HAZARD IDENTIFICATION CHECKLIST: OCCUPATIONAL SAFETY AND HEALTH ISSUES ASSOCIATED WITH GREEN BUILDING

Part A: Introduction

This checklist aims to help identify the potential hazards to workers' safety and health associated with the planning and construction of green buildings, their maintenance, renovation (retrofitting) and demolition, as well as the collection of related construction or demolition waste on site (excluding the subsequent waste treatment and recycling). It also gives examples of preventive measures to address these hazards. This checklist could be used to support the workplace risk assessment process.

A green building is a structure that is environmentally responsible and resource-efficient throughout its life-cycle, from siting to design, construction, operation, maintenance, renovation, and demolition. A common feature of green buildings is that they drastically reduce emissions, material use and water use. Green buildings have the potential to reduce energy use by 80% or more by integrating efficient systems (heating, cooling, lighting, water); use alternative energy sources (for example passive solar, wind energy, bioenergy); retain energy (efficient insulation and windows, thermal mass); and use recycled, reused, or low-energy building materials

Some of the OSH issues associated with green buildings are new compared with traditional construction sites and are associated with new green materials, technologies or design. Other risks are well-known to the construction sector (for example working at height), but new situations or combinations associated with green buildings may make their impact worse.

The checklist is based on the e-fact on occupational safety and health (OSH) issues associated with green building available at: https://osha.europa.eu/en/publications/e-facts/e-fact-70-occupational-safety-and-health-issues-associated-with-green-building and complements the checklist on the construction sector in EU-OSHA report 'Innovative solutions to safety and health risks in the construction, healthcare and HORECA sectors', available at: http://osha.europa.eu/en/publications/reports/innovative-solutions-OSHrisks/view.
The OSH associated with renewable energy systems that may be integrated into green buildings are not addressed in this checklist. Specific information on OSH and solar energy systems and on wind energy are also available in EU-OSHA's web section on green jobs at: https://osha.europa.eu/en/topics/green-jobs. In addition, information on the construction sector is available at: http://osha.europa.eu/en/sector/construction.

- **How to use this checklist**
  - This checklist is not intended to cover all the risks from activities on green buildings, but to raise awareness and to help put relevant prevention techniques into practice.
  - A checklist is only a first step in assessing hazards and should be considered as part of a risk assessment. Further information or expert help may be needed to assess more complex risks.
  - You should adapt the checklist to your particular sector or workplace and to the characteristics of the workforce, as specific workers' groups may have specific needs. Extra issues may need to be covered, or some points omitted as irrelevant.
  - It is equally important to check that any measure aimed at reducing exposure to one risk factor does not increase the risk of exposure to other factors.
- **Important issues that need to be addressed**
  - Are managers and workers aware of the potential risks from work done on green buildings and are they committed to prevention?
  - Has a practical participative approach (worker involvement) to problem-solving been adopted within the organisation?
  - Have comprehensive risk assessments been undertaken by appropriately trained staff?

- Have all reported cases of accidents and incidents been managed?
- How is the effectiveness of the measures taken to prevent risks from work on green buildings being evaluated and monitored?

Part B: Questions for the prevention of OSH risks from activities associated with green buildings

Does the hazard exist at the workplace? Are the hazards controlled to minimise negative influences on the safety and health of all the people involved?

Answering **'NO'** to one of the following questions indicates a need for improvements to be made in the workplace. Some examples of measures that could be introduced into the work environment can be found in part C. Please note that this is not a comprehensive list of measures. The examples in part C are linked to the questions in part B. In some cases more than one measure might related to one question, in order to reflect the principle that various options should be considered, according to the hierarchy of control measures.

