HAZARD IDENTIFICATION CHECKLIST: OSH RISKS ASSOCIATED WITH SMALL-SCALE SOLAR ENERGY APPLICATIONS

Part A: Introduction

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This checklist aims to help identify the potential hazards to workers' safety and health from small-scale and domestic solar energy systems, covering all stages of their life cycle, from manufacturing, installation and maintenance to decommissioning and recycling. Additionally, it gives examples of the type of action at a technical, organisational and individual level that can be put in place to prevent or reduce the risks. The checklist could be considered as part of a risk assessment.

There are two basic methods of solar power generation. Both can be applied in domestic or other small-scale premises, e.g. in companies, including small and medium-sized enterprises (SMEs), and office buildings. The first, solar thermal systems (STP), produce heat energy, while the second, photovoltaic systems (PV), generate electricity. Both types are usually roof-mounted. These will be explored further in the document. More detailed information about risks and prevention can be found in e-fact https://osha.europa.eu/en/publications/e-facts/e-fact-68-osh-and-small-scale-solar-energy-applications.

The basic concept of a thermal system is the use of sunlight to directly heat a fluid from which thermal energy is obtained. The system transfers the thermal energy to an internal storage tank (hot water heater). Often the fluid is water, but additives like glycol prevent freezing and enhance the heat transfer characteristics. The technology neither uses hazardous chemicals nor features electrical risks. However, as hot fluids are involved, they present risks for burns and scalding.

Photovoltaic systems use cells to convert solar radiation into electricity. The cell consists of one or two layers of a semi-conducting material, usually silicon. Thin-film cells contain only small amounts of semi-conductor materials and metals, e.g. cadmium telluride (CdTe). Sunlight creates an electric field across the layers, causing electricity to flow. Most PV systems are directly connected to the power grid and do not require battery storage. PV installations exhibit electrical dangers, mostly as separating the system from the mains does not stop the system from producing a dangerous direct current voltage, even out of direct sunlight. Damage to the power lines can furthermore produce a flashover and therefore risks of severe burns or even electrocution.

Solar power installations can be the source of a combination of risks throughout their life cycle. This may be influenced by the following main areas of hazards: exposure to toxic chemicals and metals, electric risks (PV)/burns (STP), working at height, and musculoskeletal disorders (MSDs). Psychosocial risks and work organisation issues are also relevant, particularly since a diverse workforce with widely different characteristics, skills and needs may be involved in work with small-scale solar energy installations, including sub-contracted workers, migrant workers, illegal workers, new, unskilled entrants into the sector. All operations on small-scale solar power installations require training to recognise the various risks and to take the appropriate safety and health measures.

The manufacture, disposal or recycling of PV systems can lead to exposure to chemicals. During their assembly and repair, or as a result of accidental damage (such as in the case of leakage), the chemical risks that may occur are lower since only small amounts of semi-conductor materials are present in the finished items. Solar installations present electric risks during (de)installing, connecting, and maintaining. Unlike a traditional system it is not possible to cut the power. (De)installation and maintenance workers as well as fire fighters face electric risks as PV systems and all their components are electrically energised when exposed to sunlight [1]. Working on rooftops can also

expose workers to the risk of electrocution from nearby power lines. Manual handling issues have to be considered in all phases of the life cycle. For those who work on and around (slanted) rooftops, this activity could contribute to the risks of falling from height, caving in and falling material. Respiratory poisons are a general risk during fires, although not significantly different from ordinary building fires.

Building owners, company holders, caretakers or maintenance workers in companies or offices undertaking upkeep activities may also be at risk. These persons usually do not have sufficient knowledge and skills to handle the diversified risks. Furthermore, owners or managers may not have the required knowledge to distinguish between those contractors who are well-trained from those who are not, when contracting them to install/maintain solar energy systems. In case of a transfer of the ownership of a house or a company, there is also a risk that the necessary information for safe maintenance of the solar energy installations may be lost.

