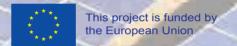
# STANDARD OPERATIONAL PROCEDURES FOR SOLAR PARKS

VOL. IV
HEALTH, SAFETY AND ENVIRONMENT (HSE)
MANUAL FOR SOLAR PARKS

THE EUROPEAN UNION'S FOREIGN POLICY INSTRUMENTS (FPI) PROGRAMME FOR INDIA











Content developed by: Santiago Mirabal, Rahul Datar & Agostinho Miguel Garcia.

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Health, safety and environment (HSE) manual for solar parks in India

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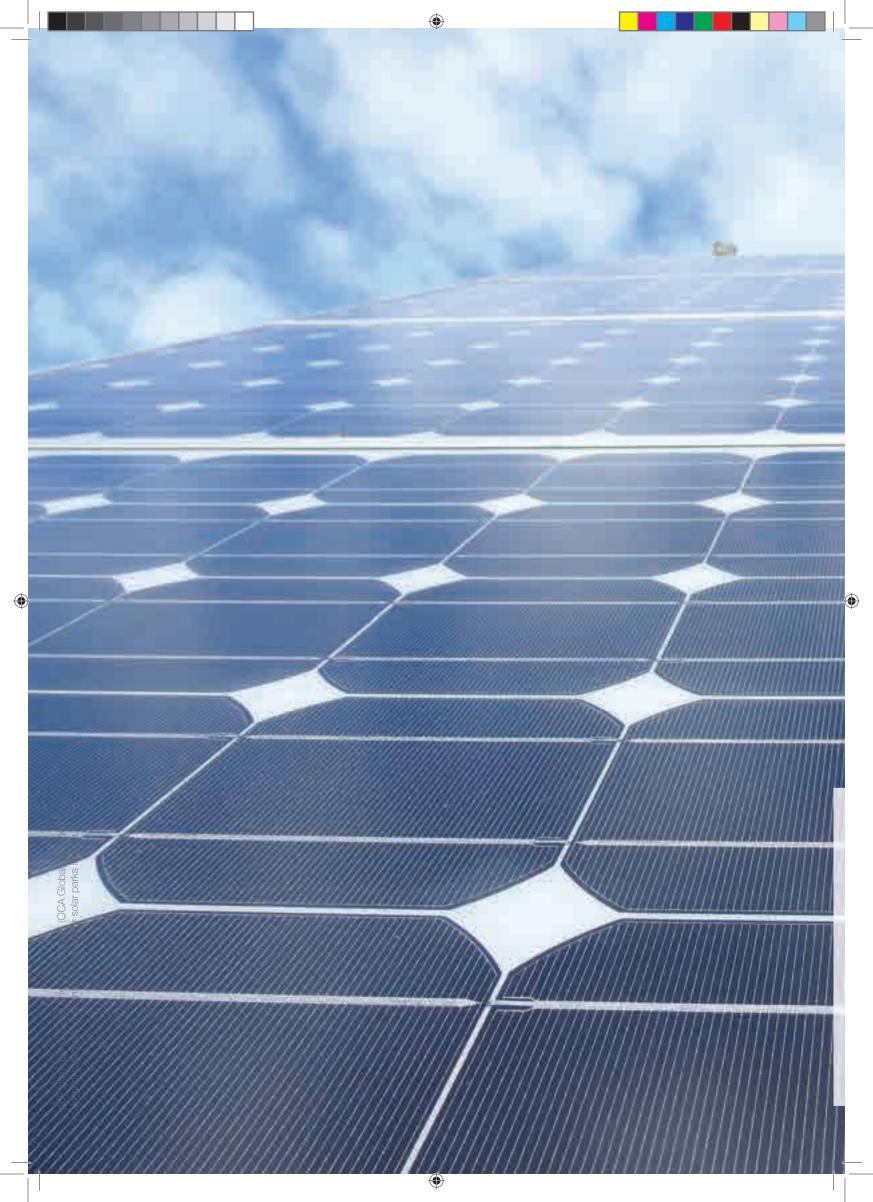


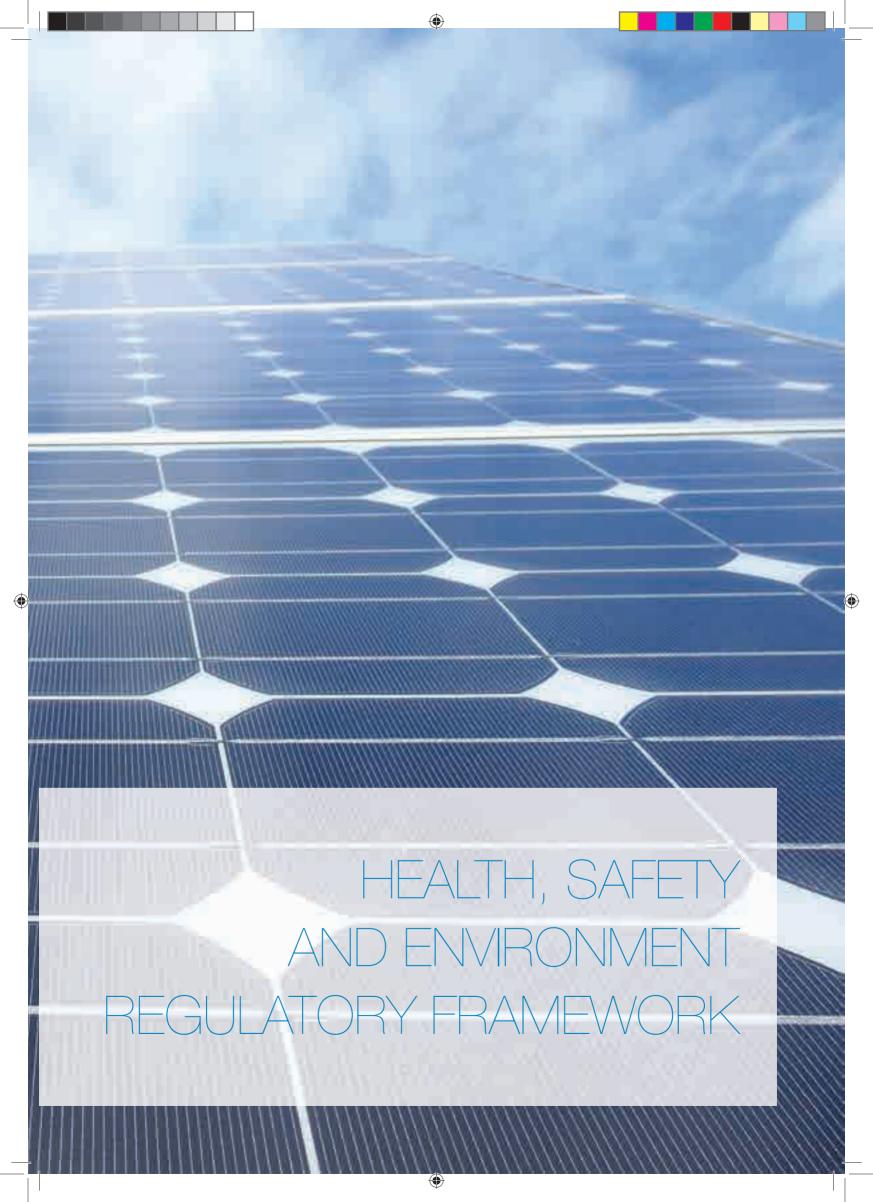
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ANNEXURE I

OHS hazards and risks operation and maintenance for solar parks

OHS hazards and risks for solar parks construction







# IBF International Consulting, EQO-NIXUS (OCA Global) and IDOM Health, safety and environment manual for solar parks in India.

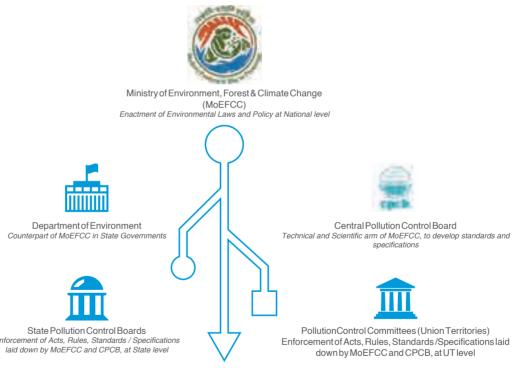
# **Environment**

# Regulatory governance in India on environmental management

The Indian State's responsibility regarding environmental protection has been laid down under Article 48-A of the Indian Constitution, which reads as follows: "The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country".

India's environmental regulatory framework is based on a system of shared central government / state pollution control administration. The environmental regulatory governance in India is headed by the Ministry of Environment, Forests and Climate Change (MoEFCC); supported by the Central Pollution Control Board (CPCB), the State Department of Environment (SDOE) and the State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs). Figure 1 below depicts the institutional structure for environmental regulatory governance in India.

The primary aims of the Ministry are implementation of policies and programmes relating to conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing these policies and programmes, the Ministry is guided by the principle of sustainable development and enhancement of human well-being.



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Figure 1 Environmental regulatory framework in India





The broad objectives of the Ministry are:

- Conservation and survey of flora, fauna, forests and wildlife.
- Prevention and control of pollution.
- Afforestation and regeneration of degraded areas.
- Protection of the environment.
- Ensuring the welfare of animals

The Ministry is also the nodal agency in the country for the United Nations Environment Programme (UNEP).

The MoEFCC is responsible for enacting various Acts and Policies in the interest of Environmental Management in the country through the parliamentary approval process (Acts need to be approved by the Cabinet of Ministers in the Central Government). Rules and Notifications issued under specific Acts can be introduced / amended by the MoEFCC and the CPCB / SPCBs directly without a cabinet approval. The Ministry has a wide set of legislative and regulatory framework which guarantees the preservation, conservation and protection of the environment.

As the technical arm of the Ministry, the responsibility for prevention and control of industrial pollution is primarily entrusted with the Central Pollution Control Board (CPCB), which is a statutory authority at the central level. The CPCB is responsible for the development of the scientific basis for all regulatory statutes in line with the Acts introduced by the MoEFCC and plays an advisory role to the Government and State Pollution Control Boards (SPCB) in matters relating to the implementation and enforcement of the air, water and environmental acts. In addition, the EIA review committee formed by the EIA division consists of a representative from the CPCB.

The State Departments of Environment and State Pollution Control Boards are the designated agencies to perform this function at the State<sup>1</sup> Level. The primary responsibility of the SPCBs is to implement and enforce the various statutes mandated by the MoEFCC. They also make specific rules applicable to their respective states in line with the central acts.

The current legal framework is divided into 12 lines of activity. These lines are the following: Water pollution; environment protection; national environment tribunal; biodiversity; national green tribunal; eco sensitive zones (ESZ) notifications; air pollution; public liability insurance; forest conservation; Indian forest service (IFS); wildlife; ESA notifications.

<sup>&</sup>lt;sup>1</sup> India is a federal constitutional republic governed under a parliamentary system consisting of 29 states and 7 union territories.





From the perspective of development of new industry or infrastructure projects or expansion of existing projects (such as highways, power plants, airports, common environmental infrastructure, manufacturing industries, etc.), the MoEFCC has introduced an Environmental Impact Assessment (EIA) Notification, in 1994, later considerably revised in 2006 and amended thereafter. The EIA lays down the mandate for a prior Environmental Clearance (EC) to such projects based on their adverse impacts and requires an environmental management plan to be put in place. MoEFCC and all the state governments have constituted expert appraisal committees at the centre and state level for assessing projects respectively.

The notification also provides for a similar clearance in cases where projects require forestland (forests notified by the MoEFCC) to be diverted. The forests division of MoEFCC along with the Principal Conservator of Forests (PCF) at state level administer this requirement.

The MoEFCC has also notified certain forest areas as Protected Areas (PAs) due to the presence of sensitive wildlife and ecological biodiversity. These include national wildlife sanctuaries and conservation parks. Projects that are located partially or wholly or within proximity (as notified by the Ministry from time to time) of these PAs are required to get a prior approval from the National Board for Wildlife (NBWL).

Thus, based on the requirements applicable to a site the following prior clearances / permits may apply to solar PV parks:

- Environmental clearance.
- Forest clearance and diversion.
- Coastal regulatory zone clearance.
- Approval from the national board for wildlife.
- Consent to establish and operate.

The MOEFCC has introduced PARIVESH, a web based, role based workflow application which has been developed for online submission and monitoring of the proposals submitted by the proponents for seeking Environment, Forest, Wildlife and CRZ Clearances from Central, State and district level authorities. It automates the entire tracking of proposals which includes online submission of a new proposal, editing/updating the details of proposals and displays status of the proposals at each stage of the workflow.

The Parivesh interface allows login for project proponents, State and Central processing authorities to manage the workflow of clearance proposals.





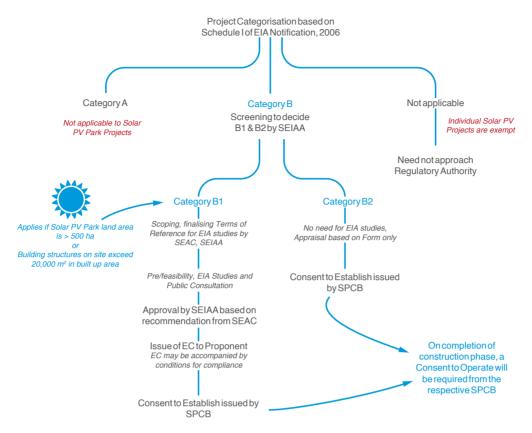


Figure 2 EC Process in India (EIA notification, 2006)

The applicability of prior EC process to solar PV park projects is discussed below.

# Prior environmental clearance (EC)

As per the environmental impact assessment (EIA) Notification of 2006 and amendments thereof, several infrastructure development sectors require a prior environmental clearance (EC) before the project is initiated, by the developer / proponent.

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The MoEFCC (then called as MOEF - Climate Change mandate was added later) had notified in May 2011 (Annex) that solar photovoltaic (PV) power projects are exempt from the EC requirement. While this is true for individual<sup>2</sup> solar PV projects, the MOEFCC has not specifically clarified the requirements for the category of solar park development (multiple solar PV projects).

Based on various requirements under the EIA notification, two scenarios of EC applicability that become relevant for solar parks in India, are discussed below:

A solar park could be defined under the category of industrial estate<sup>3</sup> / parks (clause 7c in schedule I of the EIA notification, 2006) as a large centrally administered industrial park consisting of a cluster of individual solar PV power plants. Under this category, if the total area of the park is less than 500 ha and it does not house a category A or B industry (solar PV projects are neither category A or B as per schedule I of the EIA notification) then a priori environmental clearance is not necessary to be obtained. So all parks exceeding an area of 500 ha will require a prior environmental clearance (under category B) from the State Environmental Impact Assessment Authority (SEIAA).

<sup>&</sup>lt;sup>2</sup> Individual refers to a solar PV project (SPD) on a single plot within the solar park.

<sup>&</sup>lt;sup>3</sup> A solar park would typically fall under the category of an industrial estate where the park developer prepares the land and constructs the common infrastructure and utilities of the park and leases individual plots to private developers who then construct and operate their own production facilities.

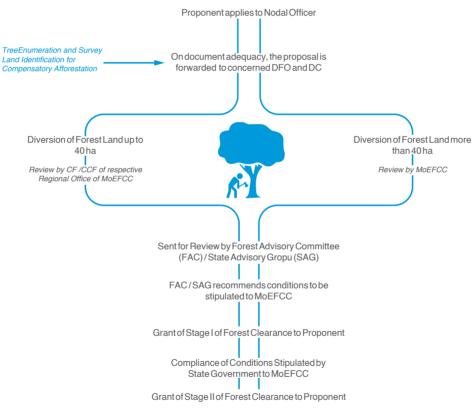


Some of the large infrastructure development projects (including solar parks) may also be considered under the category of townships and area development projects (clause 8b of in schedule I of the EIA notification, 2006), particularly on the latter basis (area development). Under this category, a project can be category A (central appraisal) if it is occupying more than 150 ha and category B1 (state appraisal) if it occupies more than 50 ha. This requirement in the EIA notification is being transferred to urban local bodies for appraisal and granting of EC. This process is in a draft stage as of now and may take time until the ULBs have the necessary internal capacity. Till such time, The State Environment Impact Assessment Agency (SEIAA) will be responsible for granting clearances.

### Forest clearance

As mentioned earlier a forest clearance is applicable if any of the proposed sites for the solar parks are wholly or partially occupying a notified forest land (reserved or protected forests). The clearance process and administering authority depend upon the area of the land to be diverted to alternative land use and its location. Figure 2 below presents the flowchart of a typical forest clearance process. Based on the location, category and area of the forest land, respective authorities will have to be approached based on the procedure laid down by MOEFCC.

If a site is adjoining (within the eco sensitive zone) or encroaching a declared protected area (wildlife sanctuaries or national parks) then an additional approval from the respective State level and National Boards for Wildlife (NBWL) may also be required.



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Figure 3 Forest clearance process

### **CRZ** clearance

The MoEFCC has introduced rules for infrastructure development in coastal regulatory zone (500 m from the high tide line) in India. While it is generally unlikely for coastal land to be allocated for solar PV projects, in the event of this possibility, the CRZ rules will have to be referred to ascertain the applicability. Figure 3 depicts the CRZ clearance process in India. CRZ clearances require an EIA document to be submitted to the authorities along with the prescribed application forms.







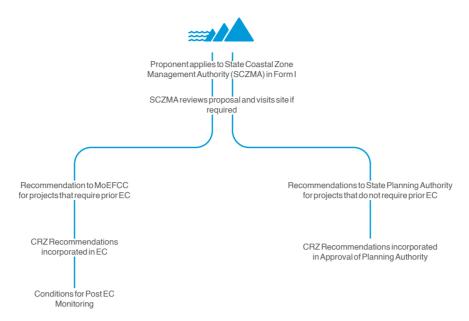


Figure 4 CRZ clearance process

As per Clause 5.1.2 (iii) of the CRZ notification, 2019, facilities for generating power by non-conventional energy sources fall under activities that are regulated or permitted in the CRZ-I B (the area between Low Tide Line and High Tide Line constitute the CRZ-I B). Also as per this notification, such facilities are permitted as part of CRZ IV (defined as the water area).

Solar PV projects fall under non-conventional energy sources.

# Other environmental regulatory clearances to solar power projects

Table 1 Environmental regulatory requirement for solar parks

Sr.No.	Act Rules / Notification	Objective / Intent of Regulation / Obligations of Project	Applicability to solar parks	Relevance <sup>4</sup> to solar PV projects	Responsible
1	Air (prevention and control of pollution) act,1981 and state	To control air pollution by controlling emission of air pollutants as per the prescribed standards.	$\bigcirc$ $\times$	This act will be applicable during construction and operation for emissions to	SPCB.
	level rules.	Seek Consent to Establish (CtE) and Consent to Operate for sites.		the air.	
2	Water prevention and control of pollution) act, 1974 and state level rules.	To control water pollution by controlling discharge of pollutants as per the prescribed standards.  Seek Consent to Establish (CtE) and Consent to Operate for sites.	$\bigcirc$ $\times$	This act will be applicable during construction and operation for discharging treated effluent from labour camps and construction activities.	SPCB.
3	Environmental protection rules, 1986.	Specific standards for discharge of emissions, wastewater discharges. Submission of annual environmental statement.	$\bigcirc \times$	For operational project sites.	SPCB.
4	State level ground water control regulation or notification from central ground water authority, 2012.	Prior Approval for abstraction of Ground Water for Park / Project Construction purpose.	$\bigcirc$ X	For abstraction of groundwater to be used in construction as well as during operational phases of the project.	SPCB / CGWA or relevant authority assigned by the State.

<sup>&</sup>lt;sup>4</sup> May apply to individual solar PV project sites or to parks in some cases





Sr.No.	Act Rules / Notification	Objective / Intent of Regulation / Obligations of Project	Applicability to solar parks	Relevance to solar PV projects	Responsible
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5	Approval for sourcing water from local water source (river, lake / reservoir).	Ensure competing users of water are not affected.	$\bigcirc \times$	For pumping of water from river or reservoir for use in project construction or operation.	State irrigation department / ministry of water resources.
6	Environment protection act, 1986.	To protect and improve overall environment.	$\bigcirc \otimes$	An Environmental Statement has to be submitted annually by the operating entity, to whom consent to establish and consent to operate have been granted by the State Pollution Control Board.	SPCB.
7	The forest (conservation) act, 1980.	To check deforestation by restricting conversion of forested areas into non- forested areas.	$\bigcirc \times$	Applicable if there is diversion of forest land for solar park sites.	Forest department, state government and MOEFCC.
8	State level tree felling act / rules, as applicable.	Seek approval before felling any trees, pay for compensatory tree plantation.	$\bigcirc \times$	Applies when site has trees of certain valuable species that need to be felled for project development.	SPCB or relevant authority.
9	Wild life (Protection) act, 1972.	To protect wildlife through national parks and sanctuaries.	$\bigcirc \times$	This act will be applicable, if there are any points of wildlife crossings within or in proximity to project locations.	Chief conservator wildlife, wildlife wing, state forest department MOEFCC.
10	Environmental Impact Assessment (EIA) notification 2006.	Sets out the procedure of conducting EIA for projects and activities covered under the notification to obtain environmental clearance.	Based on Total Area of the Park.	Please refer to section: prior Environmental Clearance (EC).	MOEF&CC/ SEIAA.
11	Coastal Regulation Zone (CRZ) Notification 2019.	Protection of fragile coastal belt ecosystem.	Depends on location of project site.	Please refer to section: CRZ Clearance .	State Coastal Zone Management Authority and MOEFCC.
12	Solid waste (handling and management) rules, 2016.	Lays down the procedure and norms for segregation, handling, storage and disposal of Municipal Solid Waste (MSW) generated.	$\bigcirc \times$	The provisions will be applicable to the labour camp that will be setup for the subprojects.  The labour camp will follow solid waste management practices.	SPCB.
13	Construction and demolition waste management rules, 2016.	Procedure for C&D (construction debris, spoil and other associated waste) collection, segregation, storage and disposal.	$\bigcirc \otimes$	Applicable as construction waste that is generated during the construction phase will need to be stored and disposed / reused as per local regulation (urban local body).	SPCB.
14	Hazardous and other wastes (management and transboundary movement) rules, 2016.	Stipulates the method of managing hazardous and other wastes regulated under the rules.  Seek authorization and follow segregation, storage and disposal of hazardous waste as per rules.	$\bigcirc \times$	Applicable to the hazardous waste (waste oil from diesel generator sets, oil soaked cotton, used oil filters) generated during construction.	SPCB.





of hazardous waste as per rules.







Sr.No.	Act Rules / Notification	Objective / Intent of Regulation / Obligations of Project	Applicability to solar parks	Relevance to solar PV projects	Responsible
15	E-waste (management) rules, 2016.	Maintain records of electronic and electrical waste generation and disposal and file annual returns.	$\bigcirc$ $\times$	Substantial e-waste will be generated during installations as well as routine operational maintenance of the solar PV projects.	SPCB.
16	Biological diversity act 2002 and biological diversity rules 2004.	The biological diversity act, which came into force in February 2003, aims to promote conservation, sustainable use and equitable sharing of benefits of India's biodiversity resources. It provides for establishment of a national biodiversity authority at national level, state biodiversity boards at state level and biodiversity management committees at the level of panchayats and municipalities.	$\bigcirc$ $\times$	To be ascertained for each sub-project during screening/ preparation process. Some sites/activities may be located close to ecologically sensitive areas that are beyond the protected domain.	Forest department, state government and ministry of environment and forests.
17	The noise pollution (regulation and control) rules, 2000.	The standards for noise for day and night have been promulgated by the MoEFCC for various land uses.	$\bigcirc$ $\times$	Applicable to all noise generating construction activities and construction equipment deployed at worksite.	SPCB.
18	Ancient monuments and archaeological sites and remains act, 1958.	Conservation of cultural and historical remains found in India.  Seek approval and modify project siting as necessary.	$\bigcirc$ $\otimes$	This act will be applicable, only if any of the sites are in proximity to any ancient monument, declared protected under the Act.	Archaeological dept. Gol, Indian heritage society and Indian National Trust for Art and Culture Heritage (INTACH).
19	Eco-sensitive zone notifications.	The activities in areas around wildlife sanctuaries and national parks are regulated from the perspective of conservation of wildlife.	Maybe	Applicable only if the urban area being developed is located in the ESZ.	Monitoring committee for ESZ in the State.
20	The manufacture, storage and import of hazardous chemical rules, 1989.	It provides measures, regulations and controls so as to reduce environmental, safety and health risks while manufacturing, handling and storage of hazardous chemicals.	$\bigcirc$ $\times$	Applicable as during construction phase, sub-projects may have to store hazardous chemicals at site.	SPCB.
01	National Building	Provides a guideline for building construction related norms and		May apply if mandated through CTO and applies only	Lirban local body

In addition to the key regulation mentioned above, Table 2 below further elaborates the typical regulatory approvals and clearances (beyond the basic clearances such as EC, FC, CRZ etc.) required for various thematic activities relevant to infrastructure development in solar parks, such as water supply, access roads, storm water drainage, building structures, sewerage and sewage treatment.

for building projects (not area

development).

Urban local body.

The points mentioned below refer to generic requirements, as not all parks would require all the activities and the size / scale of the infrastructure would also differ. This would render some of the requirements inapplicable.



design specifications, including

environmental, health and safety

requirements.

Code, 2016.









### Table 2 Indicative environmental clearances / Approvals required in solar park projects

Sr.No.	Infrastructure development activity related to solar park	Clearances / Authorization required
		Tree cutting permission from state forest department if any trees are felled.
	Common to all infrastructure types.	Contractor who employs or who employed five or more Inter-State migrant workmen need to obtain registration of interstate workmen migrant license from labour commissioner.
		TTE & CTO from SPCB for batching plant, hot mix plant, DG set.
		Approval from regulatory authority for withdrawal of water for construction purpose.
1		Obtain NOC for shifting of utilities, from concerned departments. This may be required for laying water pipelines, etc.
		PUC for construction vehicles from Motor Vehicle Department, State.
		NOC from the gram panchayat / local body for identifying area designated for disposal of construction waste, borrow areas (Department of Mining).
		Approved land acquisition plan and R&R plan from district collector, where land is being acquired, structures are affected, etc.
	Water supply to solar park sites.	Approval from respective regulatory authority (such as CGWA or state groundwater department or irrigation department) for withdrawal of water for construction / operation phase.
2		If water treatment needs to be carried out, obtain NOC for WTP sludge disposal area from concerned regulatory body governing the land obtained for sludge disposal.
		Obtain NOC from NHAI / state roads department for laying pipelines within RoW of the roads.
		Check specific requirements of authorities based on land use being converted to road (e.g. forest area, plantations, structures over water bodies).
	Creation of new access	Obtain NOC from SPCB for storage, handling and transport of hazardous material.
3	roads / restoration of existing roads.	Obtain NOC for transporting and storing diesel, oil and lubricants etc. from chief controller of explosives.
		Approved land acquisition plan and R&R plan from district collector, where land is being acquired, structures are affected, etc.
4.	Construction of storm water drainage system within / around park site.	For hilly sites where, natural drainage is being diverted, it may be required to seek an approval from the irrigation department.
	•••••	
	Building structures	Stability certificate form signed by the engineer/structural engineer.
5	(Administrative buildings).	Certificate of occupancy from ULBNOC from all utilities having service connections within the building, such as water, electricity, gas, sewer and other connection before demolition of any building.







### International environmental codes

Several international environmental regulatory frameworks will be guiding European environment until 2020<sup>5</sup>. The programme entered into force in January 2014 and helps to protect, conserve and enhance the natural capital.

Other environment policies such as air pollution, land degradation, noise pollution, soil contamination, waste disposal and protection of water resources are also considered under the European regulatory framework.

Also, multilateral banks such as the World Bank and the Asian Development Bank, have guidance for projects, which wants to ensure the environmental protection.

# **Health and safety**

As mentioned in the Ministry of Labour and Employment of India's webpage<sup>6</sup>, "the Constitution of India provides detailed provisions for the rights of the citizens and lays down the Directive Principles of State Policy which set an aim to which the activities of the state are to be guided. Based on these Directive Principles as well as international instruments, Government is committed to regulate all economic activities for management of safety and health risks at workplaces and to provide measures to ensure safe and healthy working conditions for every working man and woman in the nation".

The Constitution of India has specified provisions for ensuring occupational health and safety for workers in the form of 3 Articles i.e. 24, 39 (e and f) and 42. While the welfare of labour including conditions of work, provident funds, employers' invalidity and old age pension and maternity benefits are in the concurrent list.

The Ministry of Labour, Government of India and Labour Departments of the States and Union Territories are responsible for safety and health of workers, Directorate General of Mines Safety (DGMS) and Directorate General Factory Advice Services & Labour Institutes (DGFASLI) assist the Ministry in technical aspects of occupational safety and health in mines and factories & ports sectors, respectively.

DGFASLI is an attached office to the Ministry of Labour and relates to factories and ports/docks. It renders technical advice to the states/union territories regarding administration and enforcement of the factories act. It also undertakes support research facilities and carries out promotional activities through education and training in matters concerning occupational safety and health.

The statutes relating to OH&S are broadly divided into three:

- Statutes for safety at workplaces.
- Statutes for safety of substances.
- Statutes for safety of activities.

<sup>&</sup>lt;sup>6</sup> Ministry of Labor and Employment of India webpage (www.labour.nic.in)



<sup>&</sup>lt;sup>5</sup> Environment action programme to 2020, European Commission webpage (www.europa.eu)



At present, safety and health statutes for regulating OH&S of persons at work exist only in four sectors:

- Mining.
- Factories.
- Ports.
- Construction.

The Petroleum and Explosives Safety Organization (PESO) under the Ministry of Commerce and Industry (MoCI), Government of India (GoI) is the other nodal agency created to administer the responsibilities delegated under the explosives act 1884 and petroleum act 1934 and the rules made thereunder related to manufacture, import, export, transport, possession, sale and use of explosives, petroleum products and compressed gases.

PESO also provides operational and technical advice and assistance to the central government, states, local bodies, law enforcement agencies, industry, trade and end users of these products.

The major statutes under Occupational Health and Safety (OHS) are:

The factories act, 1948

- It regulates health, safety, welfare and other working conditions of workers in factories.
- It is enforced by the State Governments through their factory inspectorates. The Directorate General Factory Advice Service & Labour Institutes (DGFASLI) co-ordinates matters concerning safety, health and welfare of workers in the factories with the State Governments.
- DGFASLI conducts training, studies and surveys on various aspects relating to safety and health of workers through the Central Labour Institute in Mumbai and three other Regional Labour Institutes located at Kolkata, Chennai and Kanpur.
- Department of Industrial Safety and Health (DISH) has several regional offices across the States. These offices regulate the factories in their region.

In addition to the above, the State Wise Factories Rules in India provide specific requirements and guidance for application of labour welfare, occupational health and safety aspects and penalties & procedures in that State. While these are built in line with the factory Act, they often differ in terms of specific technical requirements and norms based on the policy of the respective State Governments.

The National Safety Council of India (NSCI) was set up to promote safety consciousness among workers to prevent accidents, minimize dangers and mitigate human suffering, arrange programmes, lectures and conferences on safety, conduct educational campaigns to arouse consciousness among employers and workers and collect educational and information data, etc. It has launched new initiatives in three sectors:

- Road transportation safety.
- Safety and health in the construction sector.
- Safety, health and environment in Small and Medium Scale Enterprises (SMEs).



# OHS management during construction, erection and commissioning of solar PV plants

The building and other construction workers (regulation of employment and conditions of service) act 1996 and the CESS act of 1996 (all the establishments who carry on any building or other construction work employs 10 or more workers are covered under this Act; the employer of the establishment (solar park developer) is required to provide safety measures at the construction work site and other welfare measures, such as canteens, first-aid facilities, ambulance, housing accommodation for workers near the workplace, etc.).

The factory act and rules (listed before and explained in Section 4.1.2) do not directly apply to fresh construction sites before commencement as a factory facility.

Key safety aspects under BOCW act, 1996

- 7. Registration of establishments:
  - (1) Every employer shall,
    - (a) in relation to an establishment to which this act applies on its commencement, within a period of sixty days from such commencement; and
    - (b) in relation to any other establishment to which this act may be applicable at any time after such commencement, within a period of sixty days from the date on which this act becomes applicable to such establishment,

Make an application to the registering officer for the registration of such establishment:

Provided that the registering officer may entertain any such application after the expiry of the periods aforesaid, if he is satisfied that the applicant was prevented by sufficient cause from making the application within such period.