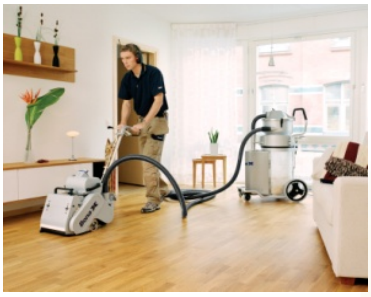
No.	Checking on hazards on site	Yes	No
1 Identification of risks in the pre-construction phase **This is relevant e.g. for architects, clients, principal contractors, investors, building owners, authorities.**			
1.1	Occupational safety and health are considered in the design phase of the building. (For example, issues such as the fact that atriums with large glass panes can be heavy and difficult for workers to carry, are considered at the design phase).	☐	☐
1.2	Skylights are designed in such a way that they can withstand a specified minimum load, and that the maximum load that skylights can withstand during, e.g. maintenance work is specified.	☐	☐
1.3	Purchased prefabricated materials (e.g. concrete walls, floors etc.) are 'tailor-made' for the particular building in a way that exposure of construction workers to noise, vibrations, manual handling and harmful dust (such as crystalline silica) is reduced (for example, the prefabricated elements are tailor-made so that the need for drilling, cutting or sawing on site is reduced).	☐	☐
1.4	In the event that a green building certification scheme is implemented, it is essential to check that occupational safety and health are considered in the green building certification system chosen.	☐	☐
2 Risks from green building materials and substances used or generated in green construction			
2.1	Exposure to dust, including dust from green, organic material such as wood dust has been assessed, monitored and controlled.	☐	☐
2.2	Exposure to dust (for example to silica - crystalline quartz dust) that results from drilling, sawing or milling concrete or asphalt materials has been assessed, monitored and controlled.	☐	☐

No.	Checking on hazards on site	Yes	No
2.3	Exposure to protein-based allergens, moulds and fungi or endotoxins from renewable organic sources (such as sheep wool, bamboo, straw, flax, cork and wood) has been assessed, monitored and controlled.	☐	☐
2.4	There are measures in place to eliminate or, where not possible, to reduce to the minimum inhalation of dust and other hazardous substances (such as boric acid) when working with recycled materials (such as recycled paper flakes or flax wool used for insulation). Any control measures that are applied give priority to prevention at source following the hierarchy of control measures, and personal protective equipment is used as a last resort only.	☐	☐
2.5	There are measures in place to eliminate or, where this is not possible, to reduce skin contact when applying conventional products (such as solvent-based products) or greener products (such as water-based paints or adhesives). Any control measures that are applied give priority to prevention at source following the hierarchy of control measures, and personal protective equipment is used as a last resort only.	☐	☐
2.6	The work areas for applying water-based paints, adhesives or two-pack reactive products such as epoxies or polyurethane coatings, adhesives or flooring materials have good ventilation.	☐	☐
2.7	When using or processing (e.g. spraying, abrading, sawing) coatings, concrete materials or other products that may contain nanomaterials, the potential risks of exposure to nanomaterials have been assessed and controlled by using adequate tools and control measures (see e-fact: https://osha.europa.eu/en/publications/e-facts/e-fact-72-tools-for-the-management-of-nanomaterials-in-the-workplace-and-prevention-measures.)	☐	☐
2.8	When polyurethane insulation foams are needed, 1-pack products are used instead of 2-pack products.	☐	☐
2.9	Exposure (eyes, skin, inhalation, ingestion) when working with insulation materials such as glass wool, rock wool, aerogels, polyurethane foam, or any 2-pack reactive coating, adhesive, flooring or insulation product has been estimated or monitored and controlled.	☐	☐
3 Risks from green technologies, methods and activities			
3.1	*In the case of off-site production of building elements:* The off-site production of prefabricated building elements such as precast concrete walls, which result in a more efficient use of resources, leads to more 'assembly' work at construction sites, thus more use of sealants or adhesives for assembling on-site. There are measures in place at the construction site to prevent inhalation or ingestion of hazardous substances when working with sealants or adhesives for assembling.	☐	☐
3.2	There are measures in place to reduce physical workload related to manual lifting of heavy prefabricated units.	☐	☐
3.3	*Green demolition and the related manual waste collection for recycling:*	☐	☐

