Risk Control Guide

PHOTOVOLTAIC PANELS

Introduction and Scope

The purpose of this document is to give guidance to end-users of photovoltaic (PV) plants, including roof-mounted installations and those mounted at ground level.

Photovoltaic is the term used to describe the direct conversion of light energy (photons) into electrical energy by means of semiconductors. The photovoltaic effect is a physical and chemical phenomenon. PV power plants eliminate the need for a machine driven generator by harnessing the light energy received from the sun and converting it directly into a useful form of electrical power.

There are 2 recognised technologies:

- Crystalline Silicon PV Cells is the most common but requires a larger investment due to the high silicon content. Sub-types of this technology are (in decreasing order of efficiency): monocrystalline, polycrystalline and thick-film panels

-Thin Film PV Cells is a newer development that requires only a fraction of the silicon content but does result in a lower electrical efficiency (around one half of crystalline ones).

The most common type is polycrystalline silicon because of its higher value for money.

The following factors are considered within the scope of the document:

- System components and specifications.
- Design and installation considerations
- Operational considerations
- Maintenance and inspections
- Property risks
- Loss expectancies

System Components and Specifications

Terminology

The main components of a PV plant are:

- PV cell: small electrical device (15cm x 15cm) that converts the energy of light into DC electricity
- PV module/panel: stable frame that groups a number of interconnected PV cells. Common characteristics are: 72 (6x12) cells, 300 Watt (peak), 36 Volts, 8 Amps, 15% efficiency, 26kg.
- PV array: linked collection of PV modules, usually wired by MC4 connectors. They are installed on structures that can be fixed or moving (solar trackers)
- Junction box: enclosure where modules and PV arrays are interconnected
- Inverter: power electronics equipment which converts the direct current (DC) output of a PV array into a utility frequency alternating current (AC)
- Transformer: passive equipment used to step up the AC voltage. They can be dry or oil-filled.
- UPS: uninterruptible power system including batteries mainly used to back up control systems.
- Wiring, grounding and metering equipment.

Standards

The PV generating system should be designed according to internationally recognised standards. The International Electrotechnical Commission (IEC) standards that apply are:

- IEC (EN) 61215 PV modules – Design qualification and type approval
- IEC (EN) 61730 PV modules – Safety qualification
- IEC (EN) 61701 PV modules – Salt mist corrosion testing

These standards reflect the latest developments and safety experience on PV modules, therefore a detailed study of the installation shall be carried out if they are not fulfilled.

The followings IEC standards apply to other equipment:

- IEC (EN) 62093 Balance-of-system components for PV systems (batteries, inverters, diodes…)
- IEC (EN) 62109 Safety of power converters for use in PV power systems

The Underwriters Laboratory standards for PV panels are:

- UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels
- UL 2703 Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels

The latter is the only international standard for mounting systems.

Other local standards may be applied by location.

Design and Installation Considerations

There are important factors to consider during the design and installation of the PV panel system, which affect both the system performance and the control of risks. The main considerations are:

Location

- Local environmental conditions to take into account are: nominal and maximum wind speeds, hailstorm and dust-storm risks, earthquake, lightning and flood zoning. Special consideration to wind, snow and sand storm loads. Calculations should be checked.
- Eurocode 1 shall be used for the wind design of the fixings. The highest wind loads are closest to the edges and about 1/10th distance in so it is not uncommon to have two designs with far more fixings around the perimeter. If their resistance cannot be ensured, the installation of wind deflectors that prevent wind from penetrating underneath the array should be considered.
- In roof mounted systems, roof strength has to be ensured taking into account the component weight and the extra loads caused by sand or snow storms, snow drifting and ice. Ballasts represent a hazard for the roof integrity and should be avoided.
- The racks shall be mechanically anchored to the roof structure, avoiding adhesive and ballasts as they are known to be unreliable during heavy winds. With metal panel roofs, fix to the structure underneath provided this does not breach the insulation/ waterproofing membrane. Otherwise, use special clips which are approved by the roof manufacturer. If this is not possible, detailed calculations shall be performed and revised as special designs might be necessary.
- PV modules resistance for common locations shall be 2400Pa (uplift/wind) and 5400Pa (snow). However this might increase where heavy wind, snow or sand storms are likely to occur (i.e. 5400Pa uplift resistance shall be required in hurricane areas).
- Special care shall be taken where prevailing winds come from the North (in the northern hemisphere) or South (southern hemisphere), as this increases the wind exposure in the most unfavourable scenario due to the tilt of the modules
- Rotating solar trackers are especially susceptible to wind damage, and a fast automatic system to move the panels to the safety position (horizontal), plus wind deflectors that avoid resonance, should be considered.
- The location of the panels must ensure enough spacing between panels to permit good access for fastening bolts and general inspections. Walkways shall be provided to allow this. Also walkways shall be provided to each drain so that they can be easily checked for debris and cleaned. No panels are to be installed over drains. An additional spacing of 1.2-m every 46-m in each direction and short of the roof edges is recommended for fire brigade access. Spacing of 5-m should be provided from combustible roof lights and 1.5-m from all roof lights.. Ensure smoke vents can open fully with the panels in place. Double nutting shall be specified for the panel bolts, especially where space for periodic re-tightening of bolts is not possible. The second nut shall be a stainless-steel lock nut with a nylon insert.
- Hydrology. The hydraulic study must be evaluated. A 100 years return period shall be considered for the calculation of all draining systems.
- The effect of water flooding is of particular concern for the inverters and batteries as they are very susceptible to water damage. If this possibility exists, they must be raised or relocated.
- Soil conditions. In ground mounted systems, the geotechnical and phreatic level studies, including the risk of expansive clays and/or soil liquefaction must be evaluated by the Risk Consultant, ensuring that all recommended mitigations are incorporated to the project.

- PV panels should not be located on combustible roofs or roofs with combustible insulation. On existing installations of this kind, special care shall be taken due to the high inherent risk. In these cases it is vital to keep a uniform surface that allows continuous resistance throughout the module array to avoid hot spots produced by the