- **How to use this checklist**
  - This checklist is not intended to cover all the risks of every workplace but to help start the hazard identification process and identify and put relevant prevention measures into practice.
  - A checklist is only a first step in carrying out 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. Some extra items may need to be covered, or some points omitted as irrelevant.
  - For practical and analytical reasons, a checklist presents problems/hazards separately, but in workplaces they may be intertwined. Therefore, you have to take into account the interactions between the different problems or risk factors identified. At the same time, a preventive measure put in place to tackle a specific risk can also help to prevent the occurrence of another.
  - 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 related to solar power installations and committed to their prevention?
  - Has the organisation adopted a practical participative approach (worker involvement) to problem-solving?
  - Have appropriately trained staff undertaken comprehensive risk assessments?
  - Are all reported cases of accidents and incidents being managed?
  - How is the effectiveness of the measures taken to prevent risks caused by solar power installations across their life cycle being evaluated and monitored?

Part B: Checklist for the prevention of accidents and damages to health in the solar energy sector (small-scale and domestic applications)

For example:

- Does the hazard exist at the workplace?
- Are the hazards eliminated, and where not possible controlled to minimise negative influences on the safety and health of all people involved?

Answering '**NO**' to one of the following questions indicates a **need for improvements** to be made in the workplace. Examples of measures that could be introduced into the work environment are shown in part C.

	QUESTIONS	Yes	No
1. Manufacture			
Exposure to dangerous substances (see also references [2] [3])			
1.1	Is worker exposure to chemicals and dust eliminated or, if not possible, reduced to the minimum, giving priority to measures at source according the hierarchy of control measures as indicated in the legislation on hazardous substances? (EU Directive 98/24/EC on the risks related to chemical agents at work (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:01998L0024-20070628:EN:NOT), and EU Directive 2004/37/EC on carcinogens or mutagens at work (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0037R(01):EN:NOT); Please note that national legislation on dangerous substances may have stricter provisions and should be checked)	☐	☐
1.2	Is mechanical ventilation provided throughout the fabrication area at a sufficient rate?	☐	☐
1.3	When risk reduction measures at source are not sufficient, is personal protective equipment (PPE) provided, used, and maintained whenever necessary?	☐	☐
1.4	Are workers properly trained to use the PPE provided?	☐	☐
1.5	Are flammable or toxic chemicals stored in appropriate containers and in a well-ventilated area, when not in use?	☐	☐
1.6	Are hazardous gas cylinders (e.g. silane) stored adequately, i.e. outside in an isolated secure area or in purged gas cabinets?	☐	☐
1.7	Are there procedures in place for the safe maintenance and cleaning of manufacturing installations where exposure to chemicals and dust could occur?	☐	☐
1.8	Is the quality of air in the workplace and of exhaust air monitored?	☐	☐
1.9	Are Safety Data Sheets provided?	☐	☐
1.10	Have the workers access to information on safe work procedures?	☐	☐
1.11	Is an emergency plan available?	☐	☐