No.	Checking on hazards on site	Yes	No
	Workers on green sites handle materials 'two to three more times' than on conventional construction sites as a result of manual collection and separation. This means a higher physical workload as well as higher risks of strains, slips, falls, sprains, punctures, and getting struck by objects. The physical workload (caused by repeated manual lifting and carrying of waste materials) in case of on-site manual waste collection for recycling has been assessed, monitored and, if necessary, reduced.	☐	☐
	The risks of strains, slips, falls, sprains and punctures due to manual waste collection for recycling has been assessed, monitored and eliminated of, if not possible, reduced to a minimum.	☐	☐
4 Risks from green design practices			
4.1	Risks of slips, trips or falls, including those possibly caused by the design of elements specific to green buildings (for example large glass panels, green roofing and skylights and atriums, the construction of which involves an increased use of scaffolding) have been assessed, monitored and controlled.	☐	☐
4.2	The physical workload (lifting, carrying heavy objects) due to the use of large glass panels or double-glazed panels has been assessed and controlled.	☐	☐
4.3	There are measures in place to eliminate and, where this is not possible, to reduce to a minimum the risk of irritation and allergies when covering or maintaining roofs with vegetation.	☐	☐
4.4	Good ventilation is in place during the internal finishing work of buildings, in particular within buildings that should be tightly sealed for energy-efficiency purposes.	☐	☐
5 Organisational issues			
5.1	The OSH performance of (sub)-contractors has been assessed.	☐	☐
5.2	All hazards to workers' safety and health are identified (including (new) hazards that are associated with green building materials, green building technologies and green design elements with which they may not be familiar), the risks are assessed and controlled, and the results of this risk assessment are communicated by the client to the contractors and respectively by the (principal) contractors to their sub-contractors.	☐	☐
5.3	Contractors are required to put measures in place to eliminate or minimise the risks from any hazards including new hazards associated with green building materials, green building technologies and green design elements.	☐	☐
5.4	Contractors are required to communicate and place the requirements mentioned in question 5.3 to their sub-contractors.	☐	☐

Part C: Examples of preventive measures

1 Prevention in the pre-construction phase	
1.1	Consider occupational safety and health in the design phase of a building. This is relevant for architects and designers. Consult the dedicated 'Prevention through design' website with many examples that have been established by the National Institute for Occupational Safety and Health (NIOSH) in the United States of America (USA): http://www.designforconstructionsafety.org. Examples include the choice of materials (e.g. low VOC paints), the processes to be carried out at the construction site (e.g. painting on-site or using pre-painted window-frames), and the establishment of anchorage points to the building parts, in order to enable fixing safety systems (e.g. guardrails). Another example is that the building design should plan for air conditioning units to be placed at ground level instead of at rooftops, in order to reduce the need for construction or maintenance workers to work at heights [1].
1.2	Provide skylights with guardrails, to reduce the risks of falls during construction or maintenance work [1, 2]. Design skylights in such a way that they can withstand a specified minimum load, and/or specify the maximum load that it can withstand during e.g. maintenance work [1, 2].
1.3	Purchase prefabricated materials (e.g. concrete walls, floors) that are as far as possible 'tailor-made' such that they reduce the need for drilling, cutting or sawing on-site, which in turn reduces exposure to noise, vibration and harmful dust such as silica (crystalline quartz). For example, such prefabricated modules should already be designed so that they contain the required spaces for cables. Close cooperation between architects, designers, manufacturers of construction materials, and planners and purchasers at contracting companies is crucial in order to achieve this goal.
1.4	Ensure that occupational safety and health are considered in green building certification systems. Check that the criteria that a green building has to meet to be accredited as such, do not negatively affect occupational safety and health. If necessary, report this to the accrediting organisation. This is relevant e.g. for architects, clients, principal contractors, investors, building owners and authorities, as well as for (sub)contractors [1].
2 Risks from building materials used in green construction	
2.1	Consider the relative health risks in the selection of the type of wood used. Use for example the information in the publication 'Less dust' of the European social partners in the wood industry (pages 7-8): http://www.cei-bois.org/files/Less_dust_brochure_GB_CORR_cropped.pdf (also available in French, German, Spanish, Italian, Polish and Dutch) Decrease the exposure to wood dust when sanding or sawing by using exhaust ventilation by the machines. Check the available guidance in English for example at: http://www.cei-bois.org/files/Less_dust_brochure_GB_CORR_cropped.pdf (Also available in French, German, Spanish, Italian, Polish and Dutch)