- (2) Every application under sub-section (1) shall be in such form and shall contain such particular and shall be accompanied by such fees as may be prescribed.
- (3) After the receipt of an application under sub-section (1), the registering officer shall register the establishment and issue a certificate of registration to the employer thereof in such form and within such time and subject to such conditions as may be prescribed.
- (4) Where, after the registration of an establishment under this section, any change occurs in the ownership or management or other prescribed particulars in respect of such establishment, the particulars regarding such change shall be intimated by the employer to the registering officer within thirty days of such change in such form as may be prescribed.
- 38. Safety Committee and safety officers:
  - (1) In every establishment wherein five hundred or more building workers are ordinarily employed, the employer shall constitute a safety committee consisting of such number of representatives of the employer and the building workers as may be prescribed by the state government:
    - Provided that the number of persons representing the workers, shall, in no case, be less than the persons representing the employer.
  - (2) In every establishment referred to in sub-section (1), the employer shall also appoint a safety officer who shall possess such qualifications and perform such duties as may be prescribed.





### 39. Notice of certain accidents:

- (1) Where in any establishment an accident occurs, which causes death or which causes any bodily injury by reason of which the person injured is prevented from working for a period of forty-eight hours or more immediately following the accident, or which is of such a nature as may be prescribed, the employer shall give notice thereof to such authority, in such form and within such time as may be prescribed.
- (2) On receipt of a notice under sub-section (1) the authority referred to in that sub-section may make such investigation or inquiry, as it considers necessary.
- (3) Where a notice given under sub-section (1) relates to an accident causing death of five or more persons, the authority shall make an inquiry into such accident within one month of the receipt of the notice.
- 40. Power of appropriate government to make rules for the safety and health of building workers:
  - (1) The appropriate government may, by notification, make rules regarding the measures to be taken for the safety and health of building workers in the course of their employment and the equipment and appliances necessary to be provided to them for ensuring their safety, health and protection, during such employment.
  - (2) In particular, and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely:
    - (a) the safe means of access to, and the safety of, any working place, including the provision of suitable and sufficient scaffolding at various stages when work cannot be safely done from the ground or from any part of a building or from a ladder or such other means of support;
    - (b) the precautions to be taken in connection with the demolition of the whole or any substantial part of a building or other structure under the supervision of a competent person and the avoidance of danger from collapse of any building or other structure while removing any part of the framed building or other structure by shoring or otherwise;
    - (c) the handling or use of explosive under the control of competent persons so that there is no exposure to the risk of injury from explosion or from flying material;
    - (d) the erection installation, use and maintenance of transporting equipment, such as locomotives, trucks, wagons and other vehicles and trailers and appointment of competent persons to drive or operate such equipment;
    - (e) the erection, installation, use and maintenance of hoists, lifting appliances and lifting gear including periodical testing and examination and heat treatment where necessary, precautions to be taken while raising or lowering loads, restrictions on carriage of persons and appointment of competent persons on hoists or other lifting appliances;
    - (f) the adequate and suitable lighting of every workplace and approach thereto, of every place where raising or lowering operations with the use of hoists, lifting appliances or lifting gears are in progress and of all openings dangerous to building workers employed;
    - (g) the precautions to be taken to prevent inhalation of dust, fumes / gases or vapours during any grinding, cleaning, spraying or manipulation of material and steps to be taken to secure and maintain adequate ventilation of every working place or confined space;
    - (h) the measures to be taken during stacking or un-stacking, stowing or un-stowing of materials or goods or handling in connection therewith;





- (i) the safeguarding of machinery including the fencing of every fly-wheel and every moving part of prime mover and every part of transmission or other machinery, unless it is in such a position or of such construction as to be safe to every worker working on any of the operations and as if it were securely fenced;
- (j) the safe handling and use of plant, including tools and equipment operated by compressed air;
- (k) the precaution to be taken in case of fire;
- (I) the limits of weight to be lifted or moved by workers;
- (m) the safe transport of workers to or from any workplace by water and provision of means for rescue from drowning;
- (n) the steps to be taken to prevent danger to workers from live electric wires or apparatus including electrical machinery and tools and from overhead wires;
- (o) the keeping of safety nets, safety sheets and safety belts where the special nature or the circumstances of work render them necessary for the safety of the workers;
- (p) the standards to be complied with regard to scaffolding, ladders and stairs, lifting appliances. Ropes, chains and accessories, earth moving equipment and floating operational equipment;
- (q) the precautions to be taken with regard to pile driving, concrete work, work with hot asphalt, tar or other similar things, insulation work, demolition operations, excavation, underground construction and handling materials;
- (r) the safety policy, that is to say, a policy relating to steps to be taken to ensure the safety and health of the building workers, the administrative arrangements therefore and the matters connected therewith, to be framed by the employers and contractors for tile operations to be carried on in a building or other construction work;
- (s) the information to be furnished to the bureau of Indian standard established under the bureau of Indian standards act, 1986 (63 of 1986), regarding the use of any article or process covered under that act in an building or other construction work:
- (t) the provision and maintenance of medical facilities for building workers;
- (u) any other matter concerning the safety and health of workers working in any of the operations being carried on in a building or other construction work.

### 44. Responsibility of employers:

An employer shall be responsible for providing constant and adequate supervision of any building or other construction work in his establishment as to ensure compliance with the provisions of this Act relating to safety and for taking all practical steps necessary to prevent accidents.

# OHS Management during operation and maintenance of solar PV plants

The Indian Factory Act, 1948, specifies in section 7-A the general duties (of care) of an occupier (plant or site owner). These apply to an operating facility (such as a solar PV plant but not a solar park) and any future development on its site.

1. Every occupier shall ensure, so far as is reasonably practicable, the health, safety and welfare of all workers while they are at work in the factory.





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IBF Inter Health,



- a. the provision and maintenance of plant and systems of work in the factory that are safe and without risks to health:
- b. the arrangement in the factory for ensuring safety and absence of risks to the health in connection with the use, handling, storage and transport of articles and substances;
- c. the provision of such information, instruction, training and supervision as are necessary to ensure the health and safety of all workers at work;
- d. the maintenance of all places of work in the factory in a condition that is safe and without risks to health and the provision and maintenance of such means of access to, and egress from, such place as are safe and without such risks;
- e. the provision, maintenance or monitoring of such working environment in the factory for the workers that is safe, without risks to health and adequate as regards facilities and arrangements for their welfare at work.
- 3. Except in such cases as may be prescribed, every occupier shall prepare, and, as often as may be appropriate, revise, a written statement of his general policy with respect to the health and safety of the workers at work and the organisation and arrangements for the time being in force for carrying out that policy, and to bring the statement and any revision thereof to the notice of all the workers in such manner as may be prescribed.

Chapter III on health, under the factory act, 1948 specifies the regulatory requirements involved in the following aspects (along with relevant clause numbers):

<ol><li>Cleanlines</li></ol>	SS.
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- 12. Disposal of wastes and effluents.
- 13. Ventilation and temperature.
- 14. Dust and fume.
- 15. Artificial humidification.

### 16. Over-crowding.

- 17. Lighting.
- 18. Drinking water.
- 19. Latrines and urinals
- 20. Spittoons.

Chapter IV on safety, under the factory act, 1948 specifies the regulatory requirements involved in the following aspects (along with relevant clause numbers):

- 21. Fencing of machinery.
- 22. Work on or near machinery in motion.
- 23. Employment of young persons on dangerous machines.
- 24. Striking gear and devices for cutting off power
- 25. Self-acting machines.
- 26. Casing of new machinery .
- 27. Prohibition of employment of women and children near cotton-openers.
- 28. Hoists and lifts.
- 29. Lifting machines, chains, ropes and lifting tackles.
- 30. Revolving machinery.
- 31. Pressure Plant.
- 32. Floors, stairs and means of access.
- 33. Pits, sumps, openings in floors, etc.
- 34. Excessive weights.

- 35. Protection of eyes.
- Precautions against dangerous fumes, gases, etc.
   a.Precautions regarding the use of portable electric light.
- 37. Explosive or inflammable dust, gas, etc.
- 38. Precautions in case of fire.
- 39. Power to require specifications of defective parts or tests.
- 40. Safety of buildings and machinery:
  - a. Maintenance of buildings.
  - b.Safety officers.
- 41. Power to make rules to supplement this chapter of safety.





In addition to the above, the State Wise Factories Rules in India provide specific requirements and guidance for application of labour welfare, occupational health and safety aspects and penalties & procedures in that State. While these are built in line with the factory Act, they often differ in terms of specific technical requirements and norms based on the policy of the respective State Governments in India.

Below there is a list of regulatory requirements that are applicable but not limited to the health and safety management in the Solar PV Sector. Nevertheless, it is recommended to prepare specific site based regulatory requirement about HSE in Solar Power Parks based on these framework and international references:

Table 3 Occupational health and safety (OHS) regulation for solar PV parks

Sr.No.	Act / Rules	Purpose	Applicability to solar parks	Relevance to solar PV projects	Responsible
1	Factory act, 1948 and State-wise factories rules (as applicable).	To regulate the manufacturing sites on licensing of operations, OHS, Labour welfare and governance.	Applies only to individual solar PV projects (not to parks).	Individual solar PV projects could be defined as a manufacturing process as they generate and transmit Power.	Regulated by state level DISH offices.
2	Building and other construction workers (regulation of employment and conditions of service) act, 1996.	It regulates the employment and conditions of service of building and other construction workers and provides for their safety, health and welfare.	$\bigcirc \times$	This will be applicable if any building or other construction works and employs 10 or more workers.	District labour commissioner and buildings inspector.
3	Building and other construction workers welfare CESS act, 1996.	An Act to provide for the levy and collection of a CESS on the cost of construction incurred by employers.	$\bigcirc \times$	Sub-projects will involve construction workers.	District labour commissioner.
4	Central motor vehicle act, 1988.	To check vehicular air and noise pollution.	$\bigcirc \times$	This rule will be applicable to vehicles deployed for construction activities and construction Machinery.	Motor vehicle department.
5	Indian electricity acts of 1910 and 2003 <sup>7</sup> .	To regulate activities related to construction, installation, protection, operation and maintenance of electrical supply lines and equipment.	$\bigcirc$ $\otimes$	Installation of electrical equipment including substations, switchyards, solar panels, wiring and related works requires compliance with IER. Health and safety aspects involved in such activities are also addressed.	
6	Explosive act, 1984.	Safe transportation, storage and use of explosive material.	$\bigcirc$ $\times$	For transporting and storing diesel, oil and lubricants etc.	
7	Gas cylinder rules, 2016.	Stipulates conditions on import, transport, storage, use, filling and possession of any compressed gas cylinders so as to reduce associated risks and hazards to the environment, health and safety.	$\checkmark$ ×	Various compressed gases will be required for metal cutting and welding during construction activities.	



<sup>&</sup>lt;sup>7</sup> The 2003 version is an umbrella act that covers generation of electricity as well, whereas the 1910 version focussed on supply (transmission and distributuon) of electricity.





Sr.No.	Act / Rules	Purpose	Applicability to solar parks	Relevance to solar PV projects	Responsible
8	Workmen compensation act, 1923.	It provides for payment of compensation by employers to their employees for injury by accident i.e. personal injury or occupational disease.	$\bigcirc \otimes$	Construction workers will be involved in the sub-projects.	District labour commissioner.
9	Employers liability act, 1938.	It was enacted (during British India) with an object to declare protection for Workmen who file suits for damages for injuries sustained by them (or death of the workman), against certain defences by the employer.	$\bigcirc \times$	Workers involved in construction and operational maintenance in solar parks and related installations.	
10	Inter-state migrant workers act, 1979.	It protects workers whose services are requisitioned outside their native states in India. Contractors who employ or who employed five or more Inter-State migrant workmen need to obtain registration under this act.	$\bigcirc$ $\times$	Construction workers involved in the solar park projects.	District labour commissioner.
11	The child labour (prohibition & regulation) amendment act, 2016.	It prohibits employment of children in certain specified hazardous occupations and processes and regulates the working conditions in others.	$\bigcirc$ $\otimes$	Construction workers will be involved in the sub-projects.	District labour commissioner.
12	Minimum wages act, 1948.	Payment of minimum rate of wages as fixed and periodically revised by the state government.	$\bigcirc$ $\otimes$	Construction/daily wage workers will be involved in the sub-projects.	



# International H&S standards and codes

The European agency for safety and health at work is the agency that collects analyses and disseminates relevant information in safety and health at work<sup>8</sup>. The EU has a wide variety of measures in this field based on Article 153 of the treaty on the functioning of the European Union.

The EU strategic framework on health and safety at work 2014-2020 defines key strategic objectives with a view to reducing occupational accidents and diseases in the EU. The European Directive 89/391 EEC guarantees minimum safety and health requirements. It is in accordance with International Labour Organization (ILO) convention No. 155 and establishes appropriate preventive measures to make the work safer. Also, it defines the principle of risk assessment in order to eliminate risk at source.

In 2004, the European Commission issued a communication COM 62/2004 for implementing the provisions of several directives including the mentioned 89/391 and the following: 89/654 EEC (workplaces); 89/655 EEC (work equipment); 89/656 EEC (personal protective equipment); 90/269 EEC (manual handling of loads); and 90/270 (display screen equipment).

There are also several EU guidelines and standards such as "exposure to physical hazards" or "exposure to chemical agents and chemical safety" that may be relevant for some solar power technologies.

EU-OSHA is the European Union information agency for occupational safety and health.



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<sup>8</sup> European agency for safety and health at work's webpage (https://osha.europa.eu/en/safety-and-health-legislation)

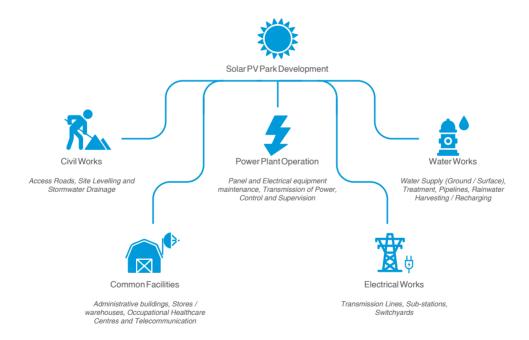
# **Documenting information for solar parks**

This section presents the key information that needs to be documented for operational purpose and future reference.

# Description of project

The principal areas of working during the construction, commissioning, operation and maintenance of the solar park could be defined and explained in categories as listed below:

- Access roads, site preparation and storm-water drainage Civil works.
- Transmission lines, electrical substations and switchyards Electrical / mechanical works.
- Water supply, treatment and pipelines Water works.
- Auxiliary facilities (administrative buildings, stores / warehouses, occupational healthcare centres and telecommunication) - Common building facilities.
- Solar PV power plant Operation of facility.



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Figure 5 Typical components of a solar park project







Each site should document the general description of the proposed site works and components of the activities to be carried out as explained in the sections below.

### Location and layout

It is necessary to indicate in this section the geographical location of the works and the impact affected area. Location will be indicated using UTM or GPS coordinates.

Two drawings shall be included on this section,

- Location site map and the surrounding land-use indicating the potential HSE impact area; and
- Engineering layout of the project area showing primary and ancillary components of the project

As per the factory act, each factory facility (individual units of solar PV projects within the park) will have to submit the final layout (as built) and detailed drawings of their sites to the local DISH office (based on the factory rules issued by the state) along with an application in relevant format for a factory license.

### Construction schedule and staff strength

In this section, the completion time of the works and the work schedule shall be indicated, referring to the phases mentioned in the previous section.

The number of estimated workers that will be involved in the execution of works shall be mentioned. The number of staff in any phases is also necessary to be considered during the health and safety analysis and, for that reason, shall be indicated.

The skills and position of workers shall be also indicated in this section.

### Information of contractors and subcontractors

All contractors and/or subcontractors that will participate in the works shall be indicated and, moreover, the scope of work of each of them. Any subcontractor shall prepare a list of workers involved during the execution of their respective works.

Contractors, having more than the stipulated number of permanent employees, need to possess the relevant license under the BOCW act and rules as mentioned in the Table 3.

Subcontractors shall prepare a health and safety manual for their works based on this guidance manual.

Subcontractors shall prepare an environmental evaluation of their works, which shall be subject to the environmental impact assessment.



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# Functional project organization chart, roles and responsibilities

A functional organization chart of site works shall be prepared, indicating the overall structure, functional responsibilities of each position and reporting hierarchy.

It is recommended to define the FEHSMS in this organization chart.

Specific roles and responsibilities related to ESH will be identified in the manual for various stakeholders and staff (such as site in-charge, department heads, EHS head and coordinators, first-aiders, fire-fighters, doctors in OHC, etc.) that are involved in the project.

Employees and visitors, should be generally responsible for:

- Following all the safety and health rules and practices of the FEHSMS and safety and health programs.
- Monitoring and reporting to their supervisor (or designee) any unsafe conditions for prompt correction.
- Correcting any hazard that they can correct and report that event to the applicable supervisor (or designee).
- Providing feedback to their applicable supervisor (or designee) regarding the need for additional controls to ensure safety and health standards are met.
- Setting the example as a leader in occupational safety and health to others during their professional duties.
- Avoiding exposure to any recognized uncontrolled hazard; and
- Participating meaningfully in FEHSMS activities.

### Climate and rainfall

The site contractor and/or subcontractor will collect the following data. If there is official current information of climate in the area, provided by India Meteorological Department (IMD) or local weather stations near the site, it should be included. Seasonal and diurnal variations should be factored in this information to provide a holistic picture.

The Indian Meteorological Department (IMD) is also the designated government agency under the Ministry of earth sciences in charge of taking meteorological observations to provide current and forecast weather / climate / earthquake information for optimum operation of weather sensitive activities such as agriculture, irrigation, shipping, aviation etc.

IMD also warns about extreme weather phenomena such as tropical cyclones, heavy rains, dust storms, etc.



The climate and rainfall data is important for the health and safety analysis and it must be as authentic and reliable as possible so that predictions made are realistic.

## Table 4 Climate factors

Climate phenomena	Relevant aspects and parameters
Maximum and minimum temperatures.	The maximum, minimum and average temperature and humidity of the site.
Wind and cloud cover.	The maximum, minimum and average wind speeds, directions and cloud cover at the site indicating seasonal / monthly variations based on past trends.
	The number of rainy days on a monthly and annual basis including average precipitation in mm.
Rain, flooding and storms.	It is important to note that working over and around water presents special dangers. Precautions specifically developed for such construction work must be addressed before work is commenced.
Sand and dust storms.	In case of sandy sites, the presence of sand / dust storms or any other kind of sand phenomena.
Other weather phenomena.	Any other kind of extreme climatic consideration (such as flash floods, hurricanes, tornadoes etc.) to be taken into account.





# **Geological Conditions**

The Building Materials and Technology Promotion Council (BMTPC) formed under the Ministry of housing and urban poverty alleviation, government of India published a hazard vulnerability atlas for the country in 1997, which was revised in 2001.

The atlas identifies vulnerable areas across the country based on natural hazards such as earthquakes, wind / cyclones and floods and provides state wise hazard maps and district wise risk tables. A technical guidance is also included for land use zoning and design guidelines for improving hazard resistant construction of buildings and structures.

In the context of solar parks, the atlas could be referred to identify potential vulnerabilities in the proposed areas and plan / design infrastructure in order to protect it as well as avoid damage to adjoining areas in the event of a natural disaster.

If potential hazards are identified for a particular site area for solar park development, they shall be mentioned in the following sections under the respective hazard.

### Seismic activity

The IMD has carried out an earthquake zoning of the country and the seismic category for the site where the solar park works will be executed shall be mentioned in this section, indicating the possibility of earthquakes and their frequency.

The site safety staff will determine the implementation of emergency procedures during an earthquake event. In case of an earthquake, the minimum actions **to be done** are the following:

- Follow the instructions of the designated official and emergency personnel;
- Remain calm;
- Take cover under a desk, in a doorway or in the centre interior of the building, or sit down against an interior wall (in covered areas);
- Stay clear of windows, bookcases, file cabinets, storage racks and similar items (in covered areas);
- Switch off all electrical equipment; and
- If an evacuation is signalled, follow your escape route to the closest available stairwell, exit the building, and proceed to your agency's designated safe assembly area.

In case of an earthquake, the actions not to be done are the following

- Use of telephones;
- Use of any electrical or mechanical devices;
- Use of lifts / elevators (if any);
- React in a manner that may cause undue panic or alarm;
- Stand near windows (in covered areas);
- Use of matchbox to illuminate area, in case of power failure; and





Panic, if you are stuck in an elevator. Emergency personnel will take action to remove passengers from inoperative elevators (if any).

### Flooding areas

A topographic survey is recommended for each site depending on the terrain and surround natural environment. The survey will indicate natural drainage elements in the site area and identify low lying areas that are prone to flooding during monsoon or flash floods.

If a solar park is within a flooding zone, it shall be indicated and marked in the site layout drawings. The designated official will determine the implementation of emergency procedures during a flooding event.

In case of flooding, the following minimum actions should be done:

- Follow the instructions of the designated official and emergency personnel;
- Remain calm;
- Stay in an upright position; and
- Turn off all electrical / mechanical equipment;

In case of flooding, the following actions should not be done:

- Use of telephones;
- React in a manner that may cause undue panic or alarm;

Local civic administration such as the urban municipal council (if the site comes under one) generally issues instructions for alerts on flash floods and managing the flood situation including disaster management.

### Water resources

Water resources (surface or ground based) to be used as source of water for the project (construction as well as operational phases), shall be identified in the planning phase, prior to the construction of the solar park. It is necessary to evaluate how the usage of this water will affect competing users (local villages, other infrastructure projects, etc.) in the surrounding areas.

The means for obtaining water shall be described in this section. It is necessary to indicate a water resource evaluation which provides a detailed and immediate "to-do list" for a facility to optimize and ensure regulatory compliance of its water and wastewater systems.

Regulatory approvals will be required if water is to be sourced from surface water bodies (irrigation department) or ground water reserves (state ground water authority or CGWA), as highlighted in the Table 2.

# Risk analysis

A list of relevant risk analysed by the promoter will be included as executive summary.



# Temporary facilities in construction phase

Basic temporary facilities that are to be provided (typically in a labour camp or housing camps as well as work areas) during the construction phase are included in this section. The requirements mentioned under the Factory's Act, 1948 and respective State Factory Rules could be used for guidance (as these are not mandated for construction sites).

Table 5 Temporary facilities during construction phase

SANITARY FA	SANITARY FACILITIES					
$\bigcirc$ X	Changing room facilities with seats and lockers.					
$\bigcirc$ X	Washbasins with cold water.					
$\bigcirc$ X	Showers area with cold or hot water according to local weather.					
$\bigcirc$ X	Toilets (urinals and latrines), mobile urinals may also be required at various work areas, if the construction site is very large.					
$\bigcirc$ X	Other:					
NOTES: Any c	other consideration to be taken into account.					
TEMPORARY	ACCOMMODATION (Chapter V of Factory Act, 1948 and respective State Level Factories Rules)					
$\bigcirc$ X	Rooms with bed and wardrobe.					
$\bigcirc$ X	Washbasins with hot water.					
$\bigcirc$ X	Showers with cold and hot water according to local weather.					
$\bigcirc$ X	Toilets (separate for Gents and Ladies).					
$\bigcirc$ X	Septic tanks for treatment of sanitary wastewater.					
NOTES: Any o	other consideration to be taken into account.					
CANTEENS (C	Chapter V of factory act, 1948 and respective state level factories rules)					
$\bigcirc$ X	Canteen with kitchen.					
$\bigcirc$ X	Dining area with tables and benches.					
$\bigcirc$ X	Appliances (dispensing machines for drinking water / tea / coffee, refrigerator, etc.).					
$\bigcirc$ X	Wash basins and toilets.					
	Others:					
NOTES: Any o	other consideration to be taken into account.					
• • • • • • • • • • • • • • • • • • • •						











# Medical facilities during operational phase

The site should have relevant first aid infrastructure indicated in the following table, which also includes the identification and the distances to the closest health care centres:

FIRST AID AND MEDICAL ASSISTANCE (Chapter V of factory act, 1948 and respective state level factories rules)

LEVEL OF ASSISTANCE	NAME AND LOCATION	APPROX. DISTANCE (km)
Occupational health care centre or first aid centre.		
Access to primary healthcare centre or local hospital (emergency).		
Access to specialized assistance (specialty hospital).		
NOTES: Any other consideration to be ta		

# Machinery

Expected machinery used in the execution of the works are shown in the attached table:

EXPECTED MACHINERY (Chapters IV and IV-A of Factory Act, 1948 and respective State Level Factories Rules)

Lifting equipment such as hoists, cranes, lifts, chain pulley systems.





Concrete mixer.

Forklifts.



Pallet trucks.

Earth-works machinery (JCB).





Winches.

Circular saw.





Others:

NOTES: Fencing of machinery, Work on or near machinery in motion, Pressure plants, Protection of eyes, Dangerous fumes, Safety of buildings and machinery







# Auxiliary means

Indian law does not specify requirements for scaffolding and support structures during construction. Many construction companies and contractors however, have their internal procedures for design / material of construction, erection, use and dismantling of scaffolds.

The minimum that every site should follow in terms of a safe practice is to ensure that scaffolding structures erected on site are inspected and approved (displayed using scaffolding tags) before use, by designated engineers so that they are safe to access and use for the given purpose of the work. Similarly dismantling of scaffolds should be carried out with proper methodology that is risk assessed and mitigated suitably.

### Description of HSE management and capacity development

For each site area, it is useful to define and implement a Site Environment, Health and Safety Management System (SEHSMS) in addition to the document on description of site works, explained above.

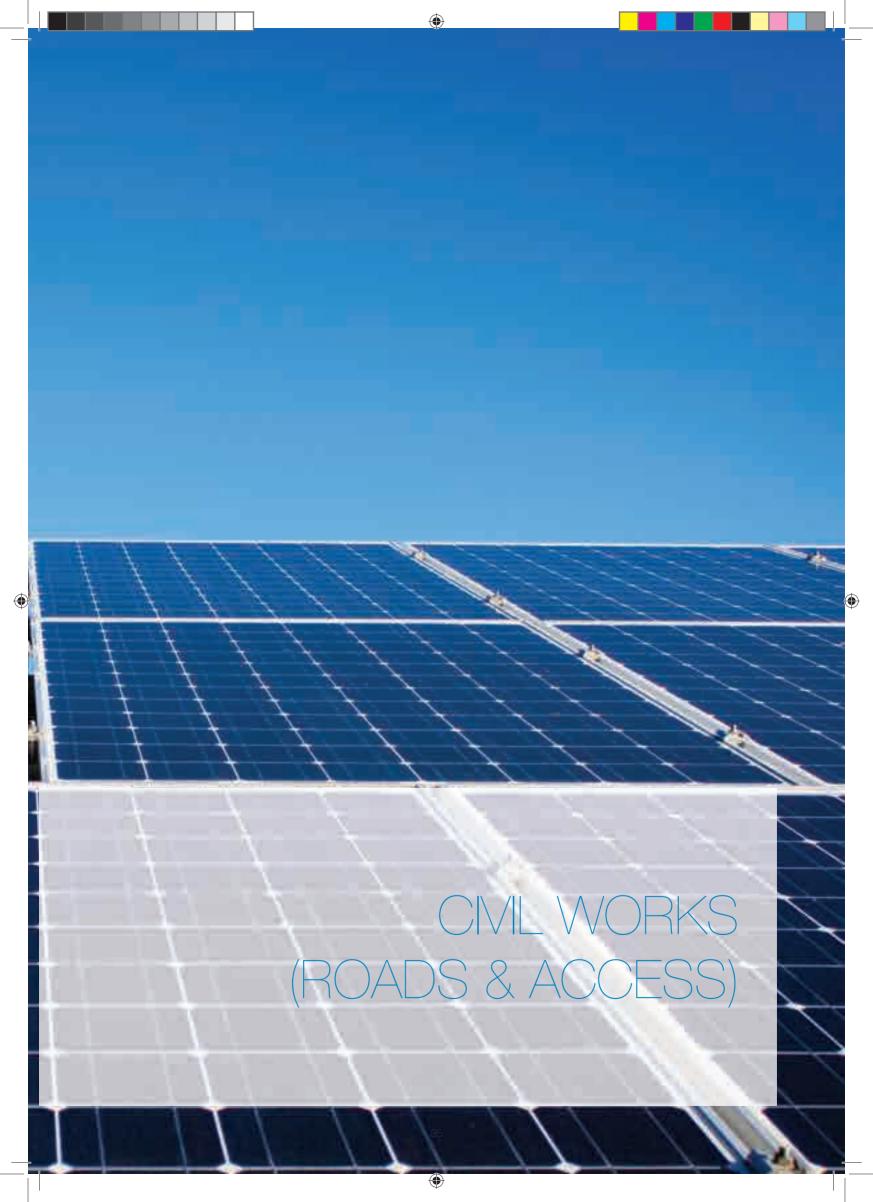
The development, implementation, and evaluation of this SEHSMS shall be a cooperative effort between solar park staff and contractors to prevent injuries, illnesses, and death from work-related causes and minimize losses of material resources.

This SEHSMS establish and document the framework of a continuing process for providing environmental, occupational safety and health guidelines and information to all personnel. The SEHSMS will include a site-specific environment health and safety guidance for the project. The SEHSMS will indicate the roles and responsibilities of personnel for the site works.

The Environmental Impact Assessment (EIA) should cover all the relevant areas. The preparation of this assessment shall be done according to the applicable Indian environmental standards and codes as explained in this manual. The purpose of this EIA is to define a general framework for environmental management. As mentioned earlier, a prior EC requirement has been exempted for individual solar PV projects in India, however a prior EC may be necessary for the solar park. In case a prior EC is required a consultant approved under the National Accreditation Board for Education and Training (NABET) will have to be engaged and the EIA process will have to be followed.













The construction of large facilities such as solar parks on land require several stages of activities such as site preparation, levelling and vegetation clearing, alteration of drainage channels, material lay down, labour camps, construction yards, excavation and earth work, civil and structural work, mechanical and electrical works, laying of pipelines, cables etc.

In case of land areas that are on a complex terrain and difficult topography, the activities are often complicated and require advanced technology and equipment. Rocky areas may need blasting or massive excavation.



Figure 6 Typical environmental impacts of construction

The clearing and usage of large areas of land for solar power facilities can adversely affect native vegetation and wildlife in many ways, including loss of habitat; interference with rainfall and drainage; or direct contact causing injury or death or poaching due to better access to locals. The impacts are exacerbated when the species affected are classified as sensitive, rare, threatened or endangered (as per red list classification, IUCN).

# **General information**

The manifestation of an adverse environmental impact varies with the location of a project and its environmental setting. Variables of environmental setting that typically influence impacts, are listed below:

- Baseline environmental quality of the area.
- Meteorology i.e. rainfall, temperature, relative humidity, wind speed & direction, mixing height, inversion conditions.
- Topography.
- Drainage pattern.
- Proximity to water bodies like rivers/ streams, ponds/ lakes/ reservoirs.
- Proximity to sensitive receptors like hospitals and schools.
- Vulnerability to hazards such as cyclones, earthquakes, flooding.





- Proximity to national parks, wildlife sanctuaries, reserved forests, notified ecologically sensitive zones, core zone of biosphere reserves, important bird areas, mangroves, coastal zones, estuaries, backwater, Ramsar sites.
- Proximity to designated archaeological sites.
- Whether the project is in or near any critically polluted area.
- Located in mountainous area (elevation above 1000 m).

Other factors can exacerbate the impacts based on local conditions. For instance, a large solar park project located near a reserve forest, whose construction period spans across 1-3 years may lead to deforestation due to hacking of trees by labour for fuel wood. Similarly, temperature inversions during winter can exacerbate air quality problems (particulates emitted due to vehicular movement) by trapping pollution near the ground.

## Site access

The construction of access roads will affect the local environment conditions. The roads will be included in the area affected by the construction of the solar park.

It is anticipated that during the construction phase of the project, road traffic to and from the site will increase over a brief period. It is expected that the major impact will be on the road, which links the highways and national roads to the site. The noise, dust and exhaust gases of cars and trucks will reach an increased level, which will be directly attributable to the civil and construction activities.

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- The impacts are generally temporary (depending on the schedule of works).
- ♦ The impacts can be assessed as slight or intermediate in severity and irreversible.

Approval from gram (village) Panchayat is often required in India for developing access roads through lands in rural areas.



# Raw material and conditioning

The impacts on soil (surface and ground) by the solar park can be described as follows:

Impacts from fuel: during the civil works, machinery will use diesel or gasoline as primary fuel. Diesel or gasoline, however, has a high potential for contaminating the soil and the ground (incl. ground water) once it has penetrated the soil surface. It also leads to emissions, impacting the ambient air quality in the local area.