QUESTIONS		Yes	No
Manual handling issues			
1.12	Is work arranged so that manual handling operations, such as lifting and carrying operations and repetitive manual handling of even lighter items are avoided and, where not possible, reduced to the minimum?	☐	☐
1.13	Have workers been trained on safe manual handling techniques?	☐	☐
2. Installation, maintenance, decommissioning			
Work organisation, psychosocial risks			
2.1	Is information on the solar system, the electrical installation and the building that is required to perform the work safely available to the workers?	☐	☐
2.2	Is training provided on safe working procedures?	☐	☐
2.3	Is there sufficient cooperation, communication and exchange of information among the different actors involved (for example building owner, site manager and the workers) in order to allow the safe performance of the work, especially if different companies and sub-contractors are involved?	☐	☐
2.4	Are workers involved in the workplace risk assessment?	☐	☐
2.5	Have workplace hazards linked to the organisation of the work and work-related stress been assessed as part of the workplace risk assessment?	☐	☐
2.6	Are there measures in place to avoid a high workload and tight deadlines?	☐	☐
2.7	Have the specific needs and risks of the different worker groups (migrant workers, young and older workers, female and male workers, etc.) been assessed?	☐	☐
2.8	Are there measures in place to ensure communication of information to (e.g. migrant) workers who may not have a good command of the working language in order to allow them to perform their work safely?	☐	☐
Working at height, slips and trips, falls (see also references [4] [5] [6] [7])			
2.9	Can work at height in general, and in particular on slanting roofs be avoided?	☐	☐
2.10	When work at height is necessary, are there mobile elevating work platforms (MEWPs) and scaffolding available if needed?	☐	☐
2.11	When ladders are used to reach the place of work at height, has the appropriate ladder been chosen and is it used safely?	☐	☐
2.12	When roof work is necessary, has the condition of the roof been assessed to ensure that the roof is dry and free from slipping and tripping hazards such as moss, snow, ice, vent pipes, equipment lying around, etc.?	☐	☐
2.13	In the case of skylights or holes/cavities, are they safeguarded?	☐	☐

	QUESTIONS	Yes	No
Electricity-related risks (PV), burns/scalds (see also references [4] [5] [6] [7])			
2.14	Are only qualified persons allowed to work on electrical equipment?	☐	☐
2.15	Is a safe distance kept for workers, tools and materials from high voltage power lines during maintenance/repair activities?	☐	☐
2.16	Is the work area at the power inverter dry?	☐	☐
2.17	Are workers aware that low voltages can cause surprise shocks and thereby falls?	☐	☐
2.18	Are workers aware that small amounts of sunlight can produce a voltage potential in the PV system and shock or arc-flash hazards?	☐	☐
2.19	In the case of STP, is the solar thermal collector cooled off?	☐	☐
2.20	Are workers provided with suitable PPE when risk reduction measures at source are not sufficient?	☐	☐
Hazards of musculoskeletal disorders (MSDs) (see also references [4] [5] [6] [7])			
2.21	Is work arranged so that manual handling operations, such as lifting and carrying are avoided and, where not possible, reduced to the minimum?	☐	☐
2.22	In case lifting or carrying operations are necessary, including lifting tools, equipment and material from the ground to the roof and vice-versa, are mechanical aids provided?	☐	☐
2.23	In case a crane is used, are workers operating the crane properly trained?	☐	☐
2.24	Are measures in place to avoid or, when not possible, to reduce to a minimum the need for workers to perform repetitive movements or to work in sustained postures?	☐	☐
2.25	Are measures in place to avoid or, when not possible, reduced to a minimum the need for workers to work frequently or in prolonged kneeling or squatting positions?	☐	☐
3. Integration into infrastructure, operation			
Electricity-related risks (PV) (see also references [4] [5] [6] [7])			
3.1	Are only qualified persons allowed to integrate the system to the mains?	☐	☐
3.2	Is the local electric power company contacted to turn the power off when connecting/separating the PV plant to/from the grid or working within a certain distance of high voltage power lines?	☐	☐
3.3	Are workers accompanied always by at least one colleague when working on electrical systems, thereby eliminating lone working?	☐	☐
3.4	Are workers aware of PV shingles bearing electric risks in case they are damaged e.g. during cleaning activities?	☐	☐