	 *After* considering measures at source, and *in addition* to technical measures such as dust suppression by water or local exhaust ventilation (LEV): For tasks that generate dust, do them outdoors as much as possible (e.g. if drilling, sawing or grinding small moveable objects, do these operations outside) or, if indoor, do them in separate areas so as not to expose other workers or, if not possible, do them when other workers are not present. (Source: http://www.bona.com) Clean work rooms (e.g. floors of buildings under construction) by vacuum or wet cleaning, in order to reduce recirculation of dust. Use *industrial* vacuum cleaners with high efficiency dust capturing filters (e.g. High-Efficiency Particulate Air (HEPA) filters). When measures at source, or technical or organisational measures are not sufficient to reduce effectively exposure to wood dust during sanding or sawing, use appropriate respiratory protection equipment (RPE): a half-face face piece or respirator covering the mouth and nose, equipped with a dust filter of class P2 or P3. Make sure that the RPE is properly maintained and that workers are trained in its proper use.
2.2	*After* considering measures at source such as 'designing out' the hazards (see the example of preventive measure 1.3): Decrease the exposure to silica dust, when drilling, abrading or grinding concrete or doing masonry work (e.g. in retrofitting), by using water sprays or exhaust ventilation at the machines. Review the available guidance, for example at http://www.hse.gov.uk/pubns/guidance/cnseries.htm. When measures at source, or technical or organisational measures are not sufficient to reduce effectively exposure to harmful silica dust during drilling, abrading or grinding concrete or masonry, use adequate RPE: dust masks class P3. Make sure that the RPE is properly maintained and that workers are trained in Its proper use.
2.3	Reduce exposure to protein-based allergens, moulds and fungi or endotoxins from renewable organic sources (such as sheep wool, bamboo, straw, flax, cork and wood) by: ▪ Getting statements from the supplier that the material meets specific criteria with respect to the content of allergens, moulds, fungi or endotoxins; ▪ Avoiding the use of water sprays to suppress dust generation, as this may increase the growth of bacteria that produce endotoxins, fungi, and moulds; ▪ Using low-dust generating techniques if you need to adapt the size of materials: e.g. cutting with a knife or scissors instead of sawing; ▪ Using equipment with built-in LEV when dust-generating activities cannot be avoided (e.g. drills, saws, grinding machines); ▪ Using personal protection if other measures have not been sufficient; e.g. dust masks of class P2 or P3, making sure that the RPE is properly maintained and that workers are trained in its proper use.
2.4	Reduce exposure to dust and hazardous substances in recycled materials such as paper flakes or flax wool by: ▪ Using low-dust techniques to adapt the size of materials, if needed: e.g. cutting paper flake panels or flax wool sheets with a knife or scissors instead of sawing; ▪ Using equipment with built-in LEV when dust-generating activities cannot be avoided (e.g. drills, saws, grinding machines);

