to bisphenol A with uncertain, but potentially significant effects on sex hormone levels and the reproductive system. Scientific research has only recently begun to address potential exposures to bisphenol A from building materials.

Regulatory bodies are only slowly and haltingly moving forward to investigate and act on toxicity concerns associated with epoxy resins and BPA.

However, with 90% of the population testing positive for BPA and a growing body of science raising increasing concern, responsible specifiers do not need to wait for regulatory action, but can take a precautionary approach to protect building occupants and manufacturing and installation workers. Low VOC products are available that can replace epoxy paints and other epoxy-based products and still meet the needs of health care.

In response to concerns about the potential health effects of bisphenol A in building materials—particularly in workers—specifiers and purchasers should seek safer alternatives.

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ANNEXE V

Jos de Krieger asked also if during the production process of a new standard playground, it may be released more bisphenol than the one released during use of Wikado playground. A comparison of bisphenol released during the production of a standard playground with bisphenol migrating from Wikado's use it's difficult to measure. There are several variables and the targets are different: workers, environment during production of a standard playground; mainly children during Wikado's use. The amount of BPA produced it depends on which type of standard playground is manufactured. In general more BPA is requested for the final product more BPA is produced, may be released and discarded. BPA is used for some plastics (like for instance polystyrene and epoxy). Standard playground are mainly built by wood, steel, some rope, only sometimes there are also some plastics like coatings or resin with fibers. BPA could be mainly present in some coatings (if used, and only some of them), in small parts of the playground and maybe in the slide (if it is in plastic plus fiber glass, even if most of them are now in steel). The amount of BPA which may be released from the rotor blades of Wikado is high. It can be contained in the epoxy resin (which is the main construction material) and the coatings.
In conclusion less BPA is present and might be released during the use of a standard playground compared to the use of Wikado. Much less is produced for a standard playground than for Wikado's rotor blades. Probably the amount of BPA which may be released during the production of a standard playground is also less than the one which may be released during Wikado's use.