QUESTIONS		Yes	No
4. Disposal/recycling			
Exposure to dangerous substances and noise (see also references [2] [3] [8] [9])			
4.1	Is workers' exposure to airborne dangerous substances such as Volatile Organic Compounds, micro-organisms and the generation of dust and aerosols avoided or, if not possible, are there measures in place to reduce workers' exposure to the minimum, giving priority to control measures at source according to the hierarchy of control measures indicated in the legislation on hazardous substances?	☐	☐
4.2	Are there adequate washing facilities available for all workers?	☐	☐
4.3	Is the exposure to noise eliminated or, if not possible, reduced to the minimum and kept within the limit of 85 dB(A) by implementing control measures at source according to the hierarchy of control measures?	☐	☐
4.4	When risk reduction measures at source are not sufficient, is appropriate PPE provided, properly maintained, and are workers trained in their correct use?	☐	☐
Manual handling issues			
4.5	Is manual handling, in particular lifting or carrying heavy items or repetitive handling, even of lighter items, avoided or where not possible, reduced to a minimum?	☐	☐
4.6	In the case of manual handling work, can the task be done without lifting the arms above the shoulder level?	☐	☐
4.7	Are workers trained in safe handling techniques?	☐	☐
5. Fire emergency (see also references [10] [11])			
Electricity-related risks (PV), burns/scalds			
5.1	Are there measures in place to ensure that emergency services would be informed about the presence and type of solar power system (STP or PV or both)?	☐	☐
5.2	Are emergency services aware of the safe distances to be kept to the (possibly) voltage carrying parts of the system, similarly to the safe distances they have to observe when intervening at electrical plants?	☐	☐
5.3	Are emergency services aware that electric arcs can be caused by high direct current voltages from PV systems (also building integrated systems)?	☐	☐
5.4	In the case of STP, can the existence of hot solar heat modules be excluded?	☐	☐
Collapses and falls, falling pieces			
5.5	Is information readily available for emergency services on the fire resistance and fire spread characteristics of the solar panels?	☐	☐
5.6	Can building-integrated PV shingles bearing slipping risks be unequivocally identified?	☐	☐

Part C: Examples of preventive measures

1. Manufacture	
Exposure to dangerous substances (see also reference [2] [3]0	
1.1	▪ Try to eliminate the use of dangerous substances or to substitute these with substances less hazardous. ▪ Implement working processes that eliminate or, if not possible, reduce the quantities of hazardous substances used in the process or generated through the process. ▪ Use a closed manufacturing system when working with hazardous substances and gases, for example with silane, with processes likely to generate gas, dust or aerosols. ▪ Apply local exhaust ventilation (LEV) at source to remove airborne dangerous substances, vapours, volatile organic compounds (VOCs), dusts or aerosols. ▪ Provide controlled general ventilation to remove contaminated air. ▪ Organise the work by adopting operating cycles so that the number of workers exposed and exposure times are reduced.
1.2	Inspect and clean exhaust ventilation systems periodically to maintain maximum efficiency.
1.3	Ensure that the PPE meets EU standards, is CE marked and is maintained or replaced when necessary.
1.4	Train workers on the correct use of PPE, and ensure that respiratory protective equipment (RPE) is fitted to each worker's face taking account of differences, such as beards. Overall, a tight-fitting face piece must have good contact between the wearer's skin and the face seal of the mask.
1.5	Store flammable or toxic reagents and gases in suitable closed vessels, within fire-resistant cupboards, cabinets or bins containing spill trays.
1.6	Store hazardous gas cylinders outside in an isolated secure area or in purged gas cabinets.
1.7	Carry out a risk assessment before any maintenance, repair, or cleaning activities are undertaken in areas where dangerous substances are used.
1.8	Assess and monitor the air in the workplace and the exhaust air.
1.9	Provide safety data sheets (SDS) for all hazardous substances used.
1.10	Provide adequate training (initial, on-the-job, refresher) and supervision for workers on safe work procedures.
1.11	Develop an emergency plan in cooperation with OSH experts, inform workers about the plan, and coordinate it with the emergency services.
Manual handling issues	
1.12	▪ Try to re-organise the work process and organisation to minimise manual handling. ▪ Provide mechanised/automated systems for tasks that require lifting heavy items (sorting, assembling). See Figures 1a and 1b.