	▪ Using personal protection if other measures have not been sufficient or if these are not feasible (e.g. when paper flakes have to be shed in room voids. Use dust masks of class P2 or P3.
2.5	Water-based paints or adhesives or (two-pack) reactive products such as epoxies or polyurethane coatings, adhesives or flooring materials have been introduced as 'measures at source' to substitute for less green and more hazardous conventional products (often solvent-based products). However, these products may contain irritating and sensitising substances. (Use databases such as GISBAU (German) to get assistance in selecting non-hazardous or least hazardous products - http://www.gisbau.de) As a complete avoidance of skin contact to these products is generally not possible without the use of PPE, ensure that appropriate skin protection is provided or properly used. Consult the relevant Safety Data Sheet for the selection of proper protective gloves, and for the maximum time of use for the substance(s) in question. Leather, cotton and polyethylene gloves and gloves that contain allergens, such as latex, are generally not suitable. Furthermore, take into account the following [3, 4]: ▪ Preferably, use disposable gloves and use them only once as: o Gloves may get contaminated inside when taking them off or putting them on; o The skin may get contaminated when taking gloves off or putting them on. ▪ When non-disposable gloves are appropriate and chosen as protective equipment: bear in mind that hazardous substances will continue to penetrate through the glove during the time the gloves are not being worn, for example during breaks from work, but should be counted as part of their total time of use. ▪ Never put on gloves when the hands or the gloves are wet or contaminated. ▪ Do not use moisture-tight gloves longer than needed; hands may get wet as a result of perspiration within 10 minutes, which may lead to contact dermatitis. ▪ Prevent the effect of moisture from perspiration by using cotton inner gloves. In addition, ensure that skin care is considered when water-based paints or adhesives or two-pack reactive products such as epoxies or polyurethane coatings, adhesives or flooring materials are used [4]. ▪ Use a skin care cream before you start work, after every hand wash, and after work.
2.6	Provide sufficient ventilation during indoor application of solvent-based as well as water-based paints, adhesives or two-pack reactive products such as epoxies or polyurethane coatings, adhesives or flooring materials, by: ▪ Ensuring that the building is not completely airtight until indoor finishing work has been completed as far as possible and practicable; ▪ Enhancing natural ventilation by using mobile ventilators; ▪ Preferably, using mobile LEV equipment that supplies fresh air from outside, and removes contaminated air, e.g. by using hoses.
2.7	The possibility that construction materials (e.g. coatings, concrete) contain nanomaterials has been checked with the supplier. If the material may contain nanomaterials, exposure should be minimised because of the current uncertainties surrounding the potential health risks of nanomaterials. Exposure may be minimised by: ▪ Considering materials that do not contain nanomaterials; ▪ Avoiding activities that generate dust or aerosols (drilling, abrading, sawing, spraying etc.);

	▪ Using personal protection with a high protection factor, such as full-face masks equipped with a P3-class dust filter. Information on the safe handling of nanomaterials are available for example at: https://osha.europa.eu/en/publications/e-facts/e-fact-72-tools-for-the-management-of-nanomaterials-in-the-workplace-and-prevention-measures; and https://osha.europa.eu/en/publications/e-facts/e-fact-74-nanomaterials-in-maintenance-work-occupational-risks-and-prevention and http://osha.europa.eu/en/practical-solutions/case-studies
2.8	Use as much as possible 1-pack polyurethane insulation foams, i.e., products that do not require mixing on-site, instead of 2-pack products, in order to reduce exposure to allergenic and highly irritating isocyanate-hardeners. If 2-pack products are used, the option to replace these by 1-pack products wherever possible has been carefully considered.
2.9	When glass wool or rock wool insulation materials are used: open the packaging only at the place of processing, in order to limit the area that may become contaminated by any loose fibres. When glass wool or rock wool insulation blankets are used: avoid sawing them when tailoring. Instead, cut the blankets with a knife. This drastically reduces the exposure to irritating fibres [5]. If sawing of glass wool or rock wool insulation blankets is unavoidable, decrease the exposure to man-made mineral fibres by the use of water sprays or exhaust ventilation at the machines. Check the available guidance for example at: http://www.hse.gov.uk/pubns/guidance/cnseries.htm. In addition to measures at source or exhaust ventilation, use respiratory protection when cutting glass wool or rock wool insulation materials (also during waste collection), or when applying paper flake insulation materials. Dust masks of class P2 will be sufficient. In addition, provide skin protection and skin care during handling of glass wool or rock wool insulation materials.
3 Risks from green technologies, methodologies and activities	
3.1	When sealants are used to assemble prefabricated modules, choose the least hazardous products (by consulting the hazard symbols and risk phrases), use systems (e.g. caulking guns) that enable precise application, and use skin protection if skin contact cannot be ruled out.
3.2	Always use mechanical equipment (cranes, forklift trucks, etc.) to lift heavy prefabricated units.
3.3	In case of on-site waste collection and separation: avoid excessive physical workload caused by repeated manual lifting and the carrying of waste materials. Consider using vehicles, such as forklift trucks. By doing so, consider safety issues related to the use of forklift trucks and other vehicles on site [https://osha.europa.eu/en/publications/reports/innovative-solutions-OSHrisks/view], and consider whether the substitution of diesel-powered by electricity or LPG powered forklift trucks is possible. Place containers for waste-collection as close to the workplace as possible, in order to reduce the physical workload as a result of manually carrying waste materials for long distances [5]. Use containers for waste-collection that have edges that are not too high (e.g. not higher than 1 metre) in order to reduce the risk when lifting heavy objects [5].