Sr.No.	Machines	Fuel consumption (litres/hour)
1	Cement concrete mixer	7
2	Cranes with clamshell bucket	8
3	Generator	30
4	Truck	8
5	Bulldozer	20
6		12
7		20
8		20
9	Dumps, trucks & tippers	18
10	Water tanker	8
11		12

Respective measures should be taken so that the impacts from the fuel on the ground are minimized, e.g.:

- Clean work without oil dripping or
- Appropriate measures to avoid the oil leaks from sealed surfaces into the ground.

During the construction of roads, a part of the soil will be sealed and compacted. The sealing will lead to a reduction of the soil surface available for rainwater infiltration.

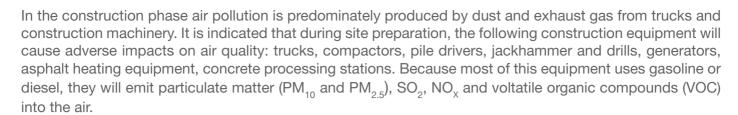
Storages of petrol (class A petroleum) and diesel oil (class B petroleum) beyond certain threshold quantities require an approval from the Chief Inspector of Explosives (CCOE) under the Petroleum and Explosives Safety Organization (PESO) in India. The storage area and boundary along with safety requirements are specified by the CCOE in the license.

# **Atmospheric pollution: emissions**

During the construction phase of the solar park and associated civil works, the following impacts are to be expected:

- Temporary increase in air pollution from the construction site, from construction materials utilized on site and from the transportation of construction materials.
- ♦ Temporary noise and vibration pollution produced by construction equipment.





The major air pollutant during the construction phase will be dust produced by earth works (excavation, filling, levelling, material hauling), particularly during the dry season. Receptors, which can be affected, are areas surrounding the construction sites, as well as houses and buildings located at a distance of approximately 200 m (non-regulatory best practice) from the construction site (in directions depending on the prevalent wind patterns). However, as the impairment is limited to the construction phase, the additional impact of air pollution on these types of receptors is intermediate.

Mitigation plan: Air pollution during the construction phase (mainly during civil work activities) may occur mainly due to dust emission. For dust emissions, the recommended pollution prevention and control techniques should take the ecological and human toxicity of the dust into account and include the following:

- Land clearing, removal of topsoil and excess materials, location of access roads, tips and stockpiles, and blasting should be planned with due consideration to meteorological factors (precipitation, temperature, wind direction and speed) and location of sensitive receptors.
- A simple, linear layout for materials-handling operations (earth moving and excavations) to reduce the need for multiple transfer points should be designed and installed (batch mixing and processing plants should ideally be located within the quarry area, where practical).
- Dust emissions from drilling activities should be controlled at the source by dust extractors, collectors and filters and wet drilling and processing should be adopted whenever possible.
- Dust emissions from processing equipment (crushers, grinders, screens) should be adequately controlled through dust collectors or wet processing (water spray based).
- Procedures to limit the drop height of falling materials should be adopted.
- Internal roads should be adequately compacted and periodically graded and maintained.
- A speed limit for trucks should be considered (generally not more than 10 miles per hour or 16 km per hour) on unpaved roads.
- Water spraying is the most effective method for reducing dust emissions.
- Along with water spraying, surface treatment such as provision of hygroscopic media, such as calcium chloride and soil natural or chemical binders) of roadways and exposed stockpiles using a sprinkler system or a water mist cannon should be implemented.
- Exposed surfaces of stockpiled material should be vegetated where practical.



# Land and water pollution: effluents and corrective actions

The rainwater drainage systems to be designed will be based on the long-term data on rainfall (e.g. over the previous ten years) to ensure adequate and sufficient drainage.

The sanitary and other water-consuming installations during construction should be selected, maintained and operated in a way that the water consumption will be minimized.

Mitigation plan: The measures for the protection of ground water and soil quality during the construction phase should comprehend, but not be limited to:

- Disposal of solid waste (construction waste, sand, stone etc.) and waste grease and oil from construction equipment to the soil and local ground water will be prevented. All the waste will be collected and transported to the approved disposal sites.
- Installation of adequate sanitation systems (for example mobile toilet facilities) for workers to prevent untreated or inappropriate domestic wastewater discharge.

A positive impact on the protection of ground water and soil quality during the construction phase will be the removal of any materials as old metal, bins and other wastes that may be left around in the area of the solar park.

The local administration in India (ULBs and Gram Panchayat), generally provide guidance on designated locations and procedures to be followed for disposal of construction and demolition waste from project sites.

## Noise: measurement and corrective actions

The assessment of the noise impact is based on the national Indian maximum allowable noise levels and the World Bank noise standards.

- World Bank's ambient noise standard for commercial areas are as follows:
  - ◆ 7AM 10PM 70 dB(A)
  - ◆ 10PM 7AM 70 dB(A)
- World Bank's ambient noise standard for residential areas are as follows:
  - 7AM 10PM 55 dB(A)
  - ◆ 10PM 7AM 45 dB(A)





The maximum allowable noise levels and the permissible noise exposure standards shall be according to national Indian guidelines, which are indicated in the Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof:

A	Cotoron of analysis	Limits in dB(A) Leq <sup>9</sup>		
Area code	Category of area/zone	Day time	Night time	
(A)	Industrial area	75	70	
(B)	Commercial area	65	55	
(C)	Residential area	55	45	
(D)	Silence zone	50	40	

Table 6 Indian ambient noise quality standards

#### Notes:

- 1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
- 2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
- 3. Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area, which is declared as such by the competent authority,
- 4. The state pollution control board or equivalent competent authority may declare mixed categories of areas as one of these four categories.

During the construction phase temporary noise emissions may be caused by:

- Construction equipment.
- Concrete mixing plant.
- Pile driving for construction.
- Rock blasting and drilling.
- Earth moving activity.
- Generators.
- Vehicles used for material transport.

<sup>&</sup>lt;sup>9</sup> dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing. A "decibel" is a unit in which noise is measured. "A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear. Leq is the mean energy level over a specified period.



For most of the above-mentioned construction equipment the noise level in 15 m distance will be in a range of 70 to 90 dB(A). The noise level at further distance can be determined using - 6 dB(A) every time distance is doubled and there is no obstacle. Thus, the maximum level will be 84 dB (A) at 30 m, 78 dB (A) at 60 m, 72 dB (A) at 120 m, 66 dB (A) at 240 m and 60 dB (A) at 440 m. Since the residential areas are in distance of less than 1000 m to the construction site, the noise impact will be within an acceptable level (according to World Bank guidelines) only if the maximum noise level of the equipment used will not reach the 80 dB (A).

Operator or Task	Range dBA	Mean TWA. dBA
Heavy-duty bulldozer	91-107	97
Vibrating road roller	91-104	97
Light-duty bulldozer	93-101	96
Asphalt road roller	85-103	95
Whell loader	87-100	94
Asphalt spreader	87-97	91
Light-duty grader	88-91	89
Power shovel	80-93	88
Labourers	78-107	90
Crawler crane, 35 ton.	78-90	85
Rubber tired cane 35 ton.	75-85	81
truck-mounted crane	76-83	79
tower crane	70-76	74

•••••		
Trade, Activity or Equipment	Range dBA	Average dBA
Carpenter	82-94	90
Mason	84-97	91
Rebar worker	91-97	95
Steel stud installer	85-104	96
Pneumatic chipper/chisel	93-113	109
Compactor	91-110	108
Hoist operator	96-104	100
Laborers - concrete pour	84-103	97
Electric drill	97-106	102
Dozers, dumpers	89-103	96
Front end loaders	87-92	90
Scrapers	84-102	97
Mobile cranes	95-102	98
Man lift	102-104	103
Pavers	84-92	90
Bar benders	94-96	95
Pneumatic breackers	94-111	103
Hydraulic breackers	90-100	96
Pile drivers (diesel)	82-105	94
Gravel plant	88-106	102

Figure 7 Typical noise emissions from construction equipment (sourced from various references)

Noise from Backup Power Generators (DG Sets):

Engine noise – This is mainly caused by mechanical and combustion forces and typically ranges from 100 dB(A) to 121 dB(A), measured at one meter, depending on the size of the engine.

Cooling fan noise – This results from the sound of air being moved at high speed across the engine and through the radiator. Its level ranges from 100 dB(A) to 105 (A) dB at one meter.

Alternator noise – This is caused by cooling air and brush friction and ranges from approximately 80 dB(A) to 90 dB(A) at one meter.

Induction noise – This is caused by fluctuations in current in the alternator windings that give rise to mechanical noise that ranges from 80 dB(A) to 90 dB(A) at one meter.

Engine exhaust – Without an exhaust silencer, this ranges from 120 dB(A) to 130 dB(A) or more and is usually reduced by a minimum of 15 dB(A) with a standard silencer.

Structural/mechanical noise - This is caused by mechanical vibration of various structural parts and components that is radiated as sound.





Mitigation plan: To reduce noise during the construction phase appropriate measures shall be taken to comply with local regulations:

- Prohibition of noisy construction activities during the night period.
- Erection of noise barriers around construction sites based on standard guidelines (the noise reduction rating of such barriers should be designed to comply with the ambient noise levels mentioned above).
- Prior information and awareness to local community in case blasting in rock is to be carried out.
- Speed restrictions (@40 kmph) to be applied to heavy material hauling and construction vehicles, which pass through residential areas.

# Environmental impacts during erection, commissioning, operation and maintenance

In the following table the contaminant source, potential for harm and corresponding corrective measures should be indicated for the construction period:

Examples of corrective and migration

Contaminant source	Potential for harm	Examples of corrective and migration measure
Solid waste from labour camps and construction sites.	Irresponsible disposal or burning of solid waste could lead to land degradation, emissions and health impacts.	Solid waste must be minimised, segregated and disposed / recycled (Refer to solid waste management rules, 2016).
	,	Dust must be collected and disposed adequately.
Liquid effluents from construction sites.	Untreated discharges of wastewater can pollute water bodies / land and cause adverse impacts on human health and aquatic ecosystems.	Liquid effluents must be collected and treated in a specific waste treatment plant as applicable based on Consent to Operate (CTO) issued to the Park / Plant.
		(Refer to environment protection rules, 1986).
Dust and air emissions from construction equipment and	Emissions can cause health impacts and visibility	Air pollutants shall be monitored.
activities.	issues.	(Refer to national ambient air quality standards, 2009).
Odours from chemical and fuel handling / storage.	Causes nuisance and unpleasantness.	Unpleasant odours shall be removed or avoided.
Noise from construction	Sustained exposure to high noise levels can cause	Noise levels must be reduced to lower than specified in legislation (Refer to noise pollution (regulation and control) rules, 2000).
activities.	hearing loss in the long term. Short term noise pollution can cause nuisance / disturb animal habitats.	High noise areas should be mandated with personal protective equipment (factories act, 1948 specifies time weighted average levels of exposure (over 8 hours)).
Vibrations due to demolition of structures, blasting / excavation in rock.	Depending on the intensity of the vibrations, they can cause structural damage to buildings as well as disturb animal habitats.	Planning of excavation / blasting activities as well as design of equipment should address this issue. Equipment installations should be undertaken with proper foundation and damping insulation to avoid the transmission of vibrations.
		(No Indian standard available – British standard BS 7385 or German standard DIN 4150 could be used).



Contaminant source	Potential for harm	Examp measu	les of corrective and migration re
		as possi	es shall be used according to specific
Flammable material and	Can cause fires / explosions and result in loss of life as well as habitats.		aterial should be stored with proper care and re infrastructure.
explosives used in rock blasting.		Refer to:	
		<b>\langle</b>	Explosives act, 1984.
		<b>\langle</b>	Manufacture, storage and import of hazardous chemicals rules, 1989.
		<b>\langle</b>	Sections of the factory act, 1948 (14, 38, and 40) and respective state factories rules.

## Post construction activities

Excavation activities at construction sites as well as raw materials extraction sites often involve major topographical and land-cover changes to allow extraction activities, often including clearing of pre-existing vegetation. Techniques to minimize the land conversion impacts include:

- a. Selection of appropriate low-impact extraction methods that result in final site contours supportive of habitat restoration principles and intended land use.
- b. Establishment of buffer zones from the edge of extraction areas considering the characteristics of the natural habitats and the type of extraction activities.
- c. Vegetation translocation and relocation techniques should be used as necessary (e.g., vegetation cover such as native local plants, topsoil, overburden, or spoils feasible for sustaining growth should be removed in separate operations and segregated for later use during site reinstatement and materials to be used for site reinstatement should be stockpiled and protected from wind and water erosion as well as contamination).
- d. Smaller, short-lived sites should be reclaimed immediately and larger sites with a useful lifespan beyond 3-5 years should be subject to ongoing rehabilitation.
- e. To the extent possible the affected land should be rehabilitated to acceptable uses as required by the permit.
- f. Test pits, interim roads, buildings, installations and structures of no beneficial use should be removed, and the land should be appropriately rehabilitated.



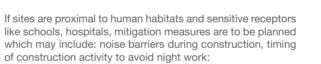
# **Generic environmental mitigation measures**

The Table 7 below presents the mitigation measures for minimizing / controlling environmental impacts described in the above sections. Many of these would need to be included as covenants, in the contractual agreements to allocate specific environmental roles and responsibilities to the construction contractors.

#### Table 7 Environmental mitigation measures

SI.No.	Environmental impact	Proposed mitigation measures	Responsible	
1	Tree cutting.	<ul> <li>Based on the tree survey conducted at the solar park sites, plan access roads, transmission line (new) alignment etc. in order to minimize tree cutting / vegetation removal.</li> <li>Trees shall be removed from the construction sites before commencement of construction with prior permission from the concerned department / authorities.</li> <li>Compensatory plantation by way of re-plantation of at least thrice the number of trees cut should be carried out in the project area, as per regulatory guidelines.</li> <li>Prior permission will have to be obtained for tree cutting from the applicable authorities.</li> </ul>	SPPD / SPD / Contractor.	





- Servicing of all construction vehicles and machinery will be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced.
- Maintenance of vehicles, equipment and machinery shall be regular and up to the satisfaction of the Engineer to keep noise levels at the minimum.
- ♦ Idling of temporary trucks or other equipment should not be permitted during periods of loading / unloading or when they are not in active use. The practice must be ensured especially near residential /commercial /sensitive areas.

Contractor.

Noise pollution from vehicles, construction equipment and other activities.

Pollution / Air emissions

Noise

- All possible and practical measures to control noise emissions during drilling shall be employed.
- Notwithstanding any other condition of contract, noise level from any item of plants must comply with the relevant legislation for levels of noise emission.
- ♦ The contractor will ensure that the ambient air quality at these construction sites is within the acceptable limits of industrial uses in case of hot mix plants and crushers and residential uses around construction camps.

SI.No.	Environmental impact	Proposed mitigation measures	Responsible
3	Severance due to utilities on site / access road.	<ul> <li>All utilities (existing roads, structures, poles, water lines etc.) will be relocated with prior approval of the concerned agencies before construction starts.</li> <li>Prior information to affected people.</li> </ul>	Contractor.
4	Replacement of common amenities on access roads.	♦ All affected common amenities such as community sources of water, bus shelters, cultural / religious properties, etc., will be relocated wherever necessary. The relocation site identification will be in accordance with the choice of the community and completed before construction starts.	SPPD / Contractor.
5	Planning temporary traffic diversion and pedestrian safety.	Where existing roads are passing through park sites a diversion road will be developed with the approval of the local municipality or gram panchayat.	Local authority/ SPPD / Contractor.
•••••		The contractor will ensure that:	
6	Sanitation and sewage system at labour camps and construction yards waste disposal at labour camps and construction yards.	<ul> <li>the sewage system for the camp is designed, built and operated in such a fashion that no health hazard occurs and no pollution to the air, ground water or adjacent water courses take place.</li> <li>separate toilets/bathrooms, wherever required, screened from those from men (marked in vernacular) are to be provided for women.</li> <li>adequate water supply is to be provided in all toilets and urinals.</li> <li>all toilets in workplaces are with dry-earth system (receptacles) which are to be cleaned and kept in a strict sanitary condition.</li> <li>Adequate health care is to be provided for the work force during the entire phase.</li> </ul>	Contractor.
	Waste disposal at labour camps and construction yards.	The contractor will provide garbage bins in the camps and ensure that these are regularly emptied, and the waste is evacuated and disposed in a hygienic manner.	Contractor.
7	Disposal of construction debris and excavated materials.	A suitable site should be identified for safe disposal, in relatively low-lying areas, away from the water bodies etc., as approved by the local authority.	Contractor.
8	Drainage (storm water) flows.	Alternate arrangement like diversion of the drainage (storm water) to be ensured to allow the natural flow of water to downstream areas without water logging / flooding.	Contractor.
9	Temporary flooding due to excavation.	Proper cross drainage arrangements to be made, to avoid the overflowing of existing drains due to excavation during the laying of sewer mains.	Contractor.

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SI.No.	Environmental impact	Proposed mitigation measures	Responsible
10	Dust pollution near settlements.	<ul> <li>All earth work will be protected in manner acceptable to the engineer to minimize generation of dust. Area under construction shall be covered &amp; equipped with dust collector.</li> <li>Construction material shall be covered or stored in such a manner so as to avoid being affected by wind direction.</li> <li>Unpaved haul roads near / passing through residential and commercial areas to be watered thrice a day.</li> <li>Trucks carrying construction material to be adequately covered to avoid the dust pollution and to avoid the material spillage.</li> </ul>	Contractor.
11	Stockyard materials causing impacts.	<ul> <li>Location for stockyards for construction materials will be identified at sufficient distance from water course, hill slopes and labour camps.</li> <li>Separate enclosures shall be planned for storing construction materials containing fine particles, chemicals, flammables etc.</li> </ul>	Contractor.
12	Soil Pollution from fuel and lubricants.	Contractor will ensure that all vehicle/machinery and equipment operation, maintenance and refuelling will be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground. Oil interceptors will be provided for vehicle parking, wash down and refuelling areas as per the design provided.  In all, fuel storage and refuelling areas, if located on agricultural land or areas supporting vegetation, the top soil will be stripped, stockpiled and returned after cessation of such storage.  Contractor will arrange for collection, storing and disposal of oily wastes to the pre-identified disposal sites (list to be submitted to Engineer) and approved by the Engineer. All spills and collected petroleum products will be evacuated in accordance with MoEF and state PCB guidelines.  Engineer will certify that all arrangements comply with the guidelines of PCB/MoEF or any other relevant laws.	Contractor.
13	Pollution from transportation of construction materials.	All vehicles delivering materials to the site will be covered to avoid spillage of materials. All existing roads used by vehicles of the contractor, or any of his sub – contractor or suppliers of materials and similarly roads which are part of the work will be kept clean and clear of dust/ mud or other extraneous materials dropped by such vehicles.  The fall height shall be kept low so that the least amount of dust is airborne, during unloading of materials.  The unloading of materials at construction sites close to settlement will be restricted to daytime.	Contractor.
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SI.No.	Environmental impact	Proposed mitigation measures	Responsible
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14	Pollution from construction wastes.	The contractor shall take all precautionary measures to prevent the wastewater generated during construction from entering into streams, water bodies or the irrigation system. All waste arising from the project is to be disposed off in the manner that is acceptable by the engineer.	Contractor.
15	Restoring temporary access roads.	Post construction of solar park sites, restore the access roads to pedestrian safe use condition.	Contractor.
		Implement measures to prevent and mitigate impacts of air and noise pollution.	
		Training of workers on safe construction practices.	
		Maintain good housekeeping in the construction area.	
		Barricade excavated areas.	
		Implement work permit system for work at height.	
	Occupational health and safety of	Provide training to construction workers on safe work practices.	
16	workers.	Record and investigate injuries to workers.	Contractor.
		Provide PPE to construction workers:	
		<ul> <li>Safety shoes, hard hat/ helmet and hand gloves with grip facility to all workers</li> </ul>	
		<ul> <li>Nose masks for those working in dusty areas</li> </ul>	







• Face shield for those engaged in welding

• Earplugs for those working in high noise areas



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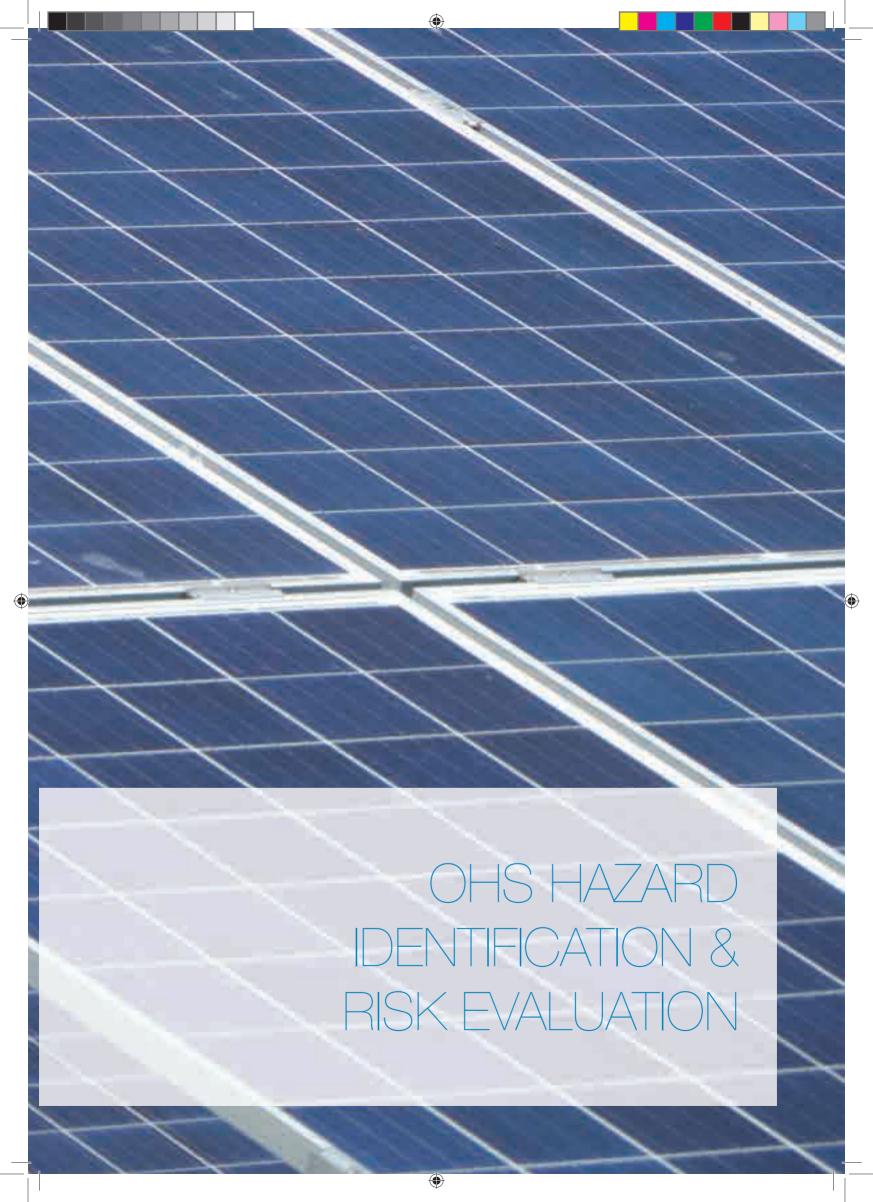


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## **OHS** hazards

Hazards and risks often decide the occurrence of incidents and their resulting consequences. Then typical hazards and risks of a construction site are listed below.

Table 8 Common OHS hazards and risks on construction sites



#### Common OHS hazards

Object striking person.

Person striking object.

Fall on same or another level.

Caught between part of body or clothing.

Exposures - inhale, ingest, contact, hear.

Excessive force causing ergonomic issues.

Repetitive activity causing ergonomic issues.

Unsafe act.

Unsafe condition.

Event.

Fire, flood, earthquake.



#### Common unsafe acts

Failure to follow instructions of proper job procedure.

Cleaning, oiling, adjusting, or repairing equipment that is moving, electrically energized, or pressurized.

Failure to use available personal protective equipment such as gloves, goggles, hard hats.

Failure to wear safe personal attire.

Failure to secure or warn.

Improper use of equipment.

Improper use of hands or body parts.

Making safety devices inoperable.

Operating or working at unsafe speeds.

Taking unsafe position or posture.

Unsafe placing, mixing, combining.

Using tools or equipment known to be unsafe.

Driving errors.



#### The potential injuries from jobsite hazards may include:

- Severe / traumatic / massive head / brain / skull injuries.
- Broken/fractured / shattered bones.
- Spinal injuries.
- Punctured lungs.
- Internal organ injuries.
- Electrocution.
- Death.

- Burns.
- Heatstroke.
- Severe cuts or lacerations.
- Serious back or neck injures.
- Puncture injuries from falling onto items.
- Eye injuries.
- Strains and sprains.

Once the jobsite evaluation is carried out and identified where and how work is being performed, associated OHS hazards and risks would need to be evaluated. The annexure I discusses how to evaluate and reduce the risks associated with the identified hazards by eliminating and controlling the hazard situation.



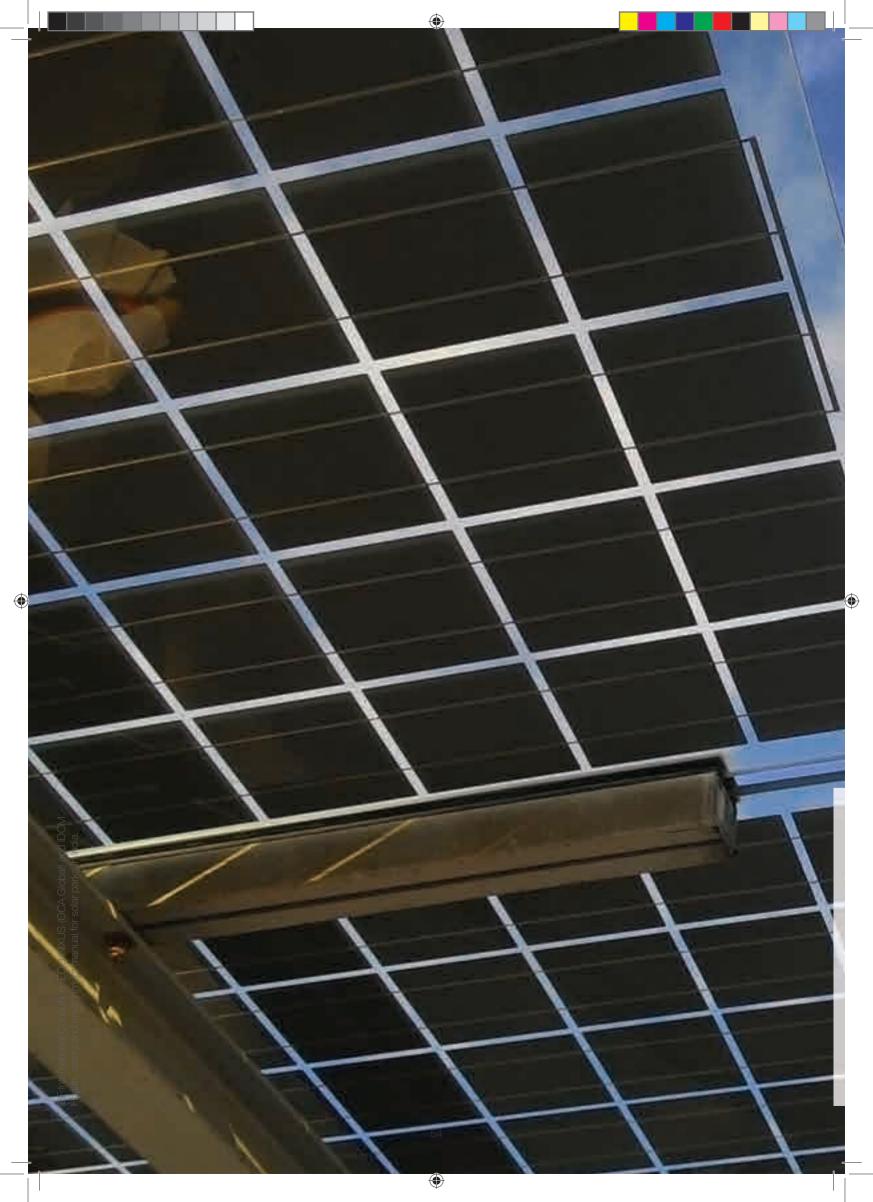


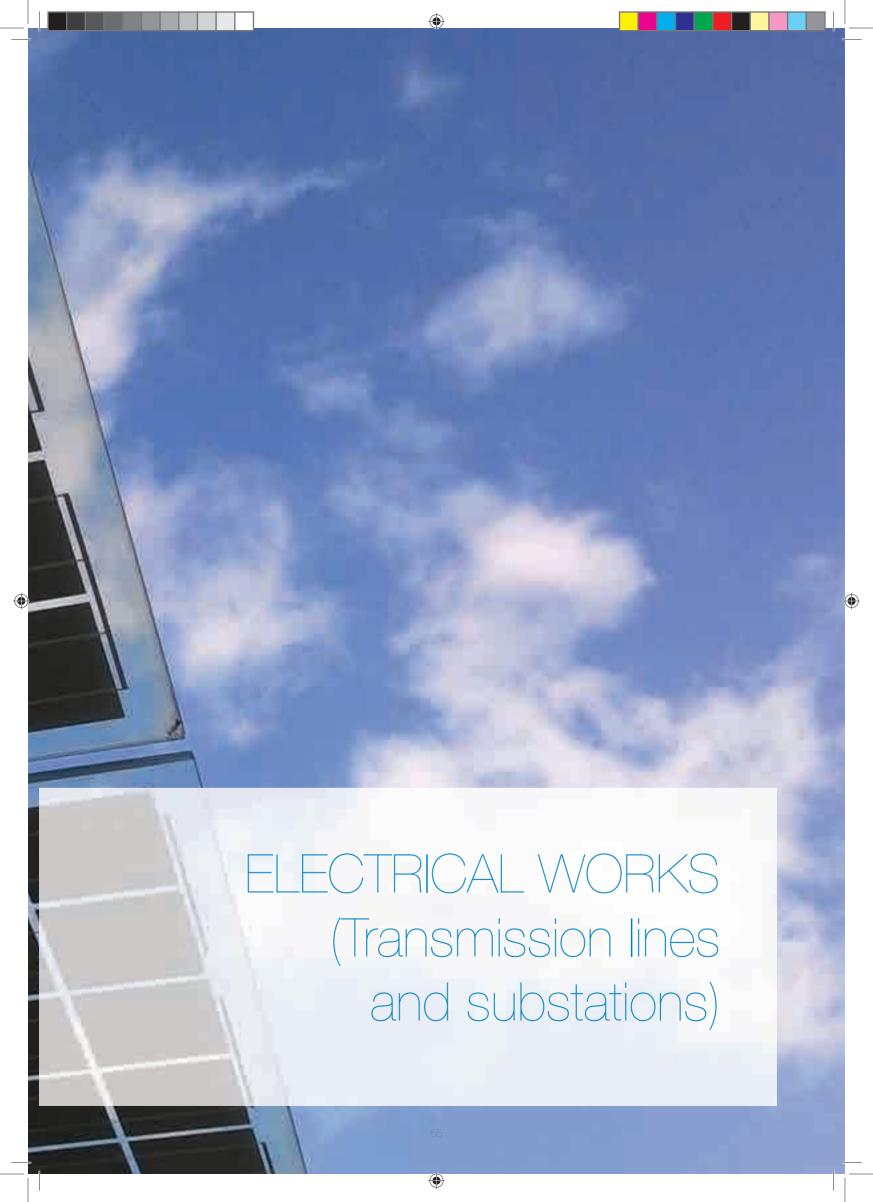


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# **Environmental impacts**

## **General information**

The electrical components in a solar park comprise substations and transmission lines to evacuate the power to the nearest grid. The typical activities involve:

- Conduct of detailed survey with respect to route alignment, optimization of tower locations, soil resistivity, etc.
- Design and testing of various families of tower for different wind zones through which the transmission
- Design of Interconnection facilities (like substation, gantries etc.).
- Statutory clearances from Government authorities.
- Fabrication and supply of all types of towers, tower accessories and line materials.
- Selecting different types of foundations for different towers and casting for foundation for tower footings including river-crossing towers.
- Erection of towers, painting of towers and supply and erection of span markers, obstruction lights, fixing of insulator string, stringing of conductors and earth wire along with all necessary line accessories.
- Testing and commissioning of respective transmission lines.
- Maintenance of Right of Way (RoW).