	Figure 1a: Sheet/trolley table Figure 1b: Vacuum hoist   Source: HSE, 2012 (http://www.hse.gov.uk/pubns/indg398.pdf). Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence v1.0. • Use ergonomically designed conveyor systems to reduce the need for awkward postures like twisting, bending down, and reaching sideways. • Alternate the nature of the working tasks as much as feasible. • Organise regular breaks (for example: The University of New South Wales - Health and Safety (UNSW-OSH) recommends: a 1-2 minute break every ½ hour, and a 30 minute break when working longer than 4 hours, see: http://www.ohs.unsw.edu.au/ohs_policies/guides/Guide%20to%20safe%20manual%20handling(2).pdf?bcsi_scan_ce299946edb5e163=0&bcsi_scan_filename=Guide%20to%20safe%20manual%20handling(2).pdf).
1.13	Provide training for workers on how to carry out safe manual handling, including safe techniques for lifting, pushing and pulling. See Figures 2a and 2b. Figure 2a: Sack truck Figure 2b. Keep the load close to the waist   Source: HSE, 2011 (http://www.hse.gov.uk/pubns/indg143.pdf). Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence v1.0.
2. Installation, maintenance, decommissioning	
Work organisation, psychosocial risks	
2.1	Ask the building/installation owners to provide the necessary information for the workers operating on the solar system to enable them to perform their work safely.
2.2	Make sure that workers have received proper training and record. In case of missing or unclear information on the system or working procedure, instruct workers to inform their line manager/employer before performing the work, so that these can contact the relevant persons and experts for assistance and provision of the missing information.
2.3	Ensure good communication and teamwork exists among building owner, all workers and site managers.
2.4	Consult and involve workers in the workplace risk assessment as well as in the choice of prevention measures.

2.5	Assess workplace hazards linked to the organisation of the work and work-related psychosocial hazards as part of the workplace risk assessment, i.e. include aspects related to workload, deadlines, support from supervisors and colleagues, autonomy, monotony, work-life balance, etc. using a measure such as the NIOSH Generic Job Stress Questionnaire (http://www.cdc.gov/niosh/topics/workorg/tools/niosh-job-stress-questionnaire.html) or the HSE management standards indicator tool http://www.hse.gov.uk/stress/standards/pdfs/indicatortool.pdf).
2.6	Assess workers' workload and the feasibility of the deadlines to be met, and check that the work can be done without generating overtime. In case of too high workloads and too tight deadlines, try to re-plan and re-organise the work in consultation with workers so that workloads and deadlines are acceptable.
2.7	Make sure to take into account the characteristics of all workers' group and adapt working conditions to their specific needs, taking into account gender, age, (migrant) worker's needs for information in their native language, etc.
2.8	Supply all safety information in the different languages of the workers on site as necessary.
Working at height, slips and trips, falls (see also references [4] [5] [6] [7])	
2.9	Try to plan and organise the work so that work at height can be avoided. When work at height cannot be avoided, ensure that a system is in place to prevent or arrest falls. See Figure 4. Figure 4  Source: HSE, no date (http://www.hse.gov.uk/falls/campaign/personalequipment.pdf). Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence v1.0.
2.10	Provide appropriate mobile elevating work platform (MEWPs) and prevent them from becoming unstable or overturning. See Figure 5. Figure 5: A mobile elevating platform being used to replace a roof sheet  Source: HSE, 2011 (http://www.hse.gov.uk/pubns/indg284.pdf). Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence v1.0.
2.11	In order to choose the adequate ladder, assess the height from the ground on which the work will be done; the surface on which the equipment will rest as well as on which the workers will work; the condition of the ground on which the equipment will rest; the weather conditions and how the working tools would be taken to the height. (http://www.hse.gov.uk/falls/roof.htm). See Figure 6.