	Provide workers with protective gloves and boots that are sufficiently resistant to penetration by sharp objects, in order to prevent punctures due to manually handling waste materials for recycling.
4 Risk from green design elements	
4.1	Mark and cover (temporary) holes, cavities or skylights in order to reduce the risk of falls. Provide guard lines or restrict access to the edges of surfaces at height when working at height, e.g. on skylights.
4.2	Use lifting aids for carrying heavy double-glazed units. An example is shown at: http://www.muyen.com/images/producten/197.jpg Make sure that bulky items such as large glass panels are carried by at least two or more people.
4.3	When green roofs are installed or maintained, reduce the risk of skin disease (contact dermatitis) by: ▪ choosing non allergenic and non-irritating plants; ▪ applying adequate skin protection when needed, and skin care (see the example at measure 2.5).
4.4	Provide for sufficient ventilation during internal finishing work, by: ▪ Ensuring that the building is not completely airtight until internal finishing work has been completed – as far as possible and practicable; ▪ Enhancing natural ventilation by means of mobile ventilators; ▪ Preferably, using mobile LEV equipment that supplies fresh air from outside, and removes contaminated air, e.g. through hoses.
5 Organisational issues	
5.1, 5.2, 5.3 and 5.4	Select (sub)-contractors (also) on the basis of OSH-performance. Ask for proof of their OSH performance, e.g. for their OSH procedures and measures to be in place to ensure good OSH management, safety certifications (such as 'Safety (Health Environment) Checklist (SCC or in Dutch VCA), 'Safety Checklist Principals' (SCP or in Dutch VCO) and Safety, Health and Environment Passport (SHE Passport), annual reports, corporate social responsibility reports or reports of inspection visits [6]. Provide accurate training and instruction tailored to the needs of construction workers and sub-contractors, e.g. through toolbox talks. Ensure that procedures are in place to identify hazards to workers' safety and health (including (new) hazards associated with green building materials, green building technologies and green design elements with which they may not be familiar), to assess and control the risks, and that the results of this risk assessment are communicated by the client to the contractors and respectively by the (principal) contractors to their sub-contractors. One way of ensuring this is to require the development of a 'project oriented health and safety plan' prior to each construction project, and to require that the contractor discusses this plan with the workers. Ensure procedures are in place to only allow access to sub-contractors to the construction site when they have implemented OSH measures that are at least of a similar level as those implemented by the contractor.

	Provide a procedure that requires construction site supervisors to communicate OSH requirements to sub-contractors. Provide a procedure to report unsafe or unhealthy situations, and ensure that the culture of the organisation is such that workers feel free to report these. Establish a procedure for recording health complaints of workers, and for the follow-up of these complaints aimed at reducing risks at work by means of the hierarchy of controls.

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