Substations have several points to be considered, they have a gravel pad with concrete foundations that support necessary electrical equipment, a tall chain link fence surrounding the equipment for safety purposes and an access road from the nearest public road (included in the previous section). Potential environment effects such as storm-water drainage, noise and road traffic must also be considered.

The impacts related to the construction and operation of a new electric substation will depend on its size as well as the topography, land cover, and existing land use of the selected site. Some impacts are temporary; however, most of the community and environmental impacts are permanent. The extensive land clearing and excavation activities required for the substation foundation creates permanent changes to the land coverage of the site. In addition, a permanent access road is needed to allow for long-term monitoring and maintenance. Larger substations may require storm-water detention ponds, berms, additional transmission structures constructed outside of the fenced area, and other landscape alterations. These changes and other impacts related to the construction and operation of electric substations are described below, separated into temporary and permanent impacts.

Temporary impacts include machinery noise, dust and temporary disruptions in local electric-service. Permanent impacts are land usage changes and habitat loss, changes to local aesthetics, noise and lighting.





## Raw material and conditioning

There is not a high impact due to raw material. The minimal quantity of solid waste generated during construction phase may include small concrete materials, bins, unused metals, packaging materials, scraps, plastic, paper and food materials etc. These kinds of wastes are limited in quantity and generation of the same is temporary in nature. These wastes will be collected, segregated, stored and disposed as per the MSW Rules, 2016. Thus, soil contamination is not expected due to solid waste generated from construction activities for electrical works.

There may be negligible amount of hazardous materials like waste oil (if existing electrical equipment is dismantled / maintained), lubricants, hydraulic fluids from maintenance of machinery or operating vehicles, empty paint or oil cans, waste batteries, transformers, used cabling etc. generated during construction. Most of these wastes are defined under the Hazardous Waste Rules (2016), mentioned in the preceding section.

Highly refined, mineral insulating oils are used to cool transformers and provide electrical insulation between live components. They are typically found in electrical substations.

In order to minimize the contamination of soil due to accidental spill or leaks of fuels, the Substation area shall be designed sufficiently with an impervious layer at the storage areas and transformer areas. Proper sloping and drainage shall be provided with proper collection or containment structure.

Used oils and other hazardous material will be properly collected and disposed of as per the Hazardous Waste Management and Handling Rules, 2008.

# Clearing of vegetation for ground preparation for transmission lines

Right of Way (ROW) width for the transmission line depends on the line voltage to be conveyed. The maximum permissible width of ROW for transmission lines on forestland and minimum clearances between conductors and trees are given in the following table.

ROW clearance between conductors and trees

TRANSMISSION VOLTAGE (IN KV)	MAX. ROW* (IN METERS)	MINIMUM CLEARANCE BETWEEN CONDUCTORS & TREES* (IN METERS)
132	27	4.0
220	35	4.6
±500 HVDC	52	7.4
400 D/C / S/C	46 / 52	5.5
800	64-85	9.0

<sup>\*</sup> As per the IS: 5613 and MoEFCC guidelines finalized in consultation with CEA.



At present, a width clearance of 3 meter is generally allowed below each conductor for the movement of tension stringing equipment. Suggestions to increase width area for 400 KV and above lines, based on the type of conductor used (3m for twin, 5m for triple and 7m for quad conductor), is also considered on a case basis by MoEFCC. Forest department is requested to undertake felling, pollarding, and pruning of trees for electrical clearance, whenever necessary.

Lopping of trees is required to facilitate stringing and maintenance of ROW. Felling, pollarding, and pruning of trees for electric clearance, whenever necessary, is done with permission from the local Forest Officer. Lopping and felling of trees can open up forest canopy allowing more sun light into the under storey where it can lead to an edge effect and allow for proliferation of socio-phytic weeds. This can have added repercussions within a semi evergreen or evergreen biotope (fragile ecosystems restricted to North East India and the Western Ghats of Maharashtra and Karnataka).

Heavy machinery is used for the installation of transmission lines and towers and may require clearing of ground vegetation for its movement. This activity can cause temporary disturbance to the forest, orchards, plantation and agriculture fields. Wherever possible existing path / access roads should be used for the movement of man and machinery. The existing roads that cannot support heavy machinery load need to be upgraded and thus the village infrastructure is also improved. In areas where lines traverse agricultural land, compensation is paid to owners for any crop damage incurred as a result of construction activities. Agricultural activities are allowed to continue after the construction period. If bunds or other on-farm works are disturbed during construction or maintenance, they are restored to the owner's satisfaction following cessation of construction or maintenance activities. In the event that private trees are felled during construction or maintenance operations, compensation is paid to the owner as determined by the forest / horticulture departments.

# Atmospheric pollution: emissions and corrective actions

The major source of air pollution during the construction phase can be due to:

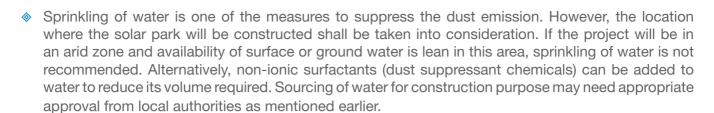
- Air borne emissions from the construction heavy machineries and vehicular movements at site.
- Air borne emissions during land clearing for site preparation and access routes, cutting and filling of soil and other construction activities.
- Exhaust emissions from the vehicular movement and other stationery backup power generator sets

The impact on air quality during construction phase is certain and minor in nature and can be minimized or mitigated by proper preventive measures.

These impacts can be minimized by proper maintenance of machinery and vehicles and by limiting the speed of vehicles. The dust emission can be reduced by:

- Minimizing the disturbance of vegetation cover present.
- Stabilization of as much unpaved operations area as is feasible.





Since, most of the cables used for power transmission are overhead, only construction of base tower is involved in the transmission line related activities, which may have minimal dust emissions.

# Land and water pollution: effluents and corrective actions

Store construction materials containing fine particles in an enclosure may slip into sediment laden water, which does not drain into nearby water drains.

If any, stabilize slopes on road or elsewhere with embankments to control sedimentation, erosion and water pollution. Also consider the use of geo-textiles to prevent soil erosion during construction. Top soil shall be re-used in the adjacent areas.

Minimal wastewater will be generated which will be collected in the septic tank No wastewater generated will be discharged into the water bodies.

## Noise: measurement and corrective actions

The major sources of the noise pollution due to construction activity are from road works, earth moving, concrete batching, levelling, grading, excavating and compacting, movement of trucks for transportation of equipment, construction materials, concrete mixers, asphalt mixing and laying equipment. All these may add to noise levels and impact the surrounding ambient noise quality.

It is necessary to minimize the impact of noise according to the minimum requirements established by law (Noise Rules, 2000). To ensure that, carry out the environmental monitoring by an accredited agency once in a quarter near the sensitive receptors. The implementation of action plans and compliance or non-compliance shall be reported in the quarterly report, which will be submitted to the lenders.

# Social issues due to land acquisition for transmission lines and substations

Social issues due to land acquisition for the laying of transmission lines and substations include the following:

Loss to standing crop: Foundation and erection of towers and stringing of transmission lines involves movement of machinery. This may cause damage to the standing crops in agriculture field resulting in serious socio-economic concerns for the cultivators.





- Change in land prices: Installation of transmission towers may reduce the price of the property.
- Aesthetic appeal of an area: Erection of transmission towers and lines affects the aesthetics of the area
- **Temporary loss of access to common property resources:** During construction phase of transmission lines, access to common property resources for the local community may be compromised.
- Loss of livelihood due to acquisition of private agricultural land: Private agricultural lands sometimes get acquired for the construction of substations. This may result in loss of livelihood to the concerned cultivators and agricultural workers. The regulation on Land Acquisition, Rehabilitation and Resettlement, 2013 mentioned earlier will need to be used for paying compensation and resettling / rehabilitation of affected families.
- Loss of common property resources due to acquisition of revenue land: The local communities use common property resource lands for various purposes such as grazing ground for their cattle and sourcing biomass for cooking fuel. Acquisition of these lands for construction of substation results in loss of common property resource of the local community that could affect their socioeconomic condition.

The LARR, 2013 mentioned earlier provides the procedures for resolving and settling the above issues.

# Environmental impacts during erection, commissioning, operation and maintenance

In the following table the contaminant source, potential for harm and corresponding corrective measures should be indicated for the construction period:

Contaminant source	Potential for harm	Examples of corrective and mitigation measures
Solid waste from labour camps and construction sites.	Irresponsible disposal or burning of solid waste could lead to land degradation, emissions and health impacts.	Solid waste must be minimised, segregated and disposed / recycled (refer to solid waste management rules, 2016); Dust must be collected and disposed adequately.
Liquid effluents from construction sites.	Untreated discharges of wastewater can pollute water bodies / land and cause adverse impacts on human health and aquatic ecosystems.	Liquid effluents must be collected and treated in a specific waste treatment plant as applicable based on Consent to Operate (CTO) issued to the Park / Plant. (Refer to Environment Protection Rules, 1986).
Dust and air emissions from construction equipment and activities.	Emissions can cause health impacts and visibility issues.	Air pollutants shall be monitored. (Refer to National Ambient Air Quality Standards, 2009) During operational phase, sulphur hexafluoride (SF <sub>6</sub> gas) is often used in switchyards / circuit breakers. This is a greenhouse gas (GWP of about 23000 as a function of CO <sub>2</sub> ) and its leakage from the substation needs to be controlled to minimise its potential of global warming contribution. The refilling of the gas in the electrical equipment also needs to be supervised to ensure zero leakage or incidents.
Odours from chemical and fuel handling / storage.	Causes nuisance and unpleasantness.	Unpleasant odours shall be removed or avoided.









Contaminant Source	Potential for harm	Examples of corrective and mitigation measures
Noise from construction activities.	Sustained exposure to high noise levels can cause hearing loss in the long term. Short term noise pollution can cause nuisance / disturb animal habitats.	Noise levels must be reduced to lower than specified in legislation (Refer to Noise Pollution (Regulation and Control) Rules, 2000).  High noise areas should be mandated with personal protective equipment (Schedule 41F, Factories Act, 1948 specifies time weighted average levels of exposure (over 8 hours).
Vibrations due to demolition of structures, blasting / excavation in rock.	Depending on the intensity of the vibrations, they can cause structural damage to buildings as well as disturb animal habitats.	Planning of excavation / blasting activities as well as design of equipment should address this issue. Equipment installations should be undertaken with proper foundation and damping insulation to avoid the transmission of vibrations.  (No Indian standard available – British standard BS 7385 or German standard DIN 4150 could be used if necessary).
Flammable material and explosives used in rock blasting.	Can cause fires / explosions and result in loss of life as well as habitats.	The use of flammable material must be avoided as far as possible.  Explosives shall be used according to specific legislation Such material should be stored with proper care and protective infrastructure.  Refer to:  Explosives act, 1984.  Manufacture, storage and import of hazardous chemicals rules, 1989.  Sections of the factory act, 1948 (14, 38, and 40) and respective state factories rules.



Excavation activities at construction sites as well as raw materials extraction sites often involve major topographical and land-cover changes to allow extraction activities, often including clearing of pre-existing vegetation. Techniques to minimize the land conversion impacts include:

- a. Selection of appropriate low-impact extraction methods that result in final site contours supportive of habitat restoration principles and intended land use.
- b. Establishment of buffer zones from the edge of extraction areas considering the characteristics of the natural habitats and the type of extraction activities.
- c. Vegetation translocation and relocation techniques should be used as necessary (e.g., vegetation cover such as native local plants, topsoil, overburden, or spoils feasible for sustaining growth should be removed in separate operations and segregated for later use during site reinstatement and materials to be used for site reinstatement should be stockpiled and protected from wind and water erosion as well as contamination).
- d. Smaller, short-lived sites should be reclaimed immediately and larger sites with a useful lifespan beyond 3-5 years should be subject to ongoing rehabilitation.
- e. To the extent possible the affected land should be rehabilitated to acceptable uses as required by the permit.
- f. Test pits, interim roads, buildings, installations and structures of no beneficial use should be removed, and the land should be appropriately rehabilitated.





# Safety requirements as per Indian Electricity Rules, 1956

The paragraphs below present the specific requirements as per IER, 1956 related to General Safety aspects for all electrical installations related to generation and transmission of power.

- 29. Construction, installation, protection, operation and maintenance of electric supply lines and apparatus.
  - (1) All electric supply lines and apparatus shall be of sufficient ratings for power, insulation and estimated fault current and of sufficient mechanical strength, for the duty which they may be required to perform under the environmental conditions of installation, and shall be constructed, installed, protected, worked and maintained in such a manner as to ensure safety of human being, animals and property.
  - (2) Save as otherwise provided in these rules, the relevant Code of Practice of the Bureau of Indian Standards, including National Electrical Code shall be followed to carry out the purposes of this rule and in the event of any inconsistency, the provisions of these rules shall prevail.
  - (3) The material and apparatus used shall conform to the relevant specification of the Bureau of Indian Standards, including National Electrical Code where such specifications have already been laid down.
- 30. Service lines and apparatus on consumer's premises.
  - (1) The supplier shall ensure that all electric supply lines, wires, fittings and apparatus belonging to him or under his control, which are on a consumer's premises are in safe condition and in all respects fit for supplying energy and the supplier shall take due precautions to avoid danger arising on such premises from such supply lines, wires, fittings and apparatus.
  - (2) Service lines placed by the supplier on the premises of a consumer which are underground, or which are accessible shall be so insulated and protected by the supplier as to be secured under all ordinary conditions against electrical, mechanical, chemical or other injury to the insulation.
  - (3) The consumer shall, as far as circumstances permit, take precautions for the safe custody of the equipment on his premises belonging to the supplier.
  - (4)The consumer shall also ensure that the installation under his control is maintained in a safe condition.
- 31. Cut-out on consumer's premises.
  - (1) The supplier shall provide a suitable cut-out in each conductor of every service line other than an earthed or earthed neutral conductor or the earthed external conductor of a concentric cable within a consumer's premises, in an accessible position. Such cut-out shall be contained within an adequately enclosed fireproof receptacle. Where more than one consumer is supplied through a common service line, each such consumer shall be provided with an independent cut-out at the point of junction to the common service.
  - (2) Every electric supply line other than the earthed or earthed neutral conductor of any system or the earthed external conductor of a concentric cable shall be protected by a suitable cut-out by its owner.
- **32.** Identification of earthed and earthed neutral conductors and position of switches and cut-outs therein.

Where the conductors include an earthed conductor of a two-wire system or an earthed neutral conductor of a multi-wire system or a conductor which is to be connected thereto, the following conditions shall be complied with:





- (1) An indication of a permanent nature shall be provided by the owner of the earthed or earthed neutral conductor, or the conductor which is to be connected thereto, to enable such conductor to be distinguished from any live conductor. Such indication shall be provided:
  - (a) where the earthed or earthed neutral conductor is the property of the supplier, at or near the point of commencement of supply;
  - (b) where a conductor forming part of a consumer's system is to be connected to the supplier's earthed or earthed neutral conductor, at the point where such connection is to be made;
  - (c) in all other cases, at a point corresponding to the point or commencement of supply or at such other point as may be approved by an Inspector or any officer appointed to assist the Inspector and authorised under sub-rule (2) of Rule 4A.
  - (2) No cut-out, link or switch other than a linked switch arranged to operate simultaneously on the earthed or earthed neutral conductor and live conductors shall be inserted or remain inserted in any earthed or earthed neutral conductor of a two-wire system or in any earthed or earthed neutral conductor of a multi-wire system or in any conductor connected thereto with the following exceptions:
  - (a) A link for testing purposes, or
  - (b) A switch for use in controlling a generator or transformer.
- ♦ 35. Danger notices.

The owner of every medium, high and extra-high voltage (as defined in the IER, 1956) installation shall affix permanently in a conspicuous position a Danger notice in Hindi or English and the local language of the district, with a sign of skull and bones of a design as per the relevant ISS No.2551 on:

- (a) every motor, generator, transformer and other electrical plant and equipment together with apparatus used for controlling or regulating the same.
- (b) all supports of high and extra-high voltage overhead lines which can be easily climbed upon without the aid of ladder or special appliances.

Explanation: Rails, tubular poles, wooden supports, reinforced cement concrete poles without steps, I-sections and channels, shall be deemed as supports which cannot be easily climbed upon for the purposes of this clause.

• (c) luminous tube sign requiring high voltage supply, X-ray and similar high-frequency installations:

Provided that it is not possible to affix such notices on any generator, motor, transformer or other apparatus, they shall be affixed as near as possible thereto or the word "danger" and the voltage of the apparatus concerned shall be permanently painted on it.

Provided further that where the generator, motor, transformer or other apparatus is within an enclosure, one notice affixed to the said enclosure shall be sufficient for the purposes of this rule.

- ♦ 36. Handling of electric supply lines and apparatus.
  - (1) Before any conductor or apparatus is handled, adequate precautions shall be taken, by earthing or other suitable means, to discharge electrically such conductor or apparatus, and any adjacent conductor or apparatus if there is danger there from, and to prevent any conductor or apparatus from being accidentally inadvertently electrically charged when persons are working thereon.

Every person who is working on an electric supply line or apparatus or both shall be provided with tools and devices such as gloves, rubber shoes, safety belts, ladders, earthing devices, helmets, line testers, hand lines and the like for protecting him/her from mechanical and electrical injury. Such tools and devices shall always be maintained in sound and efficient working conditions.



- (2) No person shall work on any live electric supply line or apparatus and no person shall assist such person on such work, unless he is authorised in that behalf, and takes the safety measures approved by the Inspector.
- (3) Every telecommunication line on supports carrying a high or extra-high voltage line shall, for the purpose of working thereon, be deemed to be a high voltage line.
- ♦ 38. Cables for portable or transportable apparatus.
  - (1) Flexible cables shall not be used for portable or transportable motors, generators, transformers, rectifiers, electric drills, electric sprays, welding sets or any other portable or transportable apparatus unless they are heavily insulated and adequately protected from mechanical injury.
  - (2) Where the protection is by means of metallic covering, the covering shall be in metallic connection with the frame of any such apparatus and earth.
  - (3) The cables shall be three core type and four core type for portable and transportable apparatus working on single phase and three phase supply respectively and the wire meant to be used for ground connection shall be easily identifiable.
- ♦ 39. Cables protected by bituminous materials.
  - (1) Where the supplier or the owner has brought into use an electric supply line (other than an over-head line) which is not completely enclosed in a continuous metallic covering connected with earth and is insulated or protected in situ by composition or material of a bituminous character:
    - (i) any pipe, conduit or the like into which such electric supply line may, have been drawn or placed shall, unless other arrangements are approved by the Inspector in any particular case, be effectively sealed at its point of entry into any street box so as to prevent any flow of gas to or from the street box; and
    - (ii) such electric supply line shall be periodically inspected and tested where accessible, and the result of each such inspection and test shall be duly recorded by the supplier or the owner.
  - (2) It shall not be permissible for the supplier or the owner after the coming into force of these rules, to bring into use any further electric supply line as aforesaid which is insulated or protected in situ by any composition or material known to be liable to produce noxious or explosive gases on excessive heating.
- ♦ 41. Distinction of different circuits.

The owner of every generating station, sub-station, junction-box or pillar in which there are any circuits or apparatus, whether intended for operation at different voltages or at the same voltage, shall ensure by means of indication of a permanent nature, that the respective circuits are readily distinguishable from one another.

♦ 41A. Distinction of the installations having more than one feed .

The owner of every installation including sub-station, double pole structure, four pole structure or any other structure having more than one feed, shall ensure by means of indication of a permanent nature, that the installation is readily distinguishable from other installations.

42. Accidental charge.

The owners of all circuits and apparatus shall so arrange them that there shall be no danger of any part thereof becoming accidentally charged to any voltage beyond the limits of voltage for which they are intended.

Where A.C. and D.C. circuits are installed on the same support they shall be so arranged and protected that they shall not come into contact with each other when live.





- (1) Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires, in addition to fire extinguishers suitable for dealing with electric fires, shall be conspicuously marked and kept in all generating stations, enclosed sub-stations and switch station in convenient situations. The fire extinguishers shall be tested for satisfactory operation at least once a year and record of such tests shall be maintained.
- (2) First-aid boxes or cupboards, conspicuously marked and equipped with such contents as the State Government may specify, shall be provided and maintained in every generating station, enclosed sub-station and enclosed switch-station so as to be readily accessible during all working hours. All such boxes and cupboards shall, except in the case of unattended sub-stations and switch-stations be kept in charge of responsible persons who are trained in first-aid treatment and one of such persons shall be available during working hours.
- (3) Two or more gas masks shall be provided conspicuously and installed and maintained at accessible places in every generating station with capacity of 5 MW and above and enclosed substation with transformation capacity of 5 MVA and above for use in the event of fire or smoke:

Provided that where more than one generator with capacity of 5 MW and above is installed in power station, each generator would be provided with at least two separate gas masks in accessible and conspicuous position:

Adequate number of gas masks should be provided by the owner of every generating station and enclosed sub-station with capacity less than 5 MW and 5 MVA respectively, if so desired by the Inspector.

- ♦ 44. Instructions for restoration of persons suffering from electric shock.
  - (1) Instructions, in English or Hindi and local language of the district, and where Hindi is the local language, in English and Hindi for the restoration of persons suffering from electric shock, shall be affixed by the owner in a conspicuous place in every generating station, enclosed sub-station, enclosed switch-station and in every factory as defined in Clause (m) of Section 2 of the factories act, 1948 (63 of 1948), in which electricity is used and in such other premises where electricity is used as the Inspector or any officer appointed to assist the inspector may, by notice in writing served on the owner, direct.
  - (2) Copies of the instructions shall be supplied on demand by an officer or officers appointed by the central or the state government in this behalf at a price to be fixed by the central or the state government.
  - (3) The owner of every generating station, enclosed sub-station, enclosed switch-station, and every factory or other premises to which this rule applies, shall ensure that all authorised persons employed by him are acquainted with and are competent to apply the instructions referred to in sub-rule (1).
  - (4) In every manned high voltage or extra-high voltage generating station, sub-station or switch station, an artificial respirator shall be provided and kept in good working condition.





If any accident occurs in connection with the generation, transmission, supply or use of energy in or in connection with, any part of the electric supply lines or other works of any person and the accident results in or is likely to have resulted in loss of human or animal life or in any injury to a human being or an animal, such person or any authorised person of the state electricity board/ supplier, not below the rank of a junior engineer or equivalent shall send to the Inspector a telegraphic report within 24 hours of the knowledge of the occurrence of the fatal accident and a written report in the form set out in Annexure XIII of the factories act, within 48 hours of the knowledge of occurrence of fatal and all other accidents. Where practicable a telephonic message should also be given to the Inspector immediately the accident comes to the knowledge of the authorised officer of the state electricity board/supplier or other person concerned.

- 45. Precautions to be adopted by consumers, owners, occupiers, electrical contractors, electrical workmen and suppliers.
  - (1) No electrical installation work, including additions, alterations, repairs and adjustments to existing installations, except such replacement of lamps, fans, fuses, switches, low voltage domestic appliances and fittings as in no way alters its capacity or character, shall be carried out upon the premises of or on behalf of any consumer, supplier, owner or occupier, for the purpose of supply to such consumer, owner, or occupier except by an electrical contractor licensed in this behalf by the State Government and under direct supervision of a person holding a certificate competency and by a person holding a permit issued or recognized by the State Government:

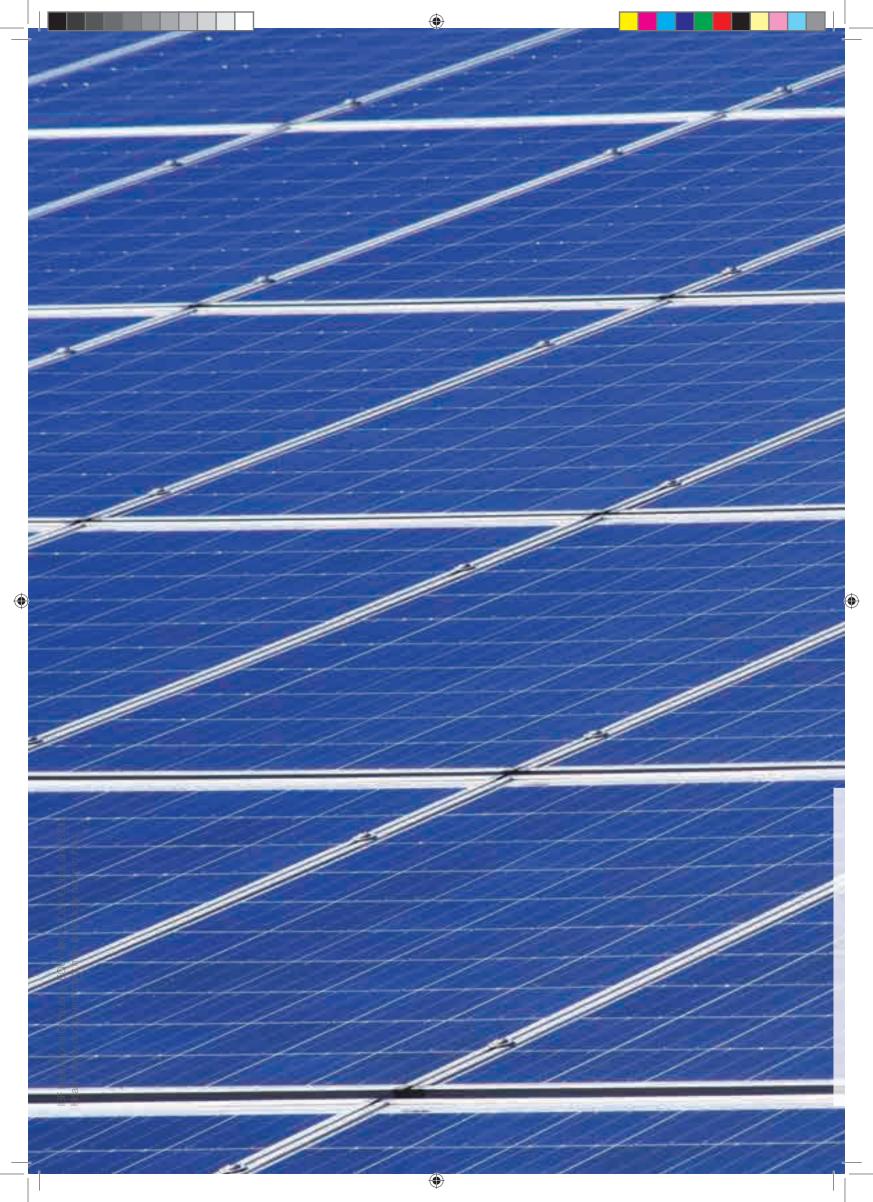
Provided that in the case of works executed for or on behalf of the central government and in the case of installations in mines, oil-fields and railways, the central government in other cases the state government may, by notification in the official gazette, exempt, on such conditions as it may impose, any such work described therein either generally or in the case of any specified class of consumers, suppliers, owners or occupiers, from so much of this sub-rule as requires such work to be carried out by an electrical contractor licensed by the state government in this behalf.

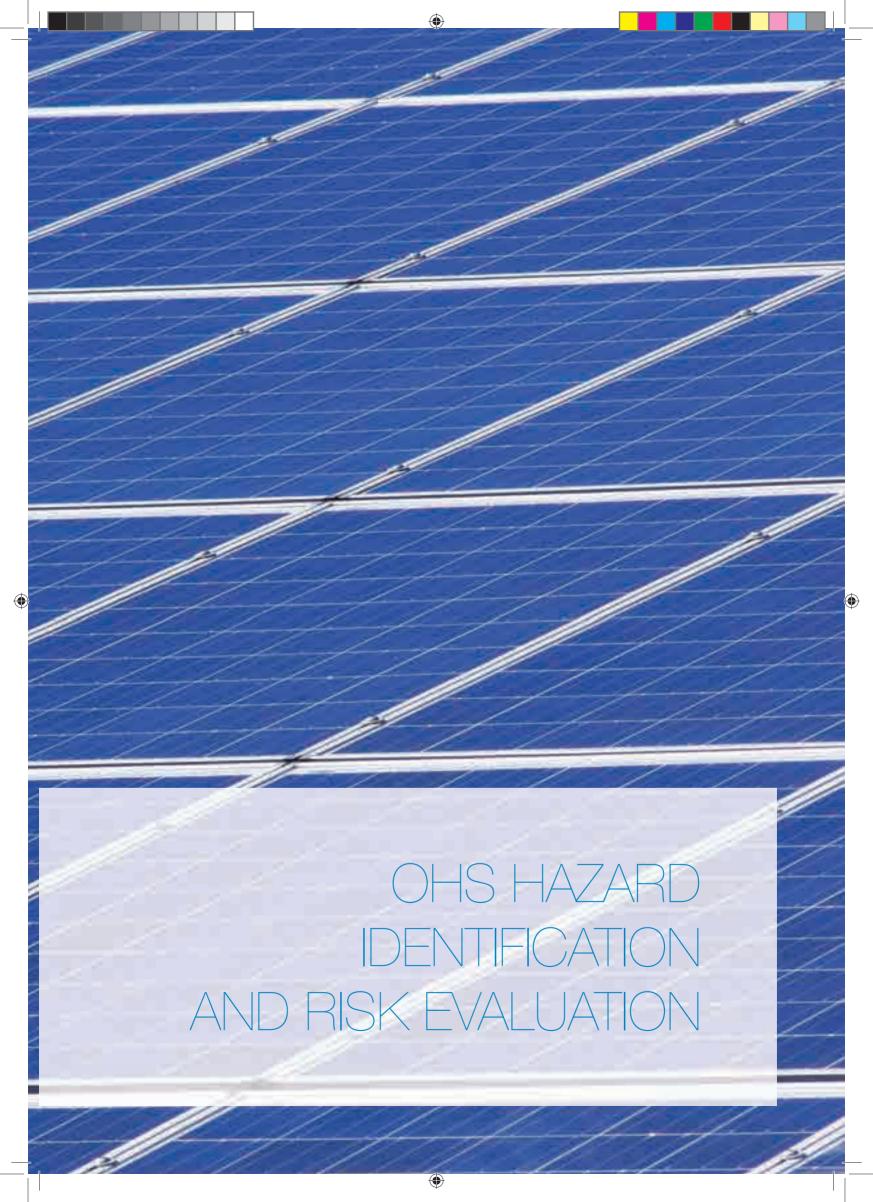
- (2) No electrical installation work which has been carried out in contravention of sub-rule (1) shall either be energised or connected to the works of any supplier.
- ♦ 46. Periodical inspection and testing of installation.
  - (1) (a) Where an installation is already connected to the supply system of the supplier, every such installation shall be periodically inspected and tested at intervals not exceeding five years either by the Inspector or any officer appointed to assist the Inspector or by the supplier as may be directed by the State Government in this behalf or in the case of installations belonging to, or under the control of the Central Government, and in the case of installations in mines, oil-fields and railways, by the Central Government.
    - The periodical inspection and testing of high voltage and extra high voltage installations belonging to supplier, shall be carried out at intervals not exceeding five years by the inspector or any officer appointed to assist the inspector.
    - Where the supplier is directed by the Central or the State Government, as the case may be, to inspect and test the installation he/her shall report on the condition of the installation to the consumer concerned in a form approved by the Inspector and shall submit a copy of such report to the Inspector or to any officer appointed to assist the Inspector and authorised under sub-rule (2) of rule 4A.
    - Subject to the approval of the inspector, the forms of the inspection report contained in Annexure IXA may, with such variations as the circumstances of each case require, be used for the purposes of this sub-rule.



<del>( ( )</del>

- (2) (a) The fees for such inspection and test shall be determined by the Central or the State Government, as the case may be, in the case of each class of consumers and shall be payable by the consumer in advance.
  - (b) In the event of the failure of any consumer to pay the fees on or before the date specified in the fee-notice, supply to the installation of such consumer shall be liable to be disconnected under the direction of the Inspector. Such disconnection, however, shall not be made by the supplier without giving to the consumer seven clear days notice in writing of his intention to do so.
  - (c) In the event of the failure of the owner of any installation to rectify the defects in his installation pointed out by the Inspector or by any officer appointed to assist him and authorised under subrule(2) of Rule 4A in the form set out in Annexure IX and within the time indicated therein, such installation shall be liable to be disconnected under the directions of the Inspector after serving the owner of such installation with a notice:
    - Provided that the installation shall not be disconnected in case an appeal is made under Rule 6 and the appellate authority has stayed the orders of disconnection.
    - Provided further that the time indicated in the notice shall not be less than forty-eight hours in any case:
    - Provided also that nothing contained in this clause shall have any effect on the application of Rule 49.
- (3) Notwithstanding the provisions of this rule, the consumer shall at all times be solely responsible for the maintenance of this installation in such condition as to be free from danger.





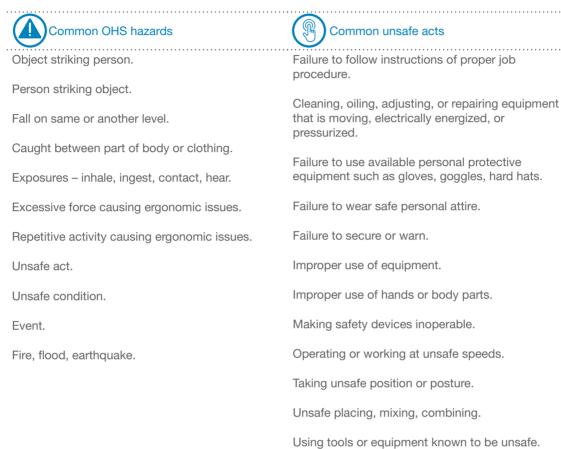


# IBF International Consulting, EQO-NIXUS (OCA Global) and IDOM Health, safety and environment manual for solar parks in India.

## **OHS** hazards

Hazards and Risks often decide the occurrence of incidents and their resulting consequences. Then typical hazards and risks of a construction site are listed below. These are generic and apply more or less across all the type of works covered in this manual.

Table 9 Common OHS hazards and risks on construction sites





- Severe / traumatic / massive head / brain / skull injuries.
- Broken/fractured / shattered bones.
- Spinal injuries.
- Punctured lungs.
- Internal organ injuries.
- Electrocution.
- Burns.

Heatstroke.

Driving errors.

- Severe cuts or lacerations.
- Serious back or neck injures.
- Puncture injuries from falling onto items.
- Eye injuries.
- Strains and sprains.
- Death.

Once the jobsite evaluation is carried out and identified where and how work is being performed, associated OHS hazards and risks would need to be evaluated. The annexure I discusses how to evaluate and reduce the risks associated with the identified hazards by eliminating and controlling the hazard situation.

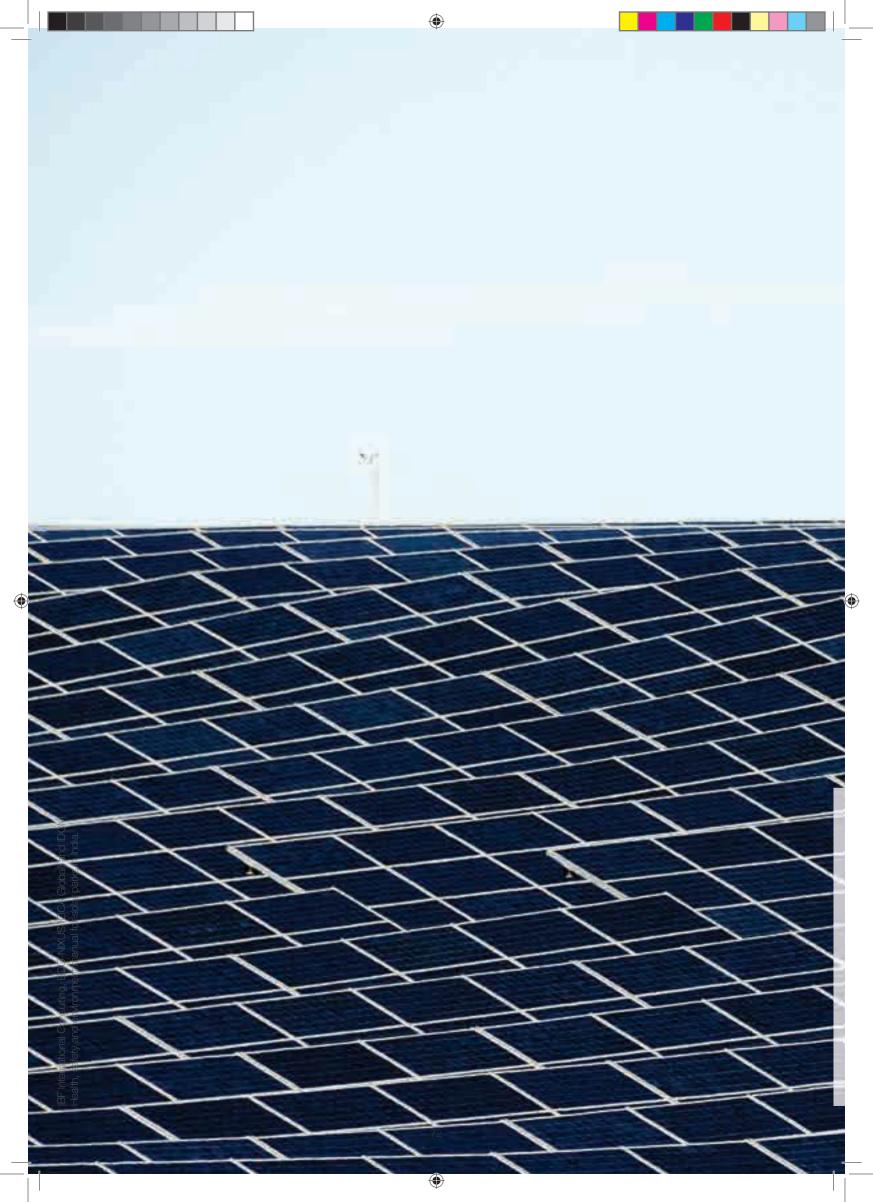




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This chapter addresses water treatment plants. The water works such as water pipelines, water reticulations, water reservoirs and pumps are considered a mix of civil and electrical works rather than water related.

## **Environmental impacts General information**

The operation of the solar park can affect surface water and groundwater in several ways, including the use of water resources, contamination of aquifers and water quality.

Activities during site construction can also potentially affect water resources. Water may be used also for dust suppression and the workforce's potable supply.

Water would be needed for various activities in the construction phase and operation phase. Water sources are likely to be local groundwater, surface water, or recycled water, depending upon availability of those resources. Water may also be trucked in from distant municipal water supplies.

Groundwater withdrawn from local aquifers could lower water levels of the source aquifer. Depending on site-specific geology, withdrawals exceeding the sustainable yield of the groundwater basin could cause permanent loss of storage capacity in the aquifer, as well as land subsidence. Impacts of reduced groundwater flow magnitude and timing of groundwater flows to streams, springs, seeps, and wetlands would depend upon the connectivity of surface water and groundwater in the region.

If surface water were used, withdrawal of surface water from a stream would reduce its flow. Replenishment of aquifers that are hydraulically connected and recharged by the stream would also be reduced. Approvals will also be required from the local authorities (CGWA and Irrigation department) for sourcing groundwater or surface water for construction purpose.

## Raw material and conditioning

Both groundwater and surface water quality could be affected by construction activities. These activities include land disturbance–related soil erosion and sedimentation; fuel and chemical spills; storage and potential treatment of wastewater; and the potential application of pesticides, herbicides, and dust suppressant chemicals. Surface water quality could be adversely affected in areas hydraulically downstream and downwind from disturbed areas, including staging areas, construction sites, access roads, soil piles, foundation excavation, trenching, and borrow pits. Sediments from these disturbed areas can be transported by wind or water to adjacent water bodies (including streams, lakes, beaches and wetlands,) and degrade water quality through the addition of sediments, dissolved solids, metals, and organics.

Improperly designed groundwater wells could create conduits for poor-quality groundwater, as well as contaminants, to move between aquifers. Chemical and fuel spills could infiltrate to groundwater and could spread by surface run-off to surface water features. Wastewater will most likely be contained in portable toilets, on-site sewage lagoons, or septic tanks with leach fields. Leaky wastewater storage containers could degrade groundwater and surface water quality and introduce pathogens.

Potential impacts on water resources during the operation phase of a solar park include land disturbance-related issues, water use, wastewater generation, and potential chemical releases affecting water quality.

Water quality could also be degraded during the operation phase as a result of the application of herbicides and pesticides used for controlling on-site vegetation. In addition, accidental spills of chemicals may contaminate nearby surface waters and groundwater.

The major environmental issues associated with a wastewater treatment plant are odour, noise and water pollution.



## Atmospheric pollution: emissions and corrective actions

During the construction of a water treatment plant and its operation, the atmospheric pollution is based mainly on odours. Sewage plants located near residential areas can be subject to political and legal problems if these facilities produce unpleasant odours. In the case of a sewage plant and the associated collection system, chemicals or enzymes may be added to the liquid phase to prevent the formation of the odours. Mechanical changes to the sewage pump stations may also be made to reduce the odour. When these methods are not sufficient to control the odour, some form of odour control in the vapour phase may need to be applied.

## Land and water pollution: effluents and corrective actions

The quality of wastewater (in terms of physical and chemical characteristics) partly determines the environmental impacts. In arid and semi-arid areas, chemical concentrations are higher than in humid ones, because less water is used at the point of generation and higher evaporation rates during distribution and treatment reduce the water component. The following components of wastewater may have an impact on the environment:

- Pathogens: These substances can contaminate crops, soil, surface water and groundwater.
- Salts: Increase of soil salinity can decrease near crop productivity.
- Heavy metals: The use of wastewater containing industrial discharges leads to metal concentration in soils and crops.
- Organic matter: Most organic compounds of human origin contained in sewage are rapidly decomposed in soils.
- Suspended solids: If they are not biodegradable, they shall be treated.

### Noise: measurement and corrective actions

Most of the noise produced by a wastewater treatment plant comes from the reaction/treatment basin and electromechanical equipment. For the operating personnel and the equipment, the working and functioning environment is highly aggressive, combining physical, chemical, and biological pollution factors.

The noise level exceeds 50 dB in any circumstance. In order to increase the inner acoustic comfort, it is recommended to make a separation and to enclose all equipment individually (depending on the needed noise protection) as follows:

- a ventilated hall, equipped with air pollution control devices; wastewater and sludge collection basins, flotation unit, sludge dewatering unit, biological reactors will be installed.
- a climatic hall, acoustic insulated; electromechanical equipment will be installed.

The insulation of equipment can reduce the noise level.



# Environmental impacts during erection, commissioning, operation and maintenance

In the following table the contaminant source, potential for harm and corresponding corrective measures should be indicated for the construction period:

Contaminant source	Potential for harm	Examples of corrective and mitigation measures
Solid waste from Labour camps and construction sites.	Irresponsible disposal or burning of solid waste could lead to land degradation, emissions and health impacts.	Solid waste must be minimised, segregated and disposed / recycled (refer to solid waste management rules, 2016).  Dust must be collected and disposed
		adequately.
Liquid effluents from construction sites.	Untreated discharges of wastewater can pollute water bodies / land and cause adverse impacts on human health and aquatic ecosystems.	applicable based on consent to operate (CTO)
		(Refer to environment protection rules, 1986).
		Air pollutants shall be monitored.
		(Refer to national ambient air quality standards, 2009).
Dust and air emissions from construction equipment and activities.	Emissions can cause health impacts and visibility issues.	During operational phase, Sulphur Hexafluoride (SF $_6$ gas) is often used in switchyards. This is a greenhouse gas (GWP of more than 23000 as a function of $\mathrm{CO}_2$ ) and its leakage from the substation needs to be controlled to minimise its potential of global warming contribution.
Odours from chemical and fuel handling / storage.	Causes nuisance and unpleasantness.	Unpleasant odours shall be removed or avoided.
Noise from construction	Sustained exposure to high noise levels can cause hearing loss in the long term. Short	
activities.	term noise pollution can cause nuisance / disturb animal habitats.	
Vibrations due to demolition of structures, blasting / excavation in rock.	Depending on the intensity of the vibrations, they can cause structural damage to buildings as well as disturb animal habitats.	
		(No Indian standard available – British standard BS 7385 or German standard DIN

4150 could be used).

Contaminant source	Potential for harm	Examples of corrective and mitigation measures
	Can cause fires / explosions and result in loss of life as well as habitats.	The use of flammable material must be avoided as far as possible.  Explosives shall be used according to specific
Flammable material and		legislation.  Such material should be stored with proper care and protective infrastructure.
explosives used in rock blasting.		Refer to:  Step   Step
		Manufacture, storage and import of hazardous chemicals rules, 1989.
		Sections of the factory act, 1948 (14, 38, and 40)

### Post construction activities

and respective state factories rules.

Excavation activities at construction sites as well as raw materials extraction sites often involve major topographical and land-cover changes to allow extraction activities, often including clearing of pre-existing vegetation. Techniques to minimize the land conversion impacts include:

- a. Selection of appropriate low-impact extraction methods that result in final site contours supportive of habitat restoration principles and intended land use.
- b. Establishment of buffer zones from the edge of extraction areas considering the characteristics of the natural habitats and the type of extraction activities.
- c. Vegetation translocation and relocation techniques should be used as necessary (e.g., vegetation cover such as native local plants, topsoil, overburden, or spoils feasible for sustaining growth should be removed in separate operations and segregated for later use during site reinstatement and materials to be used for site reinstatement should be stockpiled and protected from wind and water erosion as well as contamination).
- d. Smaller, short-lived sites should be reclaimed immediately and larger sites with a useful lifespan beyond 3-5 years should be subject to ongoing rehabilitation.
- e. To the extent possible the affected land should be rehabilitated to acceptable uses as required by the permit.
- f. Test pits, interim roads, buildings, installations and structures of no beneficial use should be removed, and the land should be appropriately rehabilitated.







## **Generic environmental mitigation measures**

The table 10 below presents the mitigation measures for minimizing / controlling environmental impacts described in the above sections. Many of these would need to be included as covenants, in the contractual agreements to allocate specific environmental roles and responsibilities to the construction contractors.

Table 10 Environmental mitigation measures

SI.No	Environmental impact	Proposed mitigation measures	Responsible
		<ul> <li>Based on the tree survey conducted at the solar park sites, plan access roads, transmission line (new) alignment etc. to minimize tree cutting / vegetation removal.</li> <li>Trees shall be removed from the construction sites before</li> </ul>	
1	Tree cutting.	commencement of construction with prior permission from the concerned department / authorities.	SPPD / SPD / Contractor.
		Compensatory plantation by way of re-plantation of at least thrice the number of trees cut should be carried out in the project area, as per regulatory guidelines.	
		Prior permission will have to be obtained for tree cutting from the applicable authorities.	
••••••			•••••••••••••
		If sites are proximal to human habitats and sensitive receptors like schools, hospitals, mitigation measures are to be planned which may include: noise barriers during construction, timing of construction activity to avoid night work:	
		Servicing of all construction vehicles and machinery will be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced.	
	Noise pollution / air	Maintenance of vehicles, equipment and machinery shall be regular and up to the satisfaction of the engineer to keep noise levels at the minimum.	
2	emissions.  Noise pollution from vehicles, construction equipment and other activities.	Idling of temporary trucks or other equipment should not be permitted during periods of loading / unloading or when they are not in active use. The practice must be ensured especially near residential /commercial /sensitive areas.	Contractor.
		All possible and practical measures to control noise emissions during drilling shall be employed.	
		Notwithstanding any other condition of contract, noise level from any item of plants must comply with the relevant legislation for levels of noise emission.	
		The contractor will ensure that the ambient air quality at these construction sites is within the acceptable limits of industrial uses in case of hot mix plants and crushers and residential uses around construction camps.	



SI.No	Environmental impact	Proposed mitigation measures	Responsible
3	Severance due to utilities on site / access road.	<ul> <li>All utilities (existing roads, structures, poles, water lines etc.) will be relocated with prior approval of the concerned agencies before construction starts.</li> <li>Prior information to affected people.</li> </ul>	Contractor.
4	Replacement of common amenities on access roads.	All affected common amenities such as community sources of water, bus shelters, cultural/religious properties, etc., will be relocated wherever necessary. The relocation site identification will be in accordance with the choice of the community and completed before construction starts.	SPPD / Contractor.
5	Planning temporary traffic diversion and pedestrian safety.	Where existing roads are passing through park sites a diversion road will be developed with the approval of the local municipality or gram panchayat.	Local authority / SPPD / Contractor.
6	Sanitation and sewage system at labour camps and construction yards.	The contractor will ensure that:  The sewage system for the camp is designed, built and operated in such a fashion that no health hazards occurs and no pollution to the air, ground water or adjacent water courses take place.  Separate toilets/bathrooms, wherever required, screened from those from men (marked in vernacular) are to be provided for women.  Adequate water supply is to be provided in all toilets and urinals.  All toilets in workplaces are with dry-earth system (receptacles) which are to be cleaned and kept in a strict sanitary condition.  Adequate health care is to be provided for the work force during the entire phase.	Contractor.
	Waste disposal at labour camps and construction yards.	The contractor will provide garbage bins in the camps and ensure that these are regularly emptied and evacuated in a hygienic manner.	Contractor.
7	Disposal of construction debris and excavated materials.	A suitable site should be identified for safe disposal, in relatively low-lying areas, away from the water bodies etc., as approved by the local authority.	Contractor.
8	Drainage flow.	Alternate arrangement like diversion of the drainage (storm water) to be ensured to allow the natural flow of water to downstream areas without water logging / flooding.	Contractor.
9	Temporary flooding due to excavation.	Proper cross drainage arrangements to be made, to avoid the overflowing of existing drains due to excavation during the laying of sewer mains.	Contractor.



SI.No	Environmental impact	Proposed mitigation measures	Responsible
10	Dust Pollution near settlements.	<ul> <li>All earth work will be protected in manner acceptable to the engineer to minimize generation of dust. Area under construction shall be covered &amp; equipped with dust collector.</li> <li>Construction material shall be covered or stored in such a manner so as to avoid being affected by wind direction.</li> <li>Unpaved haul roads near / passing through residential and commercial areas to be watered thrice a day.</li> <li>Trucks carrying construction material to be adequately covered to avoid the dust pollution and to avoid the material spillage.</li> </ul>	Contractor.
11	Stockyards.	<ul> <li>Location for stockyards for construction materials will be identified at sufficient distance from water course, hill slopes and labour camps.</li> <li>Separate enclosures shall be planned for storing construction materials containing fine particles, chemicals, flammables, etc.</li> </ul>	Contractor.
12	Soil pollution from fuel and lubricants.	Contractor will ensure that all vehicle/machinery and equipment operation, maintenance and refuelling will be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground. Oil interceptors will be provided for vehicle parking, wash down and refuelling areas as per the design provided.  In all, fuel storage and refuelling areas, if located on agricultural land or areas supporting vegetation, the top soil will be stripped, stockpiled and returned after cessation of such storage.  Contractor will arrange for collection, storing and disposal of oily wastes to the pre-identified disposal sites (list to be submitted to Engineer) and approved by the engineer. All spills and collected petroleum products will be evacuated in accordance with MoEF and state PCB guidelines.  Engineer will certify that all arrangements comply with the guidelines of PCB/MoEF or any other relevant laws.	Contractor.
13	Pollution from transportation of construction materials.	All vehicles delivering materials to the site will be covered to avoid spillage of materials. All existing roads used by vehicles of the contractor, or any of his sub – contractor or suppliers of materials and similarly roads which are part of the work will be kept clean and clear of dust/ mud or other extraneous materials dropped by such vehicles.  The fall height shall be kept low so that the least amount of dust is airborne, during unloading of materials.  The unloading of materials at construction sites close to settlement will be restricted to daytime.	Contractor.
14	Pollution from construction wastes.	The Contractor shall take all precautionary measures to prevent the wastewater generated during construction from entering into streams, water bodies or the irrigation system. All waste arising from the project is to be evacuated in the manner that is acceptable by the engineer.	Contractor.





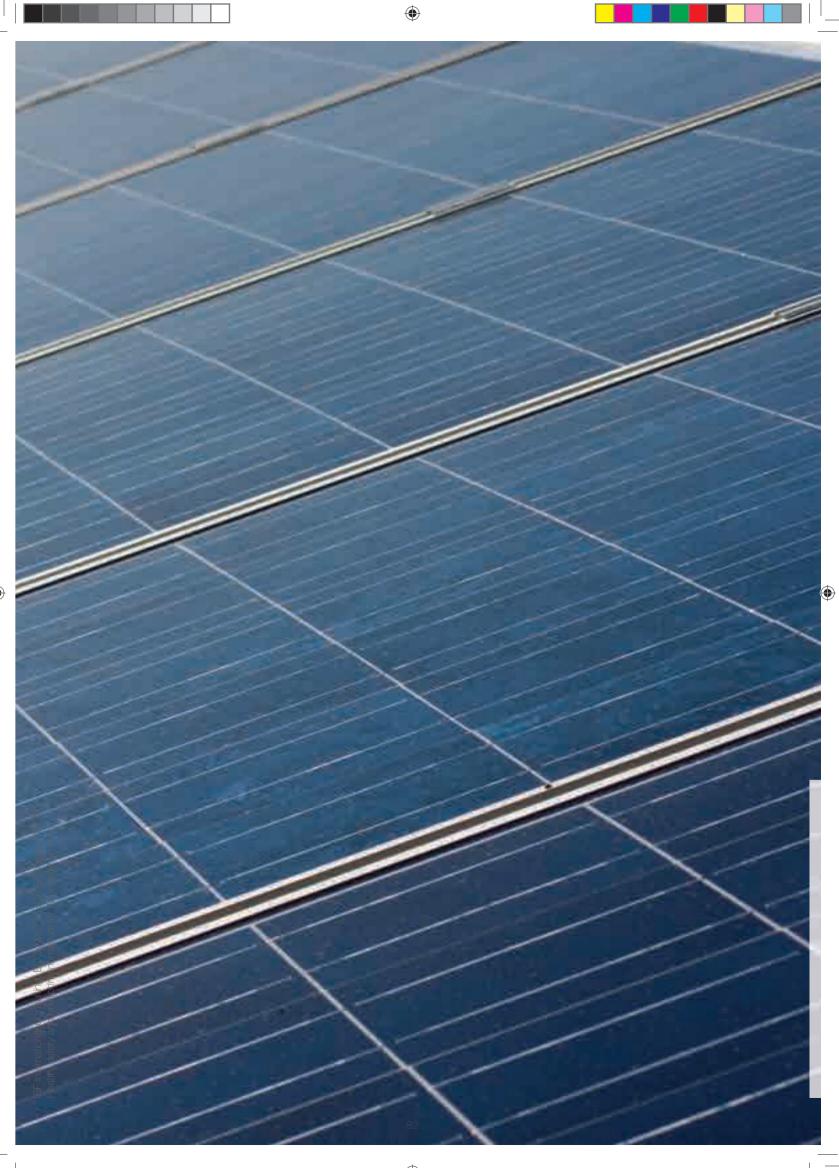


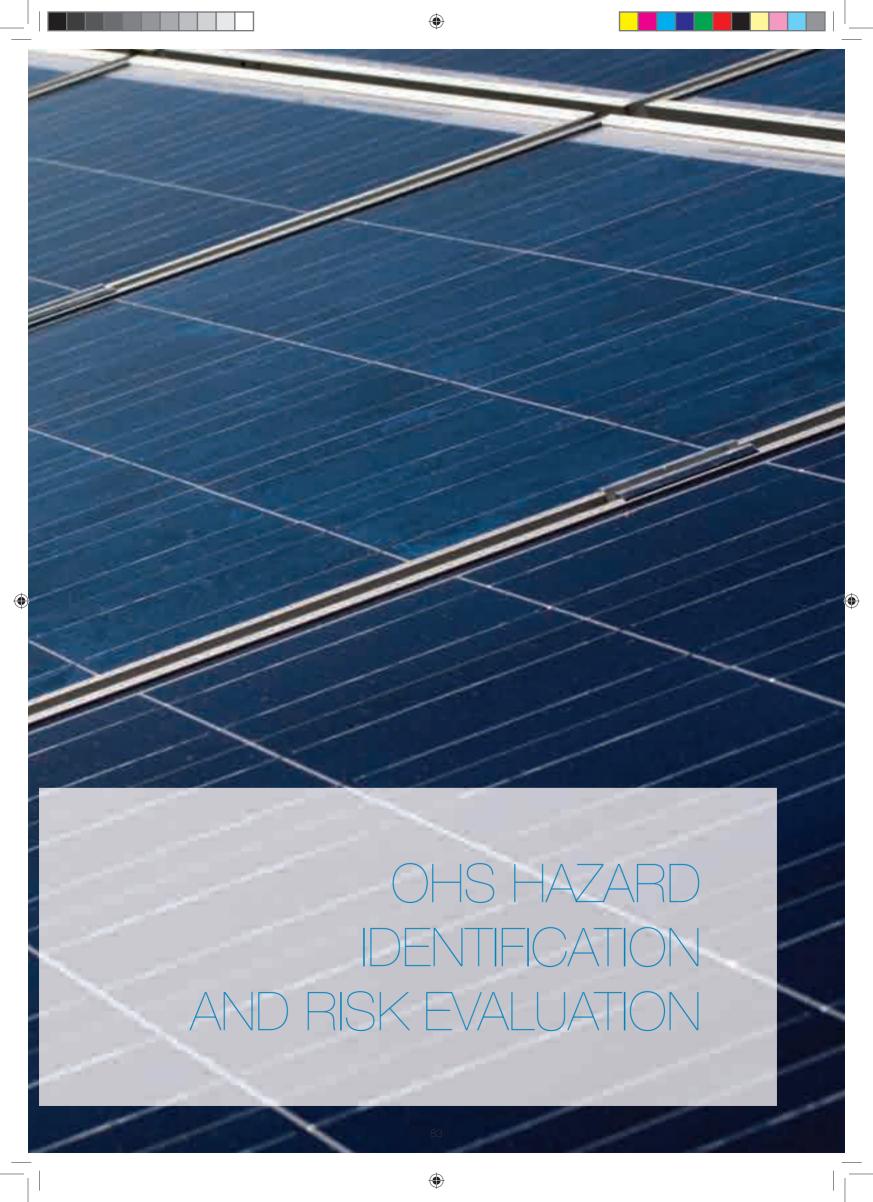
SI.No	Environmental impact	Proposed mitigation measures	Responsible
15	Restoring temporary access roads.	Post construction of solar park sites, restore the access roads to pedestrian safe use condition.	Contractor.
		<ul> <li>Implement measures to prevent and mitigate impacts of air and noise pollution.</li> <li>Training of workers on safe construction practices.</li> </ul>	
		Maintain good housekeeping in the construction area.	
		Sarricade excavated areas.	
		Implement work permit system for work at height.	
		Provide training to construction workers on safe work practices.	
16	Occupational health and safety of workers.	Record and investigate injuries to workers.	Contractor.
		Provide PPE to construction workers.	
		<ul> <li>Safety shoes, hard hat/ helmet and hand gloves with grip facility to all workers.</li> </ul>	
		<ul> <li>Nose masks for those working in dusty areas.</li> </ul>	
		<ul> <li>Earplugs for those working in high noise areas.</li> </ul>	
		<ul> <li>Nitrile rubber gloves to those engaged in painting activities.</li> </ul>	
		<ul> <li>Face shield for those engaged in welding.</li> </ul>	





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### **OHS** hazards

Hazards and Risks often decide the occurrence of incidents and their resulting consequences. The typical hazards and risks of a construction site are listed below. These are generic and apply across all the type of works covered in this manual.

Table 11 Common OHS hazards and risks on construction sites



#### Common OHS hazards

Common unsafe acts

Object striking person.

Person striking object.

Fall on same or another level.

Caught between part of body or clothing.

Exposures - inhale, ingest, contact, hear.

Excessive force causing ergonomic issues.

Repetitive activity causing ergonomic issues.

Unsafe act.

Unsafe condition.

Event.

Fire, flood, earthquake.

Failure to follow instructions of proper job procedure.

Cleaning, oiling, adjusting, or repairing equipment that is moving, electrically energized, or pressurized.

Failure to use available personal protective equipment such as gloves, goggles, hard hats.

Failure to wear safe personal attire.

Failure to secure or warn.

Improper use of equipment.

Improper use of hands or body parts.

Making safety devices inoperable.

Operating or working at unsafe speeds.

Taking unsafe position or posture.

Unsafe placing, mixing, combining.

Using tools or equipment known to be unsafe.

Driving errors.



#### The potential injuries from jobsite hazards may include:

- Severe / traumatic / massive head / brain / skull injuries.
- Broken/fractured / shattered bones.
- Spinal injuries.
- Punctured lungs.
- Internal organ injuries.
- Electrocution.
- Burns.

- Heatstroke.
- Severe cuts or lacerations.
- Serious back or neck injures.
- Puncture injuries from falling onto items.
- Eye injuries.
- Strains and sprains.
- Death.

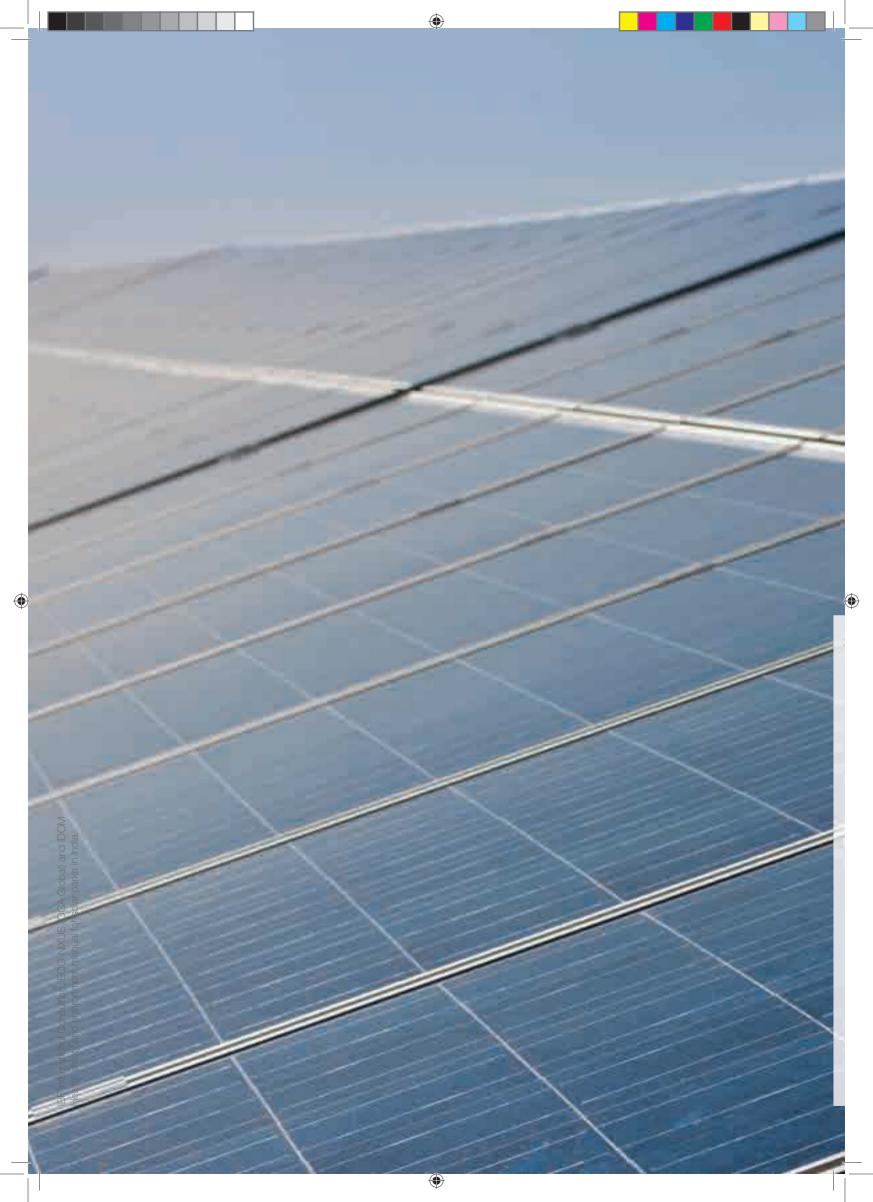
Once the jobsite evaluation is carried out and identified where and how work is being performed, associated OHS hazards and risks would need to be evaluated. The annexure I discusses how to evaluate and reduce the risks associated with the identified hazards by eliminating and controlling the hazard situation.





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## **Environmental impacts General information**

The construction of common facilities will generate certain environmental impacts.

It is anticipated that during the construction phase of the project, road traffic to and from the site will increase over a short period. It is expected that the major impact will be on the road, which links the highway to the site. The emission of noise, dust and exhaust gases of cars and trucks will reach an increased level, which will be directly attributable to the civil and construction activities.

Summarizing it can be said that during the construction phase:

- The impacts are only temporary.
- The impacts can be assessed as slight or intermediate.

## Raw material and conditioning

Impacts from fuels: During the common facilities erection, machinery will use diesel or gasoline as primary fuel. Diesel, however, has a high potential for contaminating the soil and the ground (incl. ground water) once it has penetrated the soil surface. Respective measures should be taken that the impacts from the fuel on the ground are minimized, e.g.:

- Clean work without oil dripping or
- Appropriate measures to avoid oil leakages from sealed surfaces into the ground.

Through the construction of the buildings and the other infrastructure, a part of the soil will be sealed and compacted. The sealing will lead to a reduction of the soil surface available for rain water infiltration.

## Atmospheric pollution: emissions and corrective actions

During the construction phase of the solar park and associated common facilities, the following impacts are to be expected:

- Temporary increase in air pollution from the construction site, from construction materials utilized on site and from the transportation of construction materials.
- Temporary noise and vibration pollution produced by construction equipment.

In the construction phase air pollution is predominately produced by dust and exhaust gas from trucks and construction machinery. It is indicated that during site preparation, the following construction equipment will cause adverse impacts on air quality: trucks, compactors, pile drivers, jackhammer and drills, generators, asphalt heating equipment, concrete processing stations. Because most of this equipment uses gasoline or diesel, they will emit particulate matter, SO<sub>2</sub>, N<sub>0</sub>X and VOC into the air.

The major air pollutant during the construction phase will be dust produced by earth works (digging, excavation, filling, levelling), particularly during the dry season. Receptors, which can be affected, are areas surrounding the construction sites, as well as houses and buildings located at approximately 200 m from the construction site. However, as the impairment is limited to the construction phase, the additional impact of





Mitigation plan: Air pollution during the construction phase (mainly during civil work activities) may occur mainly due to dust emission. The Contractor will be required to implement and apply the following measures to mitigate dust and prevent traffic accidents:

- Limitation of the maximum speed at the construction site, and the access road leading to the site.
- Watering of the site during works.
- Install a wind sealed fence at the border of site.
- Vehicles transporting open loads of construction materials such as sand or clay shall be covered.

## Land and water pollution: effluents and corrective actions

The rainwater drainage systems to be designed will be based on the long-term data on rainfall (e.g. over the previous ten years) to ensure adequate and sufficient drainage.

The sanitary and other water-consuming installations during construction should be selected, maintained and operated in a way that the water consumption will be minimized.

Mitigation plan: The measures for the protection of ground water and soil quality during the construction phase should comprehend, but should not be limited to:

- Disposal of solid waste (construction waste, sand, stone etc.) and waste grease and oil from construction equipment to the soil and local ground water will be prevented. All the waste will be collected and transported to the approved disposal sites.
- Installation of adequate sanitation systems (for example mobile toilet facilities) for workers to prevent untreated or inappropriate domestic waste water discharge.

A positive impact on the protection of ground water and soil quality during the construction phase will be the removal of any materials as old metal, bins and other wastes which may be stored on the area of the solar park.

## Noise: measurement and corrective actions

Typically, potential noise impacts from site characterization activities would be negligible, because these activities are short term, generate minimum noise, and can be conducted with a small crew and small equipment. These activities may require larger equipment and could generate substantial noise. However, the potential noise impacts from such activities on neighbouring communities would be much lower than those of construction activities.



## Environmental impacts during erection, commissioning, operation and maintenance

In the following table the contaminant source, potential for harm and corresponding corrective measures should be indicated for the construction period:

Table 12 Contaminant source potential for harm and corresponding corrective measures

Contaminant source	Potential for harm	Examples of corrective and mitigation measures
Solid waste from labour camps and construction sites.	Irresponsible disposal or burning of solid waste could lead to land degradation, emissions and health impacts.	Solid waste must be minimised, segregated and disposed / recycled (refer to solid waste management rules, 2016);  Dust must be collected and disposed adequately.
Liquid effluents from construction sites.	Untreated discharges of wastewater can pollute water bodies / land and cause adverse impacts on human health and aquatic ecosystems.	
Dust and air emissions from construction equipment and activities.	Emissions can cause health impacts and visibility issues.	Air pollutants shall be monitored.  (Refer to national ambient air quality standards, 2009).  During operational phase, sulphur hexafluoride (SF <sub>6</sub> gas) is often used in switchyards. This is a greenhouse gas (GWP of more than 23000 as a function of CO <sub>2</sub> ) and its leakage from the substation needs to be controlled to minimise its potential of global warming contribution.
Odours from chemical and fuel handling / storage.	Causes nuisance and unpleasantness.	Unpleasant odours shall be removed or avoided.
Noise from construction activities.	Sustained exposure to high noise levels can cause hearing loss in the long term. Short term noise pollution can cause nuisance / disturb animal habitats.	,



Contaminant source  Potential for harm  Examples of corrective and mitigation measures  Planning of excavation / blasting activities as well as design of equipment installations should be undertaken with proper foundation and damping insulation to avoid the transmission of vibrations.  Depending on the intensity of the vibrations, they can cause structural damage to buildings as well as disturb animal habitats.  Depending on the intensity of the vibrations should be undertaken with proper foundation and damping insulation to avoid the transmission of vibrations.  (No Indian standard available — British standard BS 7385 or German standard DIN 4150 could be used).  The use of flammable material must be avoided as far as possible.  Explosives shall be used according to specific legislation.  Such material should be stored with proper care and protective infrastructure.  Refer to:  Refer to:  Manufacture, storage and import of hazardous chemicals rules, 1989.				
Vibrations due to demolition of structures, blasting / excavation in rock.  Depending on the intensity of the vibrations, they can cause structural damage to buildings as well as disturb animal habitats.  Depending on the intensity of the vibrations, they can cause structural damage to buildings as well as disturb animal habitats.  (No Indian standard available – British standard BS 7385 or German standard DIN 4150 could be used).  The use of flammable material must be avoided as far as possible.  Explosives shall be used according to specific legislation.  Such material should be stored with proper care and protective infrastructure.  Refer to:  Refer to:  Manufacture, storage and import of hazardous chemicals rules, 1989.	Contaminant so	ource	Potential for harm	
avoided as far as possible.  Explosives shall be used according to specific legislation.  Such material should be stored with proper care and protective infrastructure.  Flammable material and explosives used in rock blasting.  Can cause fires / explosions and result in loss of life as well as habitats.  Refer to:  Explosives and protective infrastructure.  Refer to:  Explosives act, 1984.  Manufacture, storage and import of hazardous chemicals rules, 1989.	of structures, b	lasting /	vibrations, they can cause structural damage to buildings as well as disturb	activities as well as design of equipment should address this issue. Equipment installations should be undertaken with proper foundation and damping insulation to avoid the transmission of vibrations.  (No Indian standard available – British standard BS 7385 or German standard
Sections of the factory act, 1948	explosives used			avoided as far as possible.  Explosives shall be used according to specific legislation.  Such material should be stored with proper care and protective infrastructure.  Refer to:   Manufacture, storage and import of hazardous chemicals rules,

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state factories rules.

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SI No

Environmental impact

### Post construction activities

Excavation activities at construction sites as well as raw materials extraction sites often involve major topographical and land-cover changes to allow extraction activities, often including clearing of pre-existing vegetation. Techniques to minimize the land conversion impacts include:

- a) Selection of appropriate low-impact extraction methods that result in final site contours supportive of habitat restoration principles and intended land use.
- b) Establishment of buffer zones from the edge of extraction areas considering the characteristics of the natural habitats and the type of extraction activities.
- c) Vegetation translocation and relocation techniques should be used as necessary (e.g., vegetation cover such as native local plants, topsoil, overburden, or spoils feasible for sustaining growth should be removed in separate operations and segregated for later use during site reinstatement and materials to be used for site reinstatement should be stockpiled and protected from wind and water erosion as well as contamination).
- d) Smaller, short-lived sites should be reclaimed immediately and larger sites with a useful lifespan beyond 3-5 years should be subject to ongoing rehabilitation.
- e) To the extent possible the affected land should be rehabilitated to acceptable uses as required by the permit.
- f) Test pits, interim roads, buildings, installations and structures of no beneficial use should be removed and the land should be appropriately rehabilitated.

## Generic environmental mitigation measures

The Table 12 below presents the Mitigation measures for minimizing / controlling environmental impacts described in the above sections. Many of these would need to be included as covenants, in the Contractual agreements to allocate specific environmental roles and responsibilities to the construction contractors.

Table 13 Environmental Mitigation Measures

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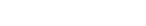
Proposed mitigation measures

SI.IVO	Environmental impact	Proposed miligation measures	Responsible
1	Tree cutting.	<ul> <li>Based on the tree survey conducted at the solar park sites, plan access roads, transmission line (new) alignment etc. to minimize tree cutting / vegetation removal.</li> <li>Trees shall be removed from the construction sites before commencement of construction with prior permission from the concerned department / authorities.</li> <li>Compensatory plantation by way of re-plantation of at least thrice the number of trees cut should be carried out in the project area, as per regulatory guidelines.</li> <li>Prior permission will have to be obtained for tree cutting from the applicable authorities.</li> </ul>	SPPD / SPD / Contractor.



SI.No	Environmental impact	Proposed mitigation measures	Responsible
		If sites are proximal to human habitats and sensitive receptors like schools, hospitals, mitigation measures are to be planned which may include: noise barriers during construction, timing of construction activity to avoid night work:	
		Servicing of all construction vehicles and machinery will be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced.	
	Noise pollution / air emissions.	Maintenance of vehicles, equipment and machinery shall be regular and up to the satisfaction of the engineer to keep noise levels at the minimum.	
2	Noise pollution from vehicles, construction equipment and other activities.	Idling of temporary trucks or other equipment should not be permitted during periods of loading / unloading or when they are not in active use. The practice must be ensured especially near residential /commercial /sensitive areas.	Contractor.
		All possible and practical measures to control noise emissions during drilling shall be employed.	
		Notwithstanding any other condition of contract, noise level from any item of plants must comply with the relevant legislation for levels of noise emission.	
		The contractor will ensure that the Ambient Air Quality at these construction sites is within the acceptable limits of industrial uses in case of hot mix plants and crushers and residential uses around construction camps.	
3	Severance due to utilities on site / access road.	All utilities (existing roads, structures, poles, water lines etc.) will be relocated with prior approval of the concerned agencies before construction starts.	Contractor.
		Prior information to affected people.	
4	Replacement of common amenities on access roads.	♦ All affected common amenities such as community sources of water, bus shelters, cultural / religious properties, etc., will be relocated wherever necessary. The relocation site identification will be in accordance with the choice of the community and completed before construction starts.	SPPD / Contractor.
5	Planning temporary traffic diversion and pedestrian safety.	Where existing roads are passing through park sites a diversion road will be developed with the approval of the local municipality or gram panchayat.	Local authority / SPPD / Contractor.





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SI.No	Environmental Impact	Proposed mitigation measures	Responsible
6	Sanitation and sewage system at labour camps and construction yards.	The contractor will ensure that:  the sewage system for the camp is designed, built and operated in such a fashion that no health hazards occurs and no pollution to the air, ground water or adjacent water courses take place.  separate toilets/bathrooms, wherever required, screened from those from men (marked in vernacular) are to be provided for women.  adequate water supply is to be provided in all toilets and urinals.  all toilets in workplaces are with dry-earth system (receptacles) which are to be cleaned and kept in a strict sanitary condition.  Adequate health care is to be provided for the work force during the entire phase.	Contractor.
	Waste disposal at labour camps and construction yards.	The contractor will provide garbage bins in the camps and ensure that these are regularly emptied and evacuated in a hygienic manner.	Contractor.
7	Disposal of construction debris and excavated materials.	A suitable site should be identified for safe disposal, in relatively low-lying areas, away from the water bodies etc., as approved by the local authority.	
8	Drainage flow.	Alternate arrangement like diversion of the drainage (storm water) to be ensured to allow the natural flow of water to downstream areas without water logging / flooding.	Contractor.
9	Temporary flooding due to excavation.	Proper cross drainage arrangements to be made, to avoid the overflowing of existing drains due to excavation during the laying of sewer mains.	Contractor.
10	Dust pollution near settlements.	<ul> <li>All earth work will be protected in manner acceptable to the engineer to minimize generation of dust. Area under construction shall be covered &amp; equipped with dust collector.</li> <li>Construction material shall be covered or stored in such a manner so as to avoid being affected by wind direction.</li> <li>Unpaved haul roads near / passing through residential and commercial areas to be watered thrice a day.</li> <li>Trucks carrying construction material to be adequately covered to avoid the dust pollution and to avoid the material spillage.</li> </ul>	Contractor.
11	Stockyards.	<ul> <li>Location for stockyards for construction materials will be identified at sufficient distance from water course, hill slopes and labour camps.</li> </ul>	Contractor.









flammables, etc.

♦ Separate enclosures shall be planned for storing construction materials containing fine particles, chemicals,



SI.No	Environmental Impact	Proposed mitigation measures	Responsible
		Contractor will ensure that all vehicle/machinery and equipment operation, maintenance and refuelling will be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground. Oil interceptors will be provided for vehicle parking, wash down and refuelling areas as per the design provided.	
12	Soil pollution from fuel and lubricants.	In all, fuel storage and refuelling areas, if located on agricultural land or areas supporting vegetation, the top soil will be stripped, stockpiled and returned after cessation of such storage.	Contractor.
		Contractor will arrange for collection, storing and disposal of oily wastes to the pre-identified disposal sites (list to be submitted to engineer) and approved by the engineer. All spills and collected petroleum products will be evacuated in accordance with MoEF and state PCB guidelines.	
		Engineer will certify that all arrangements comply with the guidelines of PCB/MoEF or any other relevant laws.	
13	Pollution from transportation of construction materials.	All vehicles delivering materials to the site will be covered to avoid spillage of materials. All existing roads used by vehicles of the contractor, or any of his sub – contractor or suppliers of materials and similarly roads which are part of the work will be kept clean and clear of dust/ mud or other extraneous materials dropped by such vehicles.	Contractor.
		The fall height shall be kept low so that the least amount of dust is airborne, during unloading of materials.  The unloading of materials at construction sites close to settlement will be restricted to daytime.	
14	Pollution from construction wastes.	The Contractor shall take all precautionary measures to prevent the wastewater generated during construction from entering into streams, water bodies or the irrigation system. All waste arising from the project is to be evacuated in the manner that is acceptable by the engineer.	Contractor.
••••	Restoring temporary	Post construction of solar park sites restore the socces	
15	Restoring temporary Access roads.	Post construction of solar park sites, restore the access roads to pedestrian in safe use condition.	Contractor.





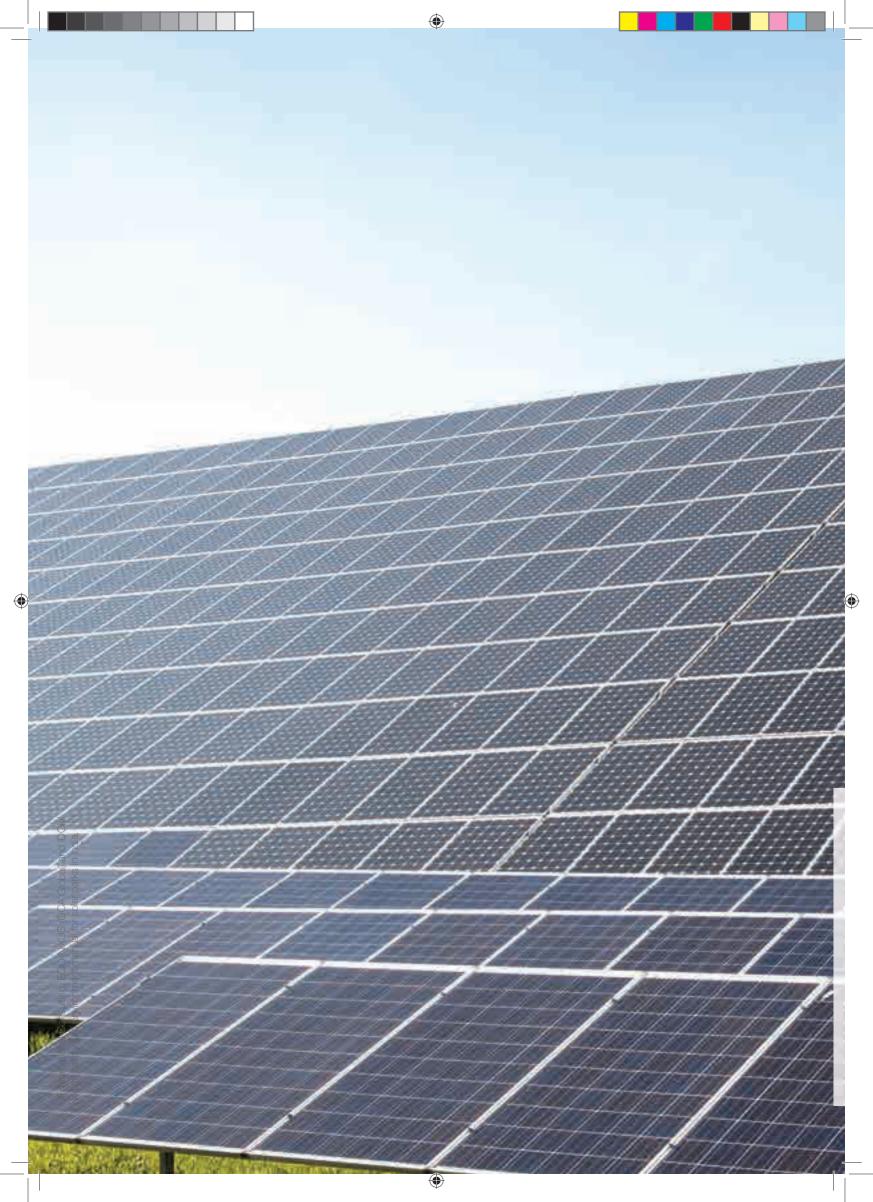
SI.No	Environmental Impact	Proposed mitigation measures	Responsible
		Implement measures to prevent and mitigate impacts or air and noise pollution.	
		Training of workers on safe construction practices.	
		Maintain good housekeeping in the construction area.	
		Barricade excavated areas.	
		Implement work permit system for work at height.	
		Provide training to construction workers on safe work practices.	
16	Occupational health and safety of workers.	Record and investigate injuries to workers.	Contractor.
		Provide PPE to construction workers:	
		<ul> <li>Safety shoes, hard hat/ helmet and hand gloves with grip facility to all workers.</li> </ul>	
		<ul> <li>Nose masks for those working in dusty area.</li> </ul>	,
		<ul> <li>Earplugs for those working in high noise areas.</li> </ul>	•
		<ul> <li>Nitrile rubber gloves to those engaged in painting activities.</li> </ul>	
		• Face shield for those engaged in welding.	

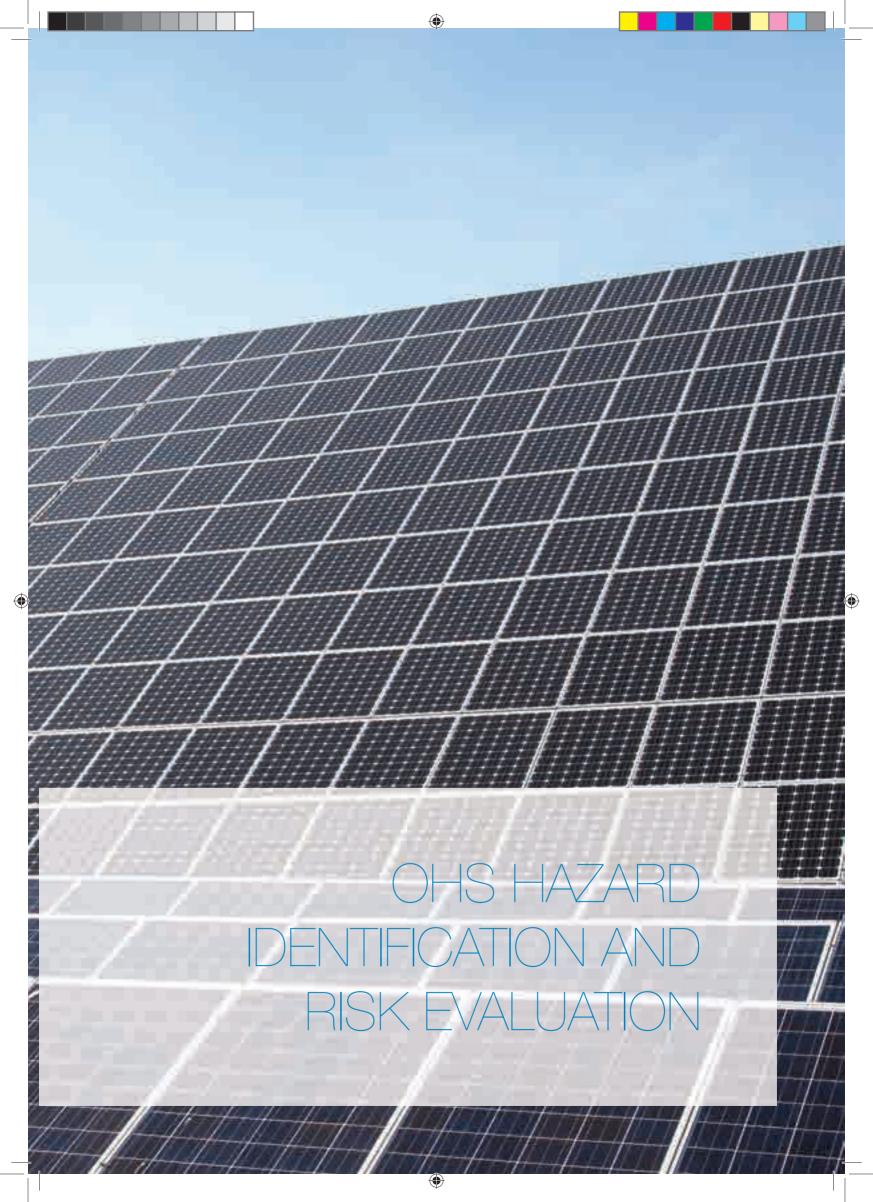




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### **OHS** hazards

Hazards and Risks often decide the occurrence of incidents and their resulting consequences. Then typical hazards and risks of a construction site are listed below. These are generic and apply more or less across all the type of works covered in this manual.

Table 14 Common OHS hazards and risks on construction sites



#### Common OHS hazards

#### Common unsafe acts

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Person striking object.

Fall on same or another level.

Caught between part of body or clothing.

Exposures - inhale, ingest, contact, hear.

Excessive force causing ergonomic issues.

Repetitive activity causing ergonomic issues.

Unsafe act

Unsafe condition.

Event.

Fire, flood, earthquake.



Failure to follow instructions of proper job procedure.

Cleaning, oiling, adjusting, or repairing equipment that is moving, electrically energized, or pressurized.

Failure to use available personal protective equipment such as gloves, goggles, hard hats.

Failure to wear safe personal attire.

Failure to secure or warn.

Improper use of equipment.

Improper use of hands or body parts.

Making safety devices inoperable.

Operating or working at unsafe speeds.

Taking unsafe position or posture.

Unsafe placing, mixing, combining.

Using tools or equipment known to be unsafe.

Driving errors.



#### The potential injuries from jobsite hazards may include:

- Severe / traumatic / massive head / brain / skull injuries.
- Broken/fractured / shattered bones.
- Spinal injuries.
- Punctured lungs.
- Internal organ injuries.
- Electrocution.
- Burns.

- Heatstroke.
- Severe cuts or lacerations.
- Serious back or neck injures.
- Puncture injuries from falling onto items.
- Eye injuries.
- Strains and sprains.
- Death.

Once the jobsite evaluation is carried out and identified where and how work is being performed, associated OHS hazards and risks would need to be evaluated. The annexures I discusses how to evaluate and reduce the risks associated with the identified hazards by eliminating and controlling the hazard situation.



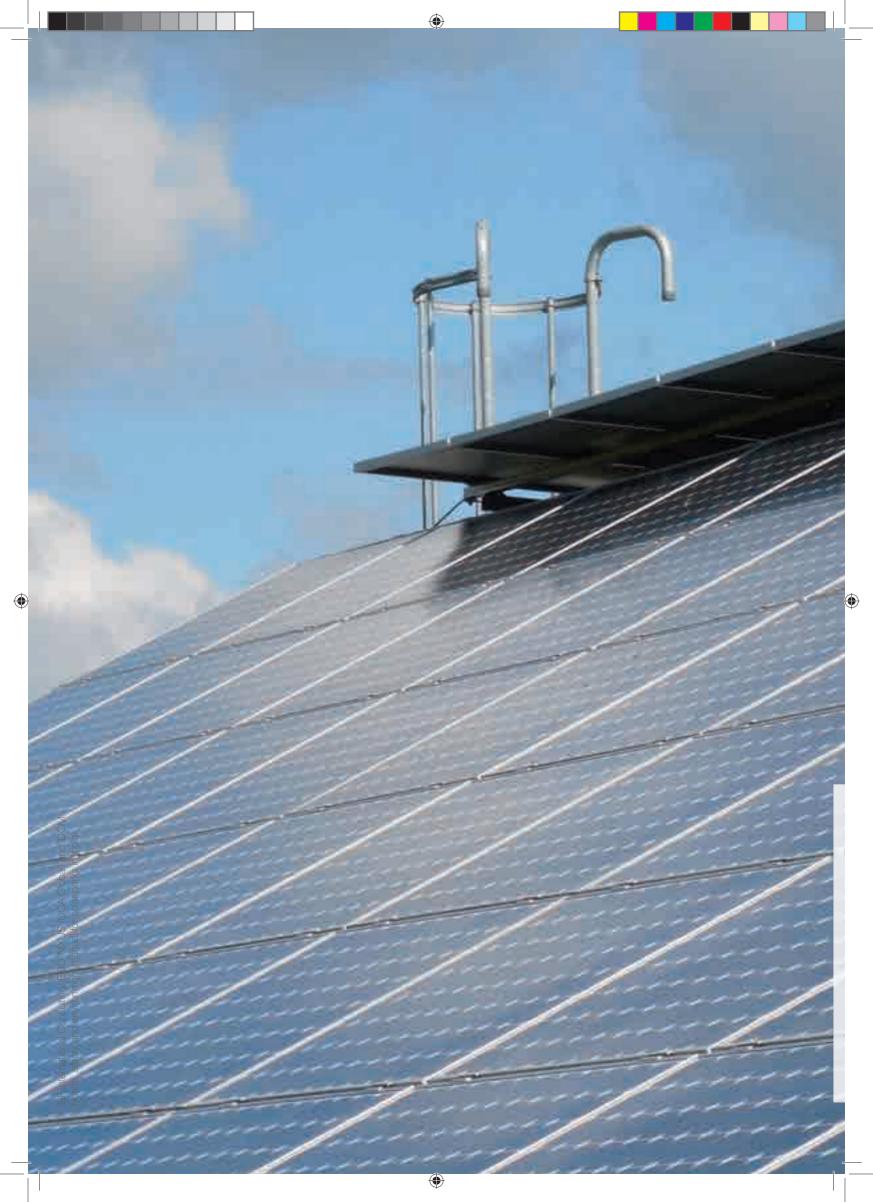
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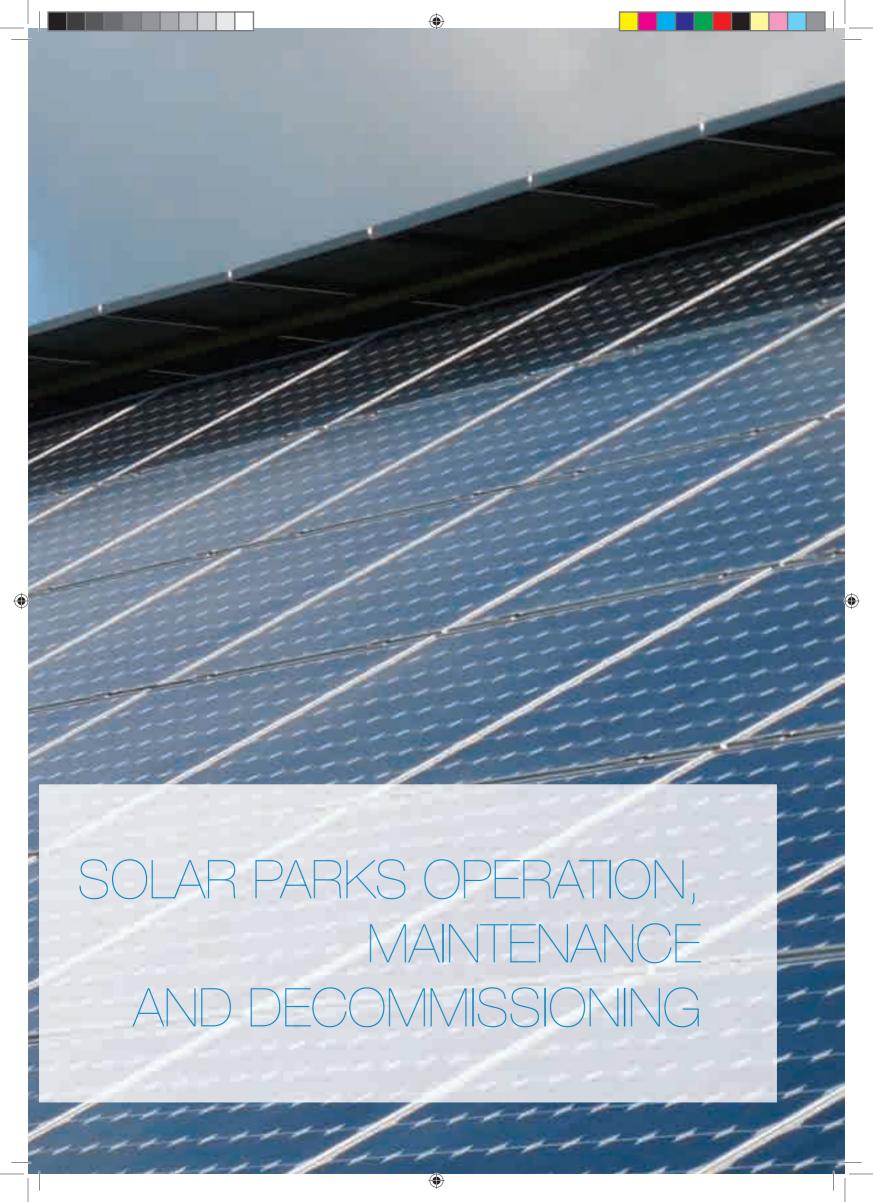




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### General

The operation, maintenance and decommissioning of solar park includes two perspectives:

1. Operation of the solar park (SPPD)

This includes all activities to be carried out by the park authorities (SPPD) for provision and maintenance of common infrastructure and utilities such as roads, water supply, wastewater treatment, storm water drainage, landscape management, security, administration of the park and other related tasks.

2. Operation of individual solar PV plants (SPD)

This would include specific requirements applicable to individual Solar PV / plants (SPD) located in the park, from regulatory requirements as well as management of HSE risks on site during construction and operation of the plant.

The environmental impacts and OHS risks involved in both these perspectives are presented below.

### **Environmental impacts**

A solar park project envisages three distinct phases for which environmental issues are relevant and need to be addressed:

Construction phase impacts:

This involves all activities related to site planning, land preparation, civil works on site and supporting utilities prior to the commissioning of the plant operations.

Operations phase impacts:

This involves the commissioning stage and the power generation (operational) stage, including maintenance.

Decommissioning phase impacts:

After the operation of the solar park and if retrofit doesn't turn out to be feasible, then decommissioning activities would need to be undertaken including safe disposal / recycling of all installed assets and the defunct PV panels. The anticipated impacts during the decommissioning stage would be similar to construction stage impacts.



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The key environmental impacts of operation and decommissioning of solar PV plants and solar parks are presented in the table below:

Table 15 PV plants and solar parks operation and decommissioning environmental impacts

Project stage	Key environmental issues
	1. Potential glare impact on avian fauna (birds), particularly in park areas proximal to plantations, water bodies, vegetation or forests.
	2. Generation of hazardous waste in the form of damaged solar PV panels, waste oil from maintenance activities of electrical installations.
On anti-malatana	3. Release of ${\rm SF}_{\scriptscriptstyle 6}$ (Greenhouse Gas) from electrical substations connected to the solar parks.
Operational stage.	4. Water logging in monsoon due to ineffective drainage channels.
	5. Soil erosion on some sites having undulating topography.
	6. Water consumption for washing and maintenance of PV modules (estimates indicate a requirement of about 2 to 3 litres per m² of PV modules).
	7. Generation, treatment and disposal of sewage and wash-water from facilities.
Decembricationing store	Impacts will be largely similar to construction phase with more emphasis on segregation and disposal of various waste streams from the dismantling of infrastructure and equipment.
Decommissioning stage.	2. Restoration of land to as-before status will be important if alternative land-use is not being considered. This may involve vegetation and tree plantation, restoration of drainage, etc.

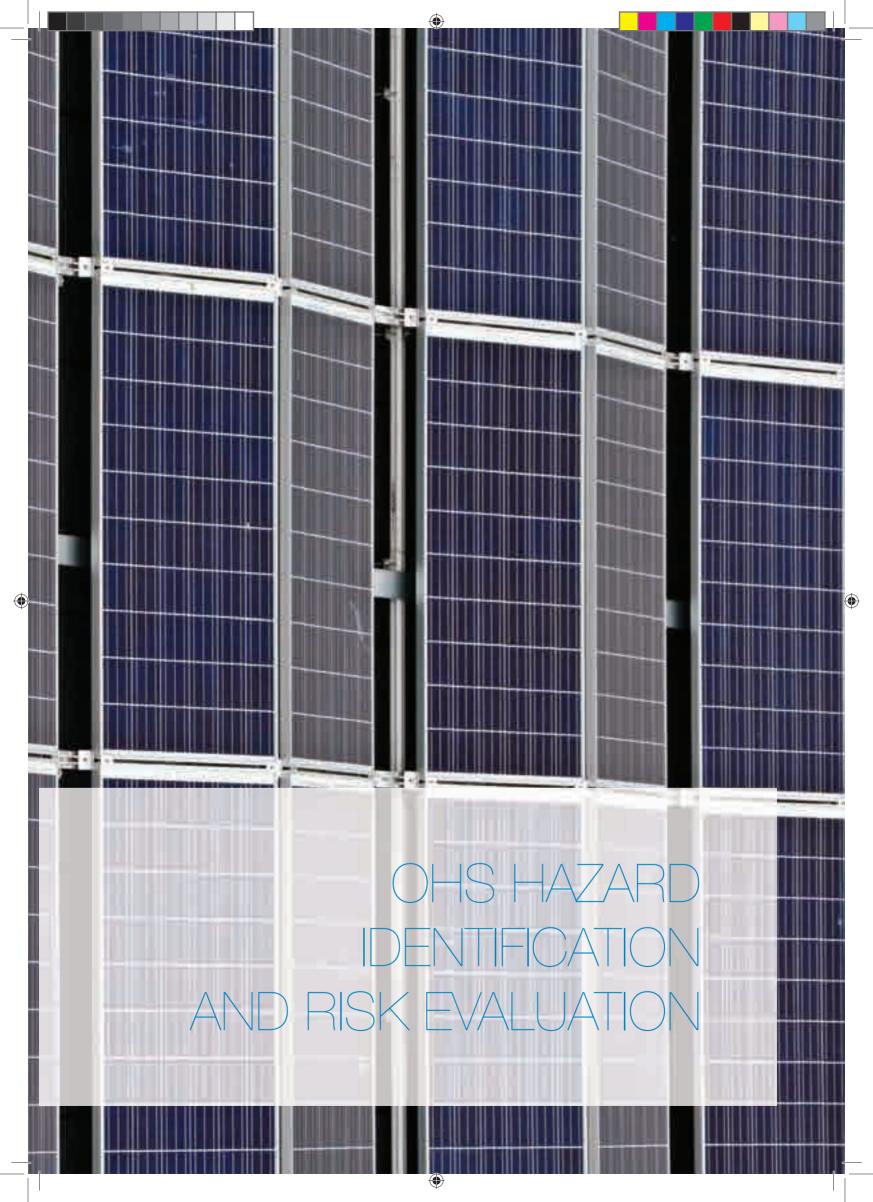
The solar park as well as the individual projects will need to seek consent to operate under the air and water acts as well as an authorization under the hazardous waste management rules (as explained earlier).

Other regulatory requirements as outlined before would need to be considered for various aspects of the operations of a solar park.

Monitoring of environmental parameters such as air emissions from DG sets, ambient air quality, noise quality, waste generation and dispatch, sewage and wastewater characteristics (raw and treated) will need to be carried out. Regulatory requirements also include periodic reporting of environmental performance to the local authorities such as pollution control board.

Similarly, periodic inspections and audits need to be performed so as to identify gaps and correct the situation.









### **OHS** hazards

Hazards and Risks often decide the occurrence of incidents and their resulting consequences. Then typical hazards and risks of a construction site are listed below. These are generic and apply more or less across all the type of works covered in this manual.

Table 16 Common OHS hazards and risks on construction sites



#### Common OHS hazards

Common unsafe acts

Object striking person.

Failure to follow instructions of proper job procedure.

Person striking object.

Cleaning, oiling, adjusting, or repairing equipment that is moving, electrically energized, or pressurized.

Fall on same or another level.

Failure to use available personal protective equipment such as gloves, goggles, hard hats.

Caught between part of body or clothing.

Failure to wear safe personal attire.

Exposures – inhale, ingest, contact, hear.

Excessive force causing ergonomic issues.

Failure to secure or warn.

Repetitive activity causing ergonomic issues.

Improper use of equipment.

Unsafe act.

Improper use of hands or body parts.

Unsafe condition.

Making safety devices inoperable.

Event.

Operating or working at unsafe speeds.

Fire, flood, earthquake.

Taking unsafe position or posture.

Unsafe placing, mixing, combining.

Using tools or equipment known to be unsafe.

Driving errors.



The potential injuries from jobsite hazards could include:

- Severe / traumatic / massive head / brain / skull injuries.
- Burns.
- Broken/fractured / shattered bones.
- Heatstroke.

Spinal injuries.

Severe cuts or lacerations.

Punctured lungs.

Serious back or neck injures.

Internal organ injuries.

Puncture injuries from falling onto items.

Electrocution.

Eye injuries.

Death.

Strains and sprains.

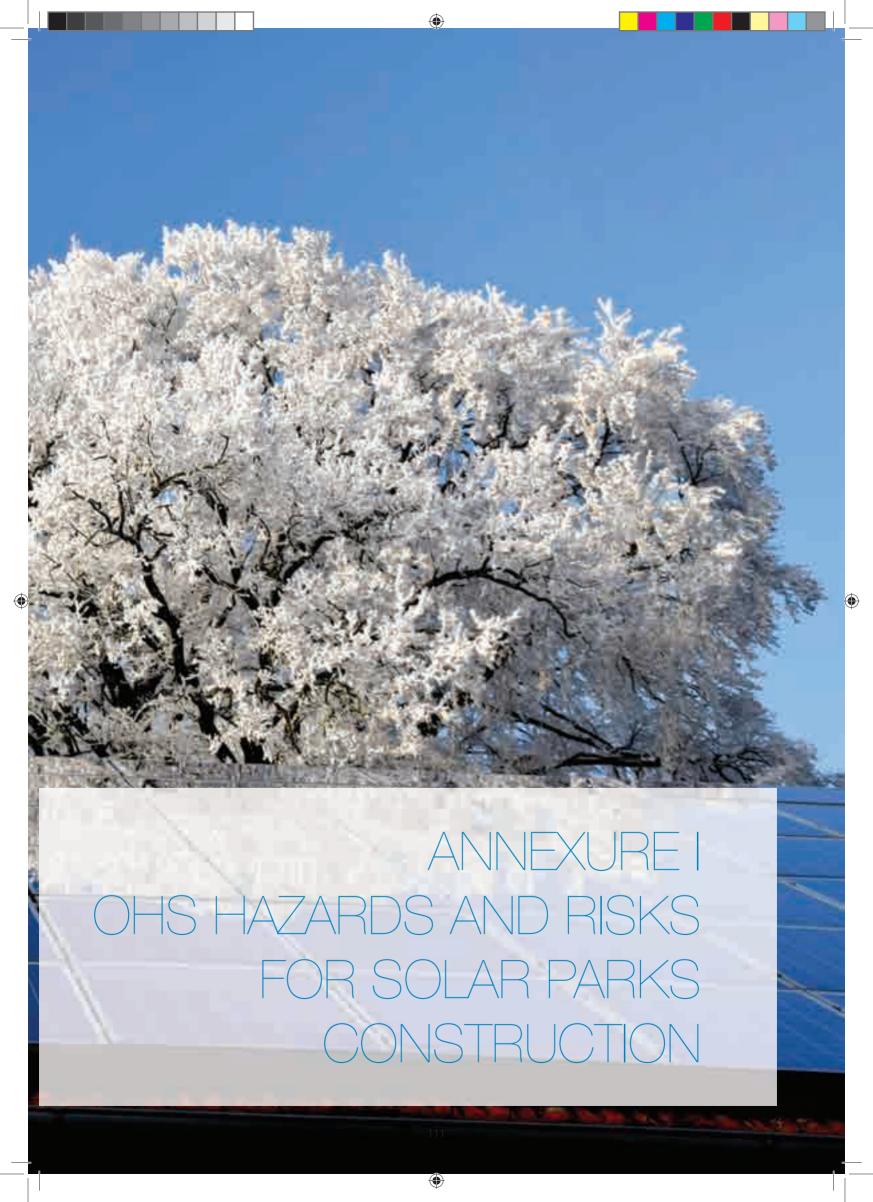
Once the jobsite evaluation is carried out and identified where and how work is being performed, associated OHS hazards and risks would need to be evaluated. The annexure II discusses how to evaluate and reduce the risks associated with the identified hazards by eliminating and controlling the hazard situation.



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## **OHS** hazards

The figure below depicts the typical transformation of a hazard into a risk and finally resulting into an accident.

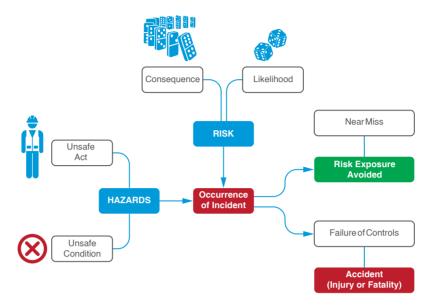


Figure 7 Mechanising of an accident.

General jobsite safety: Learning to evaluate and identify potential safety hazards is a critical first step to eliminating risks and potential injuries. A good understanding of workplace hazards enables the prevention of accidents and a quicker recovery if one occurs.

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Conducting an analysis of unique hazards:

- Leads to properly identifying safety training needs.
- Helps identify the measures necessary to ensure the workplace is a safe one, such as the need for additional equipment and personal protective gear.
- Helps determine how to eliminate or control hazards before they cause injuries.

It's important to evaluate each specific situation to develop a list of the hazards and the potential injuries that could occur. Understanding the hazards and potential injuries, and the likelihood of an accident occurring, enables you to set up a suitable safety policy for each specific situation.

Typical construction work situations include:

- Working at height.
- Carrying out hot work (welding and gas cutting).
- Accessing confined spaces for excavation / civil work.
- Using power tools.
- Working with ladders to access equipment.
- ♦ Working in extreme weather conditions (hot, cold, wind, etc.).





In addition to these, specific activities such as excavation, land levelling, batch mixing, concreting (foundations, slabs, columns etc.) material / equipment hauling and installations, and other ancillary tasks are often required.

A formal hazard identification (as explained in Table 7) should be carried out and the hazards should be risk assessed based on consequence potential, likelihood of occurrence and existing controls.

A generic guidance on categorising consequence (severity of impact) is provided below.

Severity factor (S)	Consequence/ severity	Description
1	Insignificant/ negligible.	No fatality, no injury, no ill health (momentary discomfort/ inconvenience).
2	Slightly harmful/ marginal.	No fatality, non-reportable injury requires first-aid.  Chronic work-related exposure leading to ill-health requiring in-company medication.
3	Harmful/ moderate.	Injuries, absence from the work for less than or equal to 48 hrs./ temporary disability.  Chronic work-related exposure leading to ill-health requiring medical attention (e.g. hearing loss, chronic back pain).
4	Very harmful/ severe.	Major injuries, absence from the work for more than 48 hrs./ temporary disability.  Chronic work-related exposure leading to loss of livelihood.
5	Extremely harmful/ catastrophic.	Fatal/ Permanent Disability. Major incidents involving a large number of people.  Chronic work-related exposure leading to fatal/ permanent Disability.

Similarly, a generic guidance on categorising likelihood (probability) of occurrence of a hazard / incident is described below:

Probability (P)	Probability	Description
1	Highly unlikely/ remote.	If almost no gap exists in control of the identified OHS hazard as technology, operational control, competence, measurement monitoring in place.
2	Unlikely.	If there is any minor gap/ weakness in control of the identified OHS hazard.
3	Likely/ occasional.	There are unreasonable gaps in control of the identified OHS hazard with respect to adoption of technology, operational control, measurement monitoring and competence.
4	Highly likely/ frequent.	There are unreasonable major gaps in control of the identified OHS hazard with respect to adoption of technology, operational control, measurement monitoring and competence.
5	Certain.	There are almost no controls in place in controlling the identified OHS hazard and have occurred in the past but were ignored.









Risk levels can differ based on varying conditions (unsafe acts / Risk levels can differ based on varying conditions (unsafe acts / unsafe conditions) and existing controls available.

Risk Level = Severity (S) x Probability (P)

- Low risk category is considered as an acceptable risk.
- Medium & High-risk categories are considered as unacceptable risk.

Low: No additional controls are required. Consideration may be given to a more cost-effective solution or improvement that imposes no additional cost burden to the organization. Monitoring is required to ensure that the controls are maintained.

**Medium:** Efforts should be made to reduce the risk, but the cost of prevention should be carefully measured, planned and limited, wherever possible. Risk reduction measures should be implemented by the organization.

**High:** Work should not be started or continued until the risk has been reduced. If it is not possible to reduce risk even with unlimited resources, work has to remain prohibited.

## OHS risks during construction and erection

It would be impossible to enumerate all the risks, which may arise during the development of construction projects, as the likelihood and foreseeability of accidents are sufficient factors to have them covered. It is possible to divide the risks into three different categories:

- Conventional risks.
- Extraordinary risks.
- Risk inherent to the works.

#### Conventional risks:

- Fire: There are many various reasons for a fire starting. Following is a list of typical circumstances that imply the existence of a high fire load: incorrect storage of flammable material, use of flammable liquids for engine combustion, use of plastics and combustible materials, welding works, heaters in warehouses, cigarette butts not properly extinguished, electrical material, etc.
- Lightning. Atmospheric electricity may cause damage, especially to transformers and buildings higher than others nearby. It is important to take into account the lack of lightning conductors during the construction stage. Moreover, the risk is sometimes aggravated by the presence of cranes, masts or flagpoles.
- Explosion. Provisional transformers for electricity supply, compressors or other devices m a y b e installed at the worksite, with a risk of explosion. Possible explosions originated outside the site are also covered.



#### Catastrophic risks (Force majeure):

- Winds, storms, hurricanes and cyclones: They may cause serious damage, and hence this fact must be taken into account in the project at the time of making the calculations in compliance with the regulations regarding this matter; although the completed projects are protected, this hazard exists during the construction stage.
- Floods and water-induced damage: Atmospheric variations imply that hydrological phenomena are likely to happen. Along with the fact that the mere existence of water at the worksite is already a permanent risk for the construction, it can be concluded that damage by water is one of the most frequent ones in insurance claims.
- Earthquakes: The risk of seismicity in the area is a fact that must be taken into consideration in the Project by applying the seismic regulations in force. Nevertheless, as it happened in the case of wind, there is only protection against damage for completed works, but not during the construction stage. In any case, even though a great earthquake is not likely to happen, there is still the chance of small seismic movements capable of causing, for example, the collapse of a building under construction.
- Ground subsidence, landslides and rockfalls: In these cases, the problems many times arise from
   the lack of a good geotechnical study or simply bad luck, given that -although the geological and
   geotechnical studies are more and more accurate- the deeper layers of ground may surprise with
   pockets of different material (e.g. clay strata, weathered rocks, etc.), causing accidents to happen.

Risk inherent to the works: These include the risks due to the activities carried out during the construction stage.

## Civil works related risks

The main risks associated to the civil works can be summarised in the following list:

- Defects in workmanship, unskillfulness, negligence and malicious acts (fraud).
- One of the characteristics already mentioned is the lack, in many occasions, of specialized workforce. This circumstance, together with the variety of workplaces is the reason for the unskillfulness of workers that cause a substantial number or accidents. Next are listed some of the most frequent ones:
  - Incorrect formwork underpinning, with partial collapsing.
  - Defective arrangement of formwork.
  - Abrupt concrete pouring, with collapse of plants under construction.
  - Defective crane anchoring which may cause people to fall.
  - Inadequate storages which, on producing unexpected overloads, result in partial collapse of the structure.
  - Lack of skill or carelessness in handling equipment, cause of innumerable damages to the construction work at hand as well as to third parties.
  - Negligence in the implementation of preventive measures: forgetting to connect the water evacuation pumps, lack of foresight in load lifting, and the like.





- Foundation. It is the part of a structure in direct contact with the ground, which transmits the load of the structure to the underlying ground. To prevent non-uniform building settlements, these loads must be absorbed by the ground through the foundation, which must be supported on highly resistant ground (rock or similar). There are several types of foundations in function of the loads to be transmitted and according to the characteristics of the ground and its behaviour: superficial (footings and slabs); semi-deep (floating caisson); and deep (piles and diaphragm walls).
- Structures. The group of resistant elements providing stability to the equipment. Errors in calculation or design and employment of defective or inadequate materials. Such factors usually result in large accidents. As example:
  - Fatigue of materials, due to defective manufacturing or the effect of corrosion.
  - Inadequate quality of the material.
  - Technical failure due to poor construction.

## **Electrical works related risks**

Overhead power lines: Overhead power lines are not insulated. More than half of all electrocutions are caused by direct worker contact with energized power lines. When cranes, work platforms, or other conductive materials such as ladders or aluminium mounting rails contact overhead wires, the equipment operator or other workers can be killed. If the required clearance distances from power lines are not maintained, workers can be shocked and killed. A minimum of 3 m away from overhead power lines must be kept. The minimum distance for voltages up to 50kV is 3 m. For voltages over 50kV, the minimum distance is 3 m plus 10 cm for every 10 kV over 50kV.

Electrical systems and tools that are not grounded or double-insulated. The metal parts of an electrical wiring system that are exposed (switch plates, ceiling light fixtures, conduit, etc.) should be grounded and at zero volts. If the system is not grounded properly, these parts may become energized. Metal parts of motors, appliances, or electronics that are plugged into improperly grounded circuits may be energized.

When a circuit is not grounded properly, a hazard exists because unwanted voltage cannot be safely eliminated. If there is no safe path to ground for fault currents, exposed metal parts in damaged appliances can become energized.

Extension cords with missing or broken ground terminals are unsafe and should never be used. If someone contacts a defective electrical device that is not grounded (or is grounded improperly), and completes a path to ground, that person will be shocked.

Ladders that conduct electricity:

- Do not use metal ladders near electrical circuits or lines. Instead, use ladders made of fiberglass.
- Beware of overhead power lines when you work with ladders and scaffolding.
- If someone receives a shock while on a ladder or scaffolding—even a mild one—that person may lose his balance and fall, which can result in injury or death.







Electrical hazards can be made worse if the worker, location, or equipment is wet. No one has to be standing in water to be electrocuted. Wet clothing, high humidity, and perspiration also increase the chances of being electrocuted. Working in wet conditions is hazardous because it increases the chance of completing a path for current flow. If someone touches a live wire or other electrical component—and is well-grounded because is standing in a wet area—will receive a shock.

## **Machinery related risks**

The activity developed by the construction company implies risks involved with the work itself and with its environment, which can bring about damage to third parties (either persons or properties).

Mechanical hazards: Machines have moving parts. The action of moving parts may have sufficient force in motion to cause injury to people. When reviewing machinery and equipment for possible mechanical hazards, consider:

- Machinery and equipment with moving parts that can be reached by people.
- Machinery and equipment that can eject objects (parts, components, products or waste items) that may strike a person with sufficient force to cause harm.
- Machinery and equipment with moving parts that can reach people such as booms or mechanical appendages (arms).
- Mobile machinery and equipment, such as forklifts, earth moving equipment, operated in areas where people may gain access.

Common mechanical hazards and associated risks for machinery and equipment are shown below.

Hazard	Risk
Rotating shafts, pullies, sprockets and gears.	Entanglement.
Hard surfaces moving together.	Crushing.
Sharp edge – moving or stationary.	Cutting or puncturing.
Cable or hose connections.	Slips, trips and falls (e.g. oil leaks).







Non-mechanical hazards: Non-mechanical hazards associated with machinery and equipment can include harmful emissions, contained fluids or gas under pressure, chemicals and chemical by-products, electricity and noise, all of which can cause serious injury if not adequately controlled. In some cases, people exposed to these hazards may not show signs of injury or illness for years. Where people are at risk of injury due to harmful emissions from machinery and equipment, the emissions should be controlled at their source.

When reviewing machinery and equipment for possible non-mechanical hazards, consider how machines and equipment can affect the area (environment) around them.

Common non-mechanical hazards are shown below.

Hazards	
Dust.	Noise.
Explosive or flammable atmospheres.	Ignition sources (flame or spark).
Heat (radiated or conducted).	Pressurized fluids and gases.
Heavy metals (lead, cadmium, mercury).	Electrical.

## Fire related risks

There are a variety of reasons why fires break out, although many are due to negligence and could be prevented with more care and attention. One of the best ways to protect your business against fire is to educate the staff on the causes of fire and encourage them to be vigilant and report any potential fire hazards, so that they can be dealt with swiftly.

Although each working environment is different, here are some common workplace fire hazards that should looked out for and how to reduce the risk of them causing a fire.

Waste and combustible material being stored on site: In many workplaces there can be a build-up of waste such as paper, cardboard and other combustible materials. If this is not disposed of regularly, it provides plenty of fuel for any potential fires should they break out. All it takes is a source of ignition, for example a discarded cigarette to set this alight and it could result in a fire that burns rapidly.

Objects that generate heat: Heat is one of the vital ingredients of fire. Some electrical equipment and machinery warms up when used providing the potential for a fire to start. Make sure to keep combustible materials such as paper away from heat sources and remember to unplug any equipment that is not being used if possible. Never leave any electrical equipment or machinery on overnight unless it is necessary.

**Faulty electrical equipment:** Fires caused by electrical equipment are one of the most common types of fire in the workplace. Look out for any signs of loose cabling, damaged plugs and replace any faulty equipment. All electrical equipment should be regularly checked and tested by an expert.





Overloading power sockets: This is a fairly common cause of electrical fires but it is one that is easily avoided. If too many appliances are plugged into the same socket or if faulty extension cords are used, this can result in overheating and potentially a fire.

Smoking: Discarded cigarettes can cause fires if not put out and disposed of properly. Smoking can be especially hazardous if it is allowed to take place near areas where flammable materials are present. Therefore a designated smoking area should be allocated in your workplace away from main buildings and flammables. Staff should also be encouraged to make sure that any cigarettes are put out properly and to use specially provided bins for their cigarettes.

**Human error and negligence:** It has to be said that one of the most common causes of fires in the workplace is human error. Fires can occur as a result of negligence in a variety of different ways including improper use of equipment, accidents, drinks being spilt over electrical equipment, etc.

## **Determination of OHS risk prevention controls**

Based on the OHS risk classification, the control measures or changes to existing control shall be undertaken on the following hierarchy of control.

- a. Elimination of task / activity.
- **b.** Substitution by better methods / practices (use self-locking metal scaffolds instead of bamboo and rope).
- c. Engineering controls (guards, barricades, interlocking, etc.).
- d. Effective Communication (signage / procedure / permit to work) and Inspections / Audits.
- e. Personal Protective Equipment (safety shoes, gloves, mask, hard hats / helmets).

The risk control measures shall be identified and may include the following:

- New technology / modification in technology/ physical improvements / substitution of equipment / chemicals.
- Development / Strengthening of Safe Work Procedures.
- Obvious operational control such as, signage, prohibitory notices, caution notices etc. / Standing Instructions.
- Emergency preparedness and response plan.
- Use of Personal protective equipment.
- Training and competence improvement.
- ♦ Task Observations / contractor's control mechanism.
- Strengthening of inspections and supervision systems.







Any other as relevant.

#### Controls on unsafe acts (human factor)

The previous section describes the hazards to evaluate potential risk areas and with that information, it is possible to develop a strategy to reduce the risks associated with construction and operation. By either eliminating or controlling the hazards. Since many construction hazards are difficult to eliminate altogether, most of the suggestions deal with controlling the hazard by developing safe work practices and habits.

The following actions are identified:



Action 2: Eliminate extension cord hazards by using battery-operated tools.

Action 3: Develop procedures for using power tools and extension cords.

Action 4: Develop proper lifting and carrying procedures for ladders.

Action 5: Develop proper ladder use policies.

Action 6: Develop hydration and safe practices while working in hot weather conditions.

#### Human resources

It is the responsibility of each employer to maintain a safe and healthy workplace. A safety and health management system program can help to focus the efforts at improving the work environment.

In a safe and healthy workplace, employees have a stake in the success of the program --- safety and health is everyone's responsibility. Actively encourage employee involvement is mandatory to get a program to succeed. Promote people accountability and inspect / audit to ensure compliance with procedures.

- Establishment of an active workplace safety and health & safety committee.
- Making daily safety inspections part of some employees' tasks.
- Keeping employees informed about safety inspections, injury and illness statistics, and other safety-related issues.
- Giving everyone a meaningful activity that supports safety.
- Valuing employee input and feedback. Employees often know more about safety problems and solutions than managers do.
- Making sure employees help review and improve the program.
- Holding employees accountable. Include safety and health responsibilities in their job descriptions. Making following safe work practices part of performance evaluation.





- Setting safety goals and hold everyone accountable.
- Disciplining employees who behave in ways that could harm themselves or others.
- Establishing a clear system for reporting hazards, injuries, illnesses and close calls.
- Recognizing employees who contribute to keeping the workplace safe and healthy.

#### Training and capacity building

Train personnel about the hazards they may be exposed to at work and how to protect themselves. For that reason it is mandatory to implement a training plan before starting the development of works. It is also important to keep records of all training.

To achieve it, it is necessary to provide:

- General safety orientation for new employees and employees starting new jobs, including work safety regulations and emergency procedures.
- Specific training on the hazards of their jobs and how to do their jobs safely. (Many OSHA standards include specific training requirements).
- Retraining As required by the standards:
  - When jobs change.
  - When employees return from long absence.
  - As needed to ensure employees know how to do their jobs safely.

#### Performance standards

There are two types of standards and indicators. Standards and indicators are required for:

- Measuring the effectiveness of the safety management system.
- Measuring the effectiveness of the risk control measures adopted.

Performance measures for these items should be used to provide assurance that the operator is achieving safe operation of the facility by using adequate control measures and satisfactory management systems, and that these are being maintained to provide the protection that is anticipated. The measures will need to be monitored and reported in some manner to management to ensure safe operation is being maintained.

The following factors are critical for successful performance monitoring:

- Available information on past and current performance of a risk control measure so that any assessment of adequacy is based on actual performance rather than expected or predicted performance.
- Available information on the performance of specific components of the safety management system and on the performance of the safety management system as a whole.
- Failures of control measures or deficiencies in the safety management system are recognized and remedied.
- Information on performance is provided to relevant people (including management) to ensure that appropriate corrective actions are taken.





Understanding of the specific safety management system elements needed to ensure ongoing effectiveness and reliability of each specific control measure.

Continual improvement occurs.

#### Work procedures for any job unit:

- Prioritizing the hazards found:
  - Which are most likely to cause serious injury or illness?.
  - Which can be fixed immediately?.
  - It is necessary to make long term plans to correct some of the hazards?.
- Making a plan for correcting the hazards:
  - Conducting job hazard analysis to identify how best to correct the hazards.
- Correct the hazards:
  - Engineering controls eliminate the hazards through safe tools, facilities, and equipment. These are the best controls.
  - Administrative controls don't remove the hazards; they reduce exposure by changing the work practices. For instance, rotating workers, rest breaks, training programs.
  - Personal protective equipment puts a barrier between the employee and the hazard, using, for example, gloves or safety shoes.
- Evaluating the changes to make sure they have corrected the problem and not created other hazards. And periodically re-survey the work environment and work practices.

## Controls on unsafe conditions (technical factor)

#### Planning of works

Scheduling is important to achieve the activities, goals and priorities. There are a number of different tools to choose from. In any case, it is necessary to:

- Identify available time.
- Schedule essential actions.
- Schedule high-priority activities.
- Schedule contingency time.
- Schedule discretionary time.
- Analyse the activities.

With an adequate planning, risks and dangers will be avoided. The schedule must be established prior to the start of any work and all employees must know it.



**Evacuation paths** 

An evacuation path is a continuous and unobstructed way of exit from any point within a workplace to a place of safety. An evacuation path consists of three parts:

- Exit access: portion of an evacuation path that leads to an exit.
- Exit: portion of an evacuation path that is generally separated from other areas to provide a protected way of travel to the exit discharge.
- Exit discharge: part of the evacuation path that leads directly to outside (or to a secure part or to an open space).

Normally, a workplace must have at least two evacuation routes to permit a prompt evacuation of employees or workers during an emergency. Evacuation paths must be located as far away as practical from each other in case one is blocked by fire or any other cause.

Evacuation path must be signalled adequately.

#### Welding equipment

Welding requires special safety equipment (see Description of General Protection Equipment).

Before commencing work:

- Check that the welding equipment is prepared for the power supply voltage.
- Check that the plug is of the appropriate type for the power supply outlet.
- Ensure that the welding equipment is earthed and that this earth is fully continuous.
- Before connecting the equipment, make sure that the leads are perfectly insulated, and if applicable, make any connections using weatherproof connectors. Connections using insulating tape are forbidden, as is the use of electrical leads with their outer protection broken or worn.
- Make sure that the connection terminals of the welding equipment are properly insulated.
- Check that the electrode holder is properly insulated, including its jaws. The use of worn electrode holders is forbidden.
- Welding equipment and leads are not to be placed on frameworks, so as to avoid the risk of shocks and electrical contact.
- Correctly connect the ground lead, choosing the most suitable point to do so in each case. This connection is to be made on the part to be welded, whenever possible.
- Only supply current to the holder when the welder is positioned in the workplace and immediately before the welding starts.

#### During welding work:

- Work outdoors is to be suspended when it rains.
- It is forbidden to leave the electrode holder directly on the ground or on metal sections. It is always



to be left on a holder support device.

- In no case whatsoever is the earth of the welding equipment casing to be annulled, not even if the circuit-breaker has cut off the current.
- Welding equipment is to be completely switched off each time work ceases for a prolonged period. The holder is not to be transported or taken up ladders if it is live.
- Always change electrodes with gloves on, as at that moment the voltage in the holder is greater than when welding.
- In confined premises, the welding set is to remain outside; if this is not possible, then it is to be placed on an insulating platform.
- A fixed workplace is to use equipment with autonomous filtering.

#### Work warning signs. Security signals

Safety signs and colour are useful tools to help protect the health and safety of employees and workplace visitors. Colour attracts attention and can be used extensively for safety purposes. The choice of color also draws attention to the probability of a hazard causing harm. Safety signs are used to:

- draw attention to health and safety hazards.
- point out hazards that may not be obvious.
- provide general information and directions.
- remind employees where personal protective equipment must be worn.
- show where emergency equipment is located.
- indicate where certain actions are prohibited.

When employees are aware of the hazards around them and take the necessary precautions, the possibility of an injury, illness or other loss is minimized. However, while safety signs and colours are valuable in warning of hazards, they are not substitutes for eliminating or reducing those hazards, whenever possible.

#### Protective fences and handrails

Work area shall be signalled and protected by a fence. The purpose of the fence is to reduce the access of workers to the area. Only authorized workers can access a work area signalled by a protective fence.

As is mentioned in the signals, while protective fences are valuable in warning of hazards, they are not substitutes for eliminating or reducing those hazards, whenever possible.

Fencing and authorised access is particularly required for electrical installations under the IER, 1956.

#### Earth connection (earthing)

All metallic parts and neutral of circuits shall be connected to grounded earth (earthing). Earthing, refers to a system designed to protect electrical wires and components from damage caused by sudden electrical power surges. Its main purpose is to reduce the risk of dangerous electrical shocks from uninsulated metal parts of an appliance or electrical device. Earthing systems also prevent end users from electrical shocks in the event of a short circuit.



IBF Inter Health,



## Fire extinguishers and fire-fighting systems

All components of a photovoltaic system exposed to sunshine and other exterior elements of weather need to have highly durable characteristics, and certain materials that have traditionally performed well in this regard do not necessarily have good fire-resistant characteristics. The solar panels themselves typically contain limited plastics, but it is the frames, mounting systems, cables and boxes that can add to the combustible loading of an installation and eventually to the combustibility of the entire plant.

The combustibility of a planned photovoltaic installation needs to be evaluated case by case. Fire test results for the panels alone are not enough as an increasing number of mounting systems made from plastics are on the market. There are no harmonized standards for solar cables; however, fire test results and flame-retardant characteristics of the cables need to be considered too.

For that reason, the recommendations are the following:

Cables: Only cables suitable for outdoor applications and severe weather conditions and UV radiation should be used. Protecting cables from severe weather conditions and from UV radiation helps to slow down the aging process and thus minimizes the risk of hot spots and arcing.

The Factory Act, 1948 and State Level Factory Rules provide details on fire prevention / protection, means of egress / fire exits etc. for factory activities. Some of these requirements could also be effectively applied to solar park activities.

#### Hygienic risks

Industrial hygiene has been defined as the "science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stresses arising in or from the workplace, which may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community." Industrial hygienists use environmental monitoring and analytical methods to detect the extent of worker exposure and employ engineering, work practice controls, and other methods to control potential health hazards.

To be effective in recognizing and evaluating on-the-job hazards and recommending controls, industrial hygienists must be familiar with the hazards' characteristics. Potential hazards can include air contaminants, and chemical, biological, physical, and ergonomic hazards.

The section 41-F in the Factory Act, 1948 provides specification for exposure to certain chemicals and materials (such as dust, welding fumes, etc.).

#### Noise

Continued exposure to more than 90 decibels (dBA) of noise for 8 hours (time weighted average) may cause gradual but permanent damage to hearing. Noise can also hamper job performance, increase fatigue, and cause irritability.

The Factory Act, 1948 and State Level Factory Rules specify the norms applicable for high noise areas in the work zone.

#### Dust

Finding an efficient way to eliminate dust can prove to be challenging, as a large portion of it can originate from our skin and the fabric we use. To optimize the dust control, it shall be captured at the source.

In solar parks, the dust will be generated during the construction period. To minimize the effect of dust, the best practice is reducing dust with water. Working area will be wet in order to reduce the dust emission.





Lighting at work is very important to the health and safety of everyone using the workplace. The quicker and easier a hazard is seen, the more easily it is avoided. The types of hazard present at work therefore determine the lighting requirements for safe operation.

Poor lighting can not only affect the health of people at work causing symptoms like eyestrain, migraine and headaches, but can also produce irritability and poor concentration.

There are several lighting hazards in the workplace, which can affect the health and safety of people. Typical risks from lighting originate from:

- incorrect lighting design.
- improper lighting installation, maintenance, replacement and disposal.
- improper selection of emergency lighting.

Lux levels have been prescribed in the Factory Act, 1948 based on working areas and functions. These norms should be followed as applicable.

#### Ventilation and temperature

Closed areas should be adequately ventilated (at least 6 air volume changes per hour) through natural or mechanical means and the temperatures within the working zones (workshops / electrical installation rooms) should be maintained as per State Factory Rules.

#### Risks in mobile lifting equipment / vehicles

#### **Cranes / Lifting Equipment**

- External rear view mirrors (at least 2), reverse light, reverse alarm, parking brake, safety alarm to warn of the proximity of the set load.
- 3-point safety belt for driver / occupants of the vehicle.
- Load table in the vehicle should be in the local language and the measurement units should be in the unit system adopted in the country where the equipment will be used.
- Physical blocking system to prevent load free fall.
- Operator seat that meets the ergonomic requirements for working space, vision, internal temperature and noise, arrangement of instruments, safety devices against accidental operation, seats with shock absorbing systems, height adjustment and vibration attenuation, head rest and support.
- Reflective tape on the sides, signalling using light.
- Reflective cones with horizontal signs to signal machine in operation.
- Inclinometer (to indicate the boom inclination).
- One fire extinguisher (ABC type) for the crane.





#### **Ambulances**

The Ambulance vans provided for emergency control should have the following equipment:

- General A wheeled stretcher with folding and adjusting devices with the head of the stretcher capable of being tilted upward; pillow with case; sheets and blankets; towels.
- Safely equipment Flash lights, Fire extinguisher (dry chemical powder type); Insulated gauntlets. Portable metal cutting equipment should be made available either in the patrol vehicle or the ambulance as practical. This is useful in safe and quick extraction of victims of road accidents.
- Emergency care equipment:
  - Resuscitation, portable suction unit, portable oxygen units, bag-valve-mask, hand operated artificial ventilation unit, airways-mouth gags. -tracheostomy adapters, short spine board-IV, fluids with administration unit, B. P. monometer, cups, stethoscope.
  - Immobilization- long and short padded boards, -wire ladder splints; triangular bandage- long and short spine Boards.
  - Dressings- gauze pads- 4" X 4"- universal; dressing- 10" X 36"; roll of aluminium foils-soft roller bandages 6" X 5" yards- adhesive tape in 3" roll-Safety pins; bandage and bum sheets.
- Emergency medicines standard first aid requirements as listed below (indicative):
  - Six small size sterilised dressings.
  - Three medium size sterilised dressings.
  - Three large size sterilised dressings.
  - Three large size sterilised bum dressings.
  - One (60 ml.) bottle of cetrimide solution (1 per cent) or a suitable antiseptic solution.
  - One (60ml.) bottle of mercurochrome solution (2 per cent) in water.
  - One (30 ml.) bottle containing sal-volatile having the doses and mode of administration indicated on the label.
  - One pair of scissors.
  - One roll or adhesive plaster (2 cms X 1 meter).
  - Six pieces of sterilised eye-pads in separate sealed packets.
  - A bottle containing 100 tablets (each of 5 grains) of aspirin or any other analgesic.
  - · Ointment for burns.
  - Polythene wash bottle (1/2 litre i.e. 500 c.c.) for washings eyes.
  - A snake-bite lancet.
  - One (30 ml.) bottle containing potassium permanganate crystals.
  - Practices to be followed while operation / movement of mobile lifting equipment / vehicles.
- Mobile equipment cannot be operated in places where there are people around it. For those cases where people must be near the areas where mobile equipment will be operated, an analysis should be made previously of the risks linked to the activities, a local procedure should be prepared establishing operational requirements such as: minimum safety distance, communication with the operator and/driver, special conditions for night time operations, clear identification of people from the distance, signalling and movement rules.







- When the mobile equipment is not being used and is unloaded, its moving parts (blades, buckets, forks) should be positioned on the ground such that they will not harm anyone; parked only at the permitted areas, properly signalled with cones/props.
- During all operations, workers, including vehicle drivers, should wear reflective vests or uniforms with a reflective strip.
- Headlights should be on during the movement of mobile equipment at night time.
- Only as many people as the number of available seats should travel inside the mobile equipment.
- Proper safety conditions should be established for the use of mobile equipment close to overhead obstacles such as transmission lines, over-passes, bridges and roofs of nearby structures.
- It is recommended for all vehicles to stop and take precautions to ensure safety before entering and leaving service roads and entering the main highway.
- ♦ The route where the load will pass should be unobstructed.
- All (stationary) loads handling automotive equipment should be equipped with cones and striped tapes to signal and isolate the load handling area.

#### Examples of OHS hazards, risks and control

The following examples identify hazards and risks for certain situations and indicate potential actions to correct them. It is necessary to evaluate the specific situation and identify actions to eliminate and control hazards in each case as appropriate. There are no standard solutions for risk management.

- 1. Using power tools:
  - a. Working conditions include: using many different power tools and power cords on the jobsite.
  - b. Hazards include: worn or frayed power cords and power lines (electric shock hazards), objects thrown from equipment such as saw blades (eye injury, laceration, puncture wound, and bleeding hazards), sharp tools (laceration, puncture wound, and bleeding hazards).
  - c. If the contractor is using power tools that are old and has frayed power cords and the site is poorly lighted or has uneven ground the consequence and likelihood will both be high and thus results in a medium to high risk.
  - d. Accordingly, Controls could be identified to eliminate / reduce the risk.
- Action: Develop norms for using power tool equipment and wires (for instance, for certain tasks switch to battery operated tools instead of power sourced)
- Action: develop procedure for using power tools and train workers on the proper use, storage and maintenance of power tools.
- 2. Working with ladders to access equipment:
  - a. Working conditions include: carrying and positioning ladders on walls and metallic structures, climbing and working from both step ladders and extension ladders.
  - b. Hazards include: lifting hazards from carrying ladders, fall hazards from accidents on ladders, electrical hazards from contact with electrical power lines.
  - c. If ladders are non-standard (fabricated locally) or have broken rungs or lack of proper leg supports, the risk of fall or injury will be higher if the site ground is uneven and slippery.



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d. Accordingly, Controls could be identified to eliminate / reduce the risk.



Action: Develop standards for use of ladders on site and procure accordingly.



Action: Develop ladder inspection procedures before use and maintain ladders accordingly.

Lifting safety: Lifting is one of the most common tasks, and unfortunately it is often performed incorrectly. Although lifting objects can cause various injuries, back injuries are the most common. Lifting hazards are a serious problem when you consider how debilitating a back injury can be. Back injuries do not heal quickly and can last a lifetime. It includes:

- Carrying and moving heavy tools and equipment.
- Loading and unloading equipment and tools from truck.
- Lifting tools and equipment onto a metallic structure.

After identifying where, when, and how you lift objects, determine what actions can reduce the hazards associated with lifting.

- 1. Carrying and moving tools and equipment.
  - a. Working conditions include: carrying large equipment and tools around the jobsite.
  - b. Hazards include: using improper lifting techniques or carrying awkward and heavy objects causing cumulative trauma or strains and sprains.



Action: Develop proper procedures for lifting and carrying.

- 2. Loading and unloading equipment and tools from the truck.
  - a. Working conditions include: loading and unloading ladders, tools, solar equipment.
  - b. Hazards include: using improper lifting techniques causing cumulative trauma or strains and sprains.
- - Action: Develop procedures for loading and unloading vehicles.
- 3. Lifting tools and equipment onto a metallic structure.
  - a. Working conditions include: lifting tools and equipment onto metallic structure.
  - b. Hazards include: using improper lifting techniques causing cumulative trauma or strains and sprains.
- - Action: Eliminate lifting by using a crane to hoist equipment onto the metallic structure.
- Action: Develop safe lifting policies for moving items onto metallic structure.

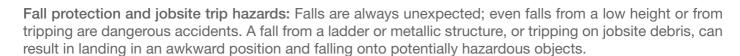
#### Working at heights, hot work and access to confined spaces

A Permit to Work (PTW) system should be developed (as a risk avoidance and management measure) for all construction activities, jobs and tasks on the site.

The PTW should be initiated by the task person and approved by the safety officer on site. It should address job / task description, identify hazards and evaluate the risk. Accordingly, mitigation measures (isolation of hazardous energy) as well as PPE requirements should be identified and assigned. PPE should be issued, and site should be inspected before start of work. The OTW should be required on a daily basis for each job / task. PTWs should be closed only when the task has been effectively and safely executed.







The purpose of identifying fall hazards is to determine how to eliminate or control them before they cause injuries.

Falls leading to serious injuries can happen anywhere, thus the jobsite evaluation needs to address potential falls wherever they may happen. Trip hazards, such as debris or tools lying on the ground or on walking surfaces, can lead to injuries such as sprained ankles but can also increase the risk of falling. Trip hazards on platforms or metallic structures create an unsafe environment that can lead to falls from them.

Some typical fall and trip hazards include:

- Tripping on jobsite debris, cords, or equipment.
- Working with ladders.
- Working from heights.

Safety procedures for fall and trip hazard protection:

- 1. General jobsite trip hazards.
  - a. Working conditions: clutter, equipment, and cords are trip hazards on the jobsite including the prep area at ground level and height level.
  - b. Hazards include: trip hazards resulting in fall-related injuries. These can occur on ground level or on metallic structures and platforms.

**(** 

- Action: Eliminate trip hazards by removing the debris.
- Action: Develop clean jobsite and work area practices.
- 2. Ladder and height area fall hazards.
  - a. Working conditions include: climbing onto and off of height and working on platforms and metallic structures.
  - b. Hazards include: falls from ladders or platforms and metallic structures resulting in fall-related injuries.
- Action: Train employees on ladder safety practices
- Action: Develop and train employees on fall-protection policies and procedures.
- 3. Soldering at or above shoulder height.
  - a. Working conditions include: lifting soldering equipment and operating it above shoulder level.
  - b. Hazards include: burn hazards from dripping solder.
  - Action: Reduce the risk by working from a step ladder and develop procedures working at shoulder heights and above when a ladder is impractical.
    - Action: Use personal protective equipment such as eye protection and clothing to prevent burns.

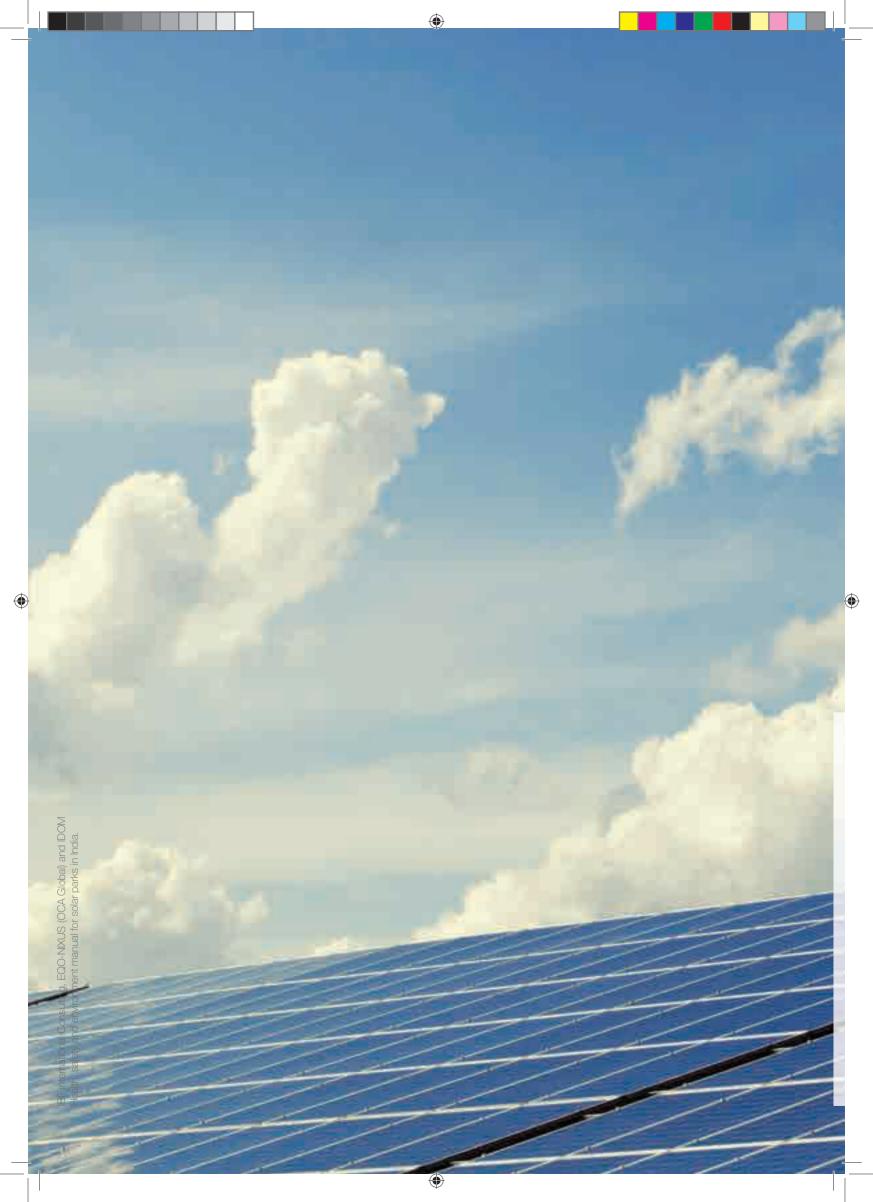


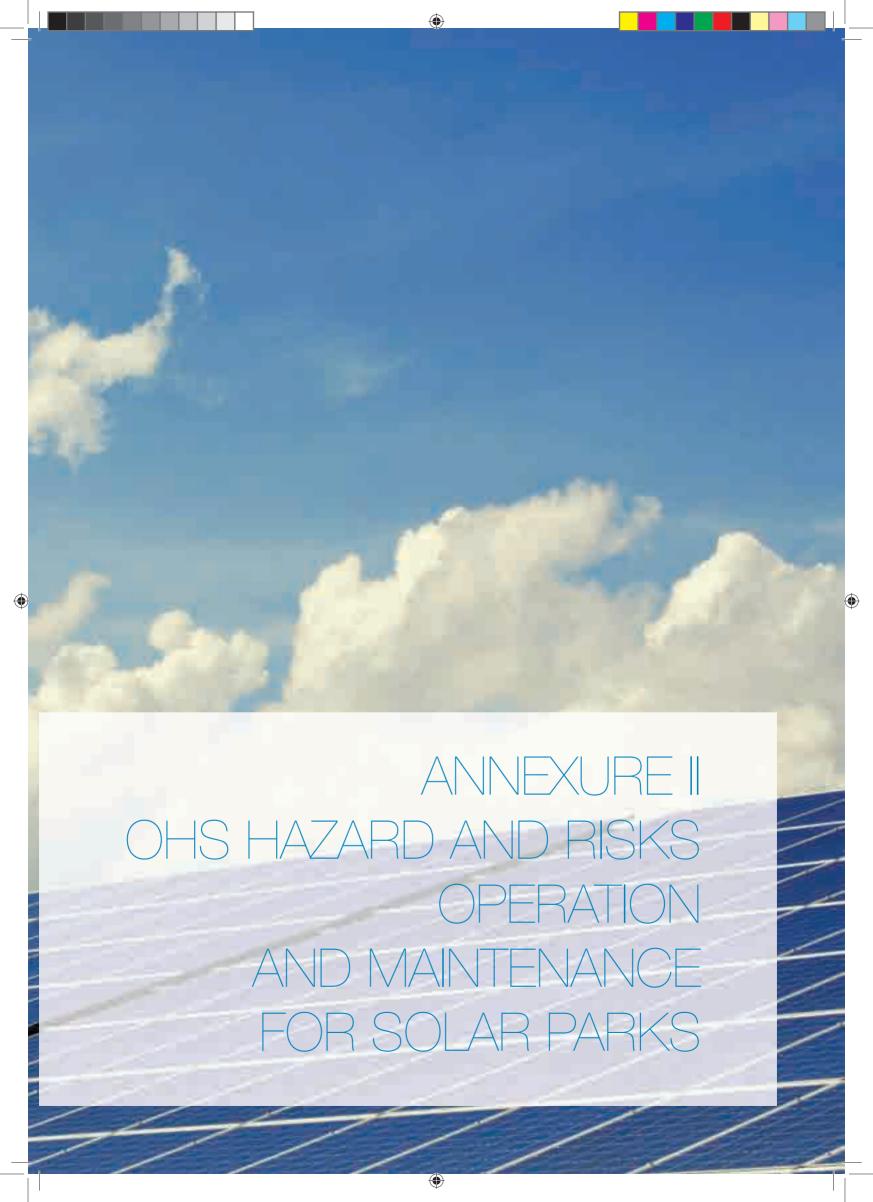


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## OHS hazards in the operation and maintenance of solar parks

The figure below depicts the typical transformation of a hazard into a risk and finally resulting into an accident.

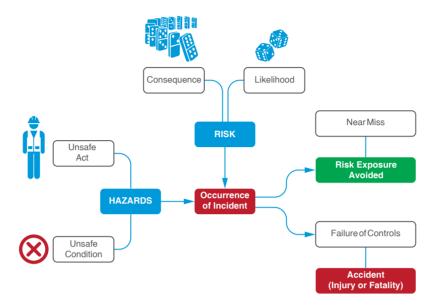


Figure 9 Mechanism of an accident

General jobsite safety: Learning to evaluate and identify potential safety hazards is a critical first step to eliminating risks and potential injuries. A good understanding of workplace hazards enables to prevent accidents and recover more quickly if one occurs.

Conducting an analysis of unique hazards:

- Leads to properly identifying safety training needs.
- Helps identify the measures necessary to ensure the workplace is a safe one, such as the need for additional equipment and personal protective gear.
- Helps determine how to eliminate or control hazards before they cause injuries.

It's important to evaluate each specific situation to develop a list of the hazards and the potential injuries that could occur. Understanding the hazards and potential injuries, and the likelihood of an accident occurring, enables you to set up a suitable safety policy for each specific situation.

Typical construction work situations include:

- Working at height.
- Carrying out hot work (welding and gas cutting).
- Accessing confined spaces for excavation / civil work.
- Using power tools.
- Working with ladders to access equipment.
- Working in extreme weather conditions (hot, cold, windy, etc.).





In addition to these, specific activities such as excavation, land levelling, batch mixing, concreting (foundations, slabs, columns etc.) material / equipment hauling and installations, and other ancillary tasks are often required.

A formal Hazard identification should be carried out and the hazards should be risk assessed based on consequence potential, likelihood of occurrence and existing controls.

A generic guidance on categorising consequence (severity of impact) is provided below.

Severity factor (S)	Consequence/ severity	Description
1	Insignificant / negligible.	No fatality, no injury, no ill health (momentary discomfort/ inconvenience).
2	Slightly harmful / marginal.	No fatality, non-reportable injury requires first-aid.  Chronic work-related exposure leading to ill-health requiring in-company medication.
3	Harmful/ moderate.	Injuries, absence from the work less than or equal to 48 hrs./ temporary disability.  Chronic work-related exposure leading to ill-health requiring medical attention (e.g. hearing loss, chronic back pain).
4	Very harmful / devere.	Major injuries, absence from the work more than 48 hrs./ temporary disability.  Chronic work-related exposure leading to loss of livelihood.
5	Extremely harmful / catastrophic.	Fatal/ permanent disability. Major incidents involving substantial number of people.  Chronic work-related exposure leading to fatal/ permanent disability.

Similarly, a generic guidance on categorising likelihood (probability) of occurrence of a hazard / incident is described below:

Probability (P)	Probability	Description
1	Highly unlikely / remote.	If almost no gap exists in control of the identified OHS hazard as technology, operational control, competence, measurement monitoring in place.
2	Unlikely.	If there is any minor gap/ weakness in control of the identified OHS hazard.
3	Likely/ occasional.	There are unreasonable gaps in control of the identified OHS hazard with respect to adoption of technology, operational control, measurement monitoring and competence.
4	Highly likely/ frequent	There are unreasonable major gaps in control of the identified OHS hazard with respect to adoption of technology, operational control, measurement monitoring and competence.
5	Certain.	There are almost no controls in place in controlling the identified OH&S hazard and have occurred in the past but ignored.



Risk levels can differ based on varying conditions (unsafe acts / unsafe conditions) and existing controls available:

Risk Level = Severity (S) x Probability (P)

- Low risk category is considered as an acceptable risk.
- Medium & high-risk categories are considered as unacceptable risk.

Low: No additional controls are required. Consideration may be given to a more cost-effective solution or improvement that imposes no additional cost burden to the organization. Monitoring is required to ensure that the controls are maintained.

**Medium:** Efforts should be made to reduce the risk, but the cost of prevention should be carefully measured, planned and limited, wherever possible. Risk reduction measures should be implemented by the organization.

**High:** Work should not be started or continued until the risk has been reduced. If it is not possible to reduce risk even with unlimited resources, work has to remain prohibited.

# OHS risks and mitigation measures during operation and maintenance

It would be impossible to enumerate all the risks, which may arise during the operation of solar parks and solar PV, however the key issues have been covered below.

The factory act, 1948 and the state level factories rules, mandate specific requirements applicable as far as management of key permits, health, safety, labour welfare etc. are concerned.

The main risks associated to the maintenance of civil works can be summarised in the following list:

- Weathering impact leading to surface damage on structures.
- Natural calamities leading to impact on structural safety.
- Modifications and alterations carried out without considering impacts on the civil structure can seriously damage the structures over the long term.
- Foundations of solar panel installations could be affected due to soil erosion / storm water runoff, if not managed properly.
- Structures housing electrical equipment are also prone to damage due to poor maintenance and housekeeping.

The mains risks associated with the operation and maintenance of electrical infrastructures is mentioned below:

- Electrical systems and tools that are not grounded or double-insulated.
- The metal parts of an electrical wiring system that are exposed (switch plates, ceiling light fixtures, conduit, etc.) should be grounded and at zero volts. If the system is not grounded properly, these parts may become energized.
- Metal parts of motors, appliances, or electronics that are plugged into improperly grounded circuits may be energized.



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- When a circuit is not grounded properly, a hazard exists because unwanted voltage cannot be safely eliminated.
- If there is no safe path to ground for fault currents, exposed metal parts in damaged appliances can become energized.

Extension cords with missing or broken ground terminals are unsafe and should never be used. If someone contacts a defective electrical device that is not grounded (or is grounded improperly), and completes a path to ground, a shock will happen.

Ladders that conduct electricity:

- Do not use metal ladders near electrical circuits or lines. Instead, use ladders made of fiberglass.
- Beware of overhead power lines when you work with ladders and scaffolding.
- ♦ If someone receives a shock while on a ladder or scaffolding—even a mild one—he/she may lose his balance and fall, which can result in injury or death.

Electrical hazards can be made worse if the worker, location, or equipment is wet. Wet clothing, high humidity, and perspiration also increase the chances of being electrocuted. Working in wet conditions is hazardous because it increases the chance of completing a path for current flow. If someone touches a live wire or other electrical component—and he is well-grounded because is standing in a wet area—he/she will be electrocuted.

The operational phase of the solar parks and plants will require certain chemicals for certain activities such as paints / thinners for infrastructure and signage, pesticides and insecticides for plantation, cleaning chemical solutions for office areas, etc.

While many of these activities would generally be outsourced to a contractor, some activities may be carried in-house. In either case, an interim storage of such chemicals in the Project Office or on site may be required.

These chemicals should be stored with the following precautions:

- Stored in designated areas with proper secondary containment and ambient conditions suitable to the contents.
- Provided with proper signage highlighting the contents and hazardous nature (NFPA).
- A material safety data sheet (MSDS) procured from the chemical supplier, should be made available at or near the storage or use of the chemical.
- ♦ For flammable chemicals, suitable fire extinguishing equipment should be provided nearby.
- For fuels such as Diesel etc., bulk storages beyond certain thresholds require a license from the CCOE, PESO as mentioned earlier.
- Suitable EHS instructions on safe handling, storage and firefighting should be provided to contractual supervisors / labour through toolbox talks organized by the HSE manager of the park.
- Disposal of discarded containers of hazardous chemicals should be carried out through suitable hazardous waste treatment agency as far as possible. Or the containers should be adequately decontaminated before disposal of containers as general municipal waste.



Signage and boards displaying do's and don'ts based on environment and safety concerns of using the roads should be put up at key locations.

The norms applicable for provision of road safety infrastructure and signage / communication, such as speed limit signs, reflectors, traffic signs etc. are based on the guidelines by the Indian road congress (IRC), Regional transport office (RTO) requirements and applicable best practices.

However, additional road safety infrastructure / communication signage may be identified and provided from time to time by SPPD as necessary, based on the findings of inspections / audits conducted on EHS, past incidents / accidents and requests based on local community concerns.

#### Permit to work (PTW) for all jobs and maintenance activities

Every job such as working at height, hot work, entry into confined spaces, etc. needs to be pre-assessed for OHS risk involved. Before the start of the activity the issuer should assess the job risk and conduct a risk assessment. Accordingly, the necessary permit for carrying out work should be issued. Permits need to be inspected to ensure that contractors are observing necessary mitigation procedures and PPE.

PTW procedures are designed for the following objectives:

- To provide guidance under which work can be carried out in safety which could otherwise be potentially hazardous such as confined space entry, work on energy systems, ground disturbance, hot work or other hazardous activities and to allow such activity to be carried safely with appropriate level of control measures.
- To prescribe conditions and describing nature and scope of the proposed work, site where it will be performed, equipment that will be used, authorization of personnel to carry out work, personal protective equipment to be worn and any special precautions required.
- As an employer, SPPD or SPD has a legal duty to take reasonable care for the safety of all employees and contractual labour.
- To set out basic requirements of permit to work systems to be used within the solar park facility.

## Training of staff and workers

A training-needs matrix should be developed based on EHS requirements and competence necessary for execution where the nature, target, periodicity, content and effectiveness of training requirements need to be addressed. Typical training topics on EHS could include:

- First aid.
- Fire fighting.
- Electrical safety.
- Waste management.
- Energy conservation.
- Water saving.
- Emergency response drill.





- Ergonomics / safety in manual material handling.
- Behavioral based safety training.
- Permit to work.
- Chemical safety.
- Confined space entry.
- Electrical safety.
- Fall protection.
- Hazardous energy.
- Moving equipment & pedestrian segregation (traffic management on internal roads).
- Machine guarding.
- Use of personal protective equipment.

Accordingly, training should be provided to all concerned and records should be maintained.

'Tool box talks' should be conducted (at least once a week to all group of workers or before specific jobs to be undertaken) thereby informing the workers about the occupational risks and safe operating measures as well as steps to follow in case of an emergency.

### Use of personal protective equipment (PPE)

Every activity / task to be carried out as part of the operational phase of the project should be risk assessed to identify safety hazards and determine the risk involved. While PPE is the last resort and means to avoid / minimize the risk level it should be implemented on priority. The residual risk should be managed by using suitable PPE.





Table 15 below provides a general guideline for identification of appropriate PPE based on various activities and hazards involved in the operational phase of the project.

Table 15 Identification of personnel protection equipment (PPE) for specific functions

Eye and face protection			
Source	Hazard assessment	Recommended PPE	
<ul><li>Dust / grit.</li><li>Road maintenance work, debris</li></ul>	Flying fragments/objects.	♦ Glasses.	
removal.	Particles of sand, dirt.	Face shield.	
<ul><li>Liquid chemicals handling.</li><li>Cleaning chemicals.</li></ul>	Splash hazard.	♦ Goggles.	
Injurious light radiation.	<ul><li>Welding; electric arc, gas.</li><li>Gas cutting.</li></ul>	Welding helmet.	
,	♦ Glare.	Eye protection (Goggles, face shield).	
	♦ Use of human source material.	♦ Glasses.	
♦ Biohazards.	Use of infectious agents.	<ul><li>Goggles.</li><li>Face shield.</li></ul>	
Head protection			
Source	Hazard assessment	Recommended PPE	
Moving, falling, flying, or fixed objects.	Working at heights on embankments / slopes or below other working areas where using tools and materials that can fall off.	♦ Helmet.	
Electric shock or burn.	Working on exposed energized conductors / MC panels.	Hard hats classified for electrical performance.	
Feet protection			
Source	Hazard assessment	Recommended PPE	
♦ Impact.	Carrying or handling materials such as debris / stones, or heavy tools.	Safety shoes with steel toe.	
•	Activities where objects could fall on the feet.	Safety shoes with metatarsal guard.	
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Static electricity.



Working on or near equipment which

could pose a static discharge exposure.

Electrically conductive shoes.

Other \_\_



Hand protection		
Source	Hazard assessment	Recommended PPE
Severe cuts or lacerations.	Using, cleaning or dismantling equipment with sharp points or edges.	<ul><li>♦ Kevlar.</li><li>♦ Nitrile-coated.</li></ul>
Severe abrasions.	Use of abrasive materials (e.g., with sanders, buffers).	♦ Leather.
♦ Electric shock or burn.	Working on or near energized circuits.	♦ Insulated gloves.
Respiratory protection		
Source	Hazard assessment	Recommended PPE
^ D .	Nuisance.	♦ Dust mask.
Ousts.	Fine dust from paving / construction activities.	Half-face respirator.
<ul><li>♦ Vapours.</li><li>♦ Diesel.</li></ul>	Exposure to vapours, during filling / fuel movement / spraying of pesticides on median plantation.	Organic vapour mask or respirator.
♦ Fumes.	♦ Welding.	♦ Full-face respirator.
Oxygen deficiency.	Confined space entry.	Supplied-air respirator.
Hearing protection		
Source	Hazard assessment	Recommended PPE
A Naise	♦ Continuous (8h) > 85 db(A).	♦ Ear plugs.
♦ Noise.	♦ Intermittent > 80 but < 85 db(A).	♦ Ear muffs.
Body protection		
Source	Hazard assessment	Recommended PPE
♦ Electrical.	Working with high voltage.	Fire resistant clothing.
♦ Fire.	Working in hazardous location.	Fire resistant clothing.
Moving vehicles.	Regular exposure to danger of injury / accident from moving vehicles.	Reflective vest/jackets.