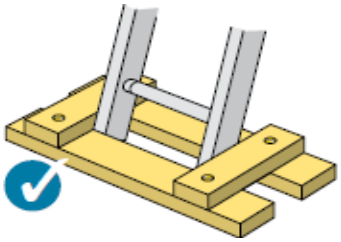
	Figure 6: Securing at the base Ensure that the ladder is fixed safely and positioned on a stable, flat surface.  Source: HSE, 2011 (http://www.hse.gov.uk/pubns/indg402.pdf). Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence v1.0.
2.12	Assess the condition of the roof, the types of roofing material and the roof cavity to ensure that it can be accessed safely. In case the surface is wet (in case of rain, snow, ice), try to re-schedule the work so that it can be done once the surface is dry. Eliminate any tripping and slipping hazards, paying particular attention to moss, debris and tools lying around. If a trip hazard cannot be eliminated signs and cones should be used to warn workers of the hazard.
2.13	Use rigid covers for skylights or temporary openings and holes, or safeguard them by means of protective rails or guards.
Electricity-related risks (PV), burns/scalds (see also references [4] [5] [6] [7])	
2.14	Ensure that workers who conduct the work are specifically trained on electrical risks and on the specific characteristics of solar energy systems.
2.15	Perform a risk assessment of the work area, including electrical hazards from high voltage power lines. Make sure all workers are aware of the importance to strictly respect the safety distances to high power lines and check that they comply strictly with this.
2.16	Keep the power inverter dry and isolate it suitably.
2.17	Make sure that workers are aware of electric risks of PV systems and that detailed information on these are available. In particular, make sure that workers are informed about the risks of low voltages causing surprise shocks and consequently possible falls.
2.18	Prevent potential hazardous currents by using Ground Fault Circuit Interrupters (GFCI).
2.19	Provide information about solar thermal collectors. Note that applying fluid to a hot system can quickly turn the liquid to steam.
2.20	Supply appropriate PPE (eye protectors/face shields, footwear, gloves) and ensure that it is properly maintained and that workers are trained in its use.
MSD hazards (see also references [4] [5] [6] [7])	
2.21	Try to re-organise the work so as to minimise the need for workers to manually lift and carry weight. In case that the lifting and the carrying of weight cannot be avoided, develop safe procedures/techniques for proper lifting, carrying and (un)loading vehicles, inform workers accordingly. Train workers in proper work postures and the use of techniques for lifting, carrying and (un)loading vehicles.
2.22	Assess the characteristics of the load to be carried or lifted and provide adapted carrying or lifting aid depending on the situation.

	Figure 7: Lever hoist  For example, provide a pulley or similar system for hoisting items onto/off upper surfaces (See Figure 7), or deploy forklifts or cranes with an experienced operator if needed. Source: HSE, 2009 (http://www.hse.gov.uk/pubns/priced/hsg221.pdf, p. 50). Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence v1.0.
2.23	Assure that the crane operator is competent and undertake a risk assessment of the operation at the site.
2.24	Try to re-organise the work, for example by enabling workers to alternate tasks as often as possible to avoid the same movements/work in the same posture over long periods. Implement regular breaks (for example: The Deakin University – Occupational Health and Safety recommends a 10 minute break every hour when working in a constrained posture, see http://www.deakin.edu.au/hr/assets/resources/ohs/preventing-manual-handling-injuries.pdf).
2.25	Try to re-organise the work so as to avoid or reduce the amount of time spent in kneeling or squatting work positions. See Figure 8. Figure 8: Kneeling mat  Use appropriate knee protection while kneeling on hard floor surfaces. Source: HSE, 2008 (http://www.hse.gov.uk/research/rrpdf/rr647.pdf, p. 4). Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence v1.0.
3. Integration into infrastructure, operation	
Electricity-related risks (PV) (see also references [4] [5] [6] [7])	
3.1	Ensure that only workers who are specifically trained on electrical risks, the characteristics of solar energy systems and on how to perform this work actually conduct the work.
3.2	Evaluate the hazards of the connection to the power supply system and have the contact details of the power company at hand until the work is completely finished. Contact the power company to turn off the power, if required.
3.3	Ensure that workers do not work alone but at least in pairs. In general, ensure that the number of workers doing a certain task is enough to perform this task safely.
3.4	Instruct workers to avoid broken shingles and to take the necessary measures to dispose of them safely.

4. Disposal/recycling	
Exposure to dangerous substances [9] and noise (see also references [2] [3] [8])	
4.1	While it may not be possible to eliminate the hazards linked to the dangerous substances contained in the waste, the most efficient prevention measure is to reduce the generation of dust and volatile organic compounds (VOCs). Control measures to avoid the presence of such airborne substances include: ▪ replacement of manual handling of waste with automated processes, for example replacing manual with mechanical pre-sorting; ▪ local exhaust ventilation at source, for example inserted in the sorting band; ▪ installation of sorting cabins with proper ventilation; ▪ provide adequate mechanical ventilation throughout the working area at a sufficient rate ▪ closed vehicles equipped with air filters; ▪ reduce the number of workers in areas where they can be exposed to dangerous substances, dust and aerosols and reduce the amount of time they spend in such areas ▪ hygiene plans, regular cleaning and decontamination measures also contribute to a considerable reduction in the exposure of workers.
4.2	Provide appropriate lavatories, washing equipment, and eating areas separated from the working areas for all workers.
4.3	▪ Replace the noise-generating equipment with more silent tools. ▪ Put technical measures in place to noise-isolate devices through encapsulation etc. or use noise-dampening materials to reduce noise. ▪ Reduce the number of workers in areas where they can be exposed to noise and reduce the amount of time spent in these areas.
4.4	Provide PPE to protect workers from released chemicals, aerosols and dust (respiratory protection), flying debris (safety helmet) and noise (ear protection).
Manual handling issues	
4.5	▪ Try to organise the work so as to minimise the need for manual handling, such as lifting and carrying operations, in particular of heavy items, or repetitive handling of even lighter items. ▪ When lifting operations are necessary, use vacuum lifting devices, and powered trucks, conveyors, roller balls, etc. for carrying operations. See Figures 9a and 9b. Figure 9a: Conveyor and vacuum hoist Figure 9b: Gravity rollers   Source: HSE, 2012 (http://www.hse.gov.uk/pubns/indg398.pdf). Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence v1.0. ▪ Avoid repetitive, in particular high frequency manual lifting and carrying by providing lifting and handling aids and/or by task automation.

	▪ Limit the duration of the work and ensure that regular breaks are taken (for example: The University of New South Wales - Health and Safety (UNSW-OSH) recommends: a 1-2 minute break every ½ hour, and a 30 minute break when working longer than 4 hours, see http://www.ohs.unsw.edu.au/ohs_policies/guides/Guide%20to%20safe%20manual%20handling(2).pdf?bcsi_scan_ce299946edb5e163=0&bcsi_scan_filename=Guide%20to%20safe%20manual%20handling(2).pdf).
4.6	▪ Provide conveyor belts and mechanical aids allowing the work to be performed between shoulder and waist levels. (See http://www.hse.gov.uk/waste/conveyorbelt.pdf). ▪ Make sure that tools, instruments, and machinery are designed, positioned, and handled so that tasks can be performed comfortably.
4.7	Organise training sessions to train workers on how to avoid risks arising from manual handling and how to use mechanical aids.
5. Fire emergency (see also references [10] [11])	
Electricity-related risks (PV), burns/scalds	
5.1	Ensure that detailed information on the solar power system, including the type of system used (PV or STP) and its location, is readily available in order to enable the preparation of an action plan.
5.2	The emergency intervention team should be informed about the distinct features of solar systems, as well as about safety distances when extinguishing a fire, especially if voltages are unknown. The team should include a person skilled in dealing with electrical hazards.
5.3	Make sure that the emergency intervention team is informed about the risks of flashovers and their control (e.g. safety distances) as far as possible.
5.4	In case of hot solar modules, use the safety relief valve to reduce pressure and to avoid the emission of overheated steam.
Collapses and falls, falling pieces	
5.5	Make sure to provide detailed information on local solar systems, including their resistance and fire properties to the emergency services in advance.
5.6	Do not step on solar modules and assume all surfaces to be potentially slippery.

References and further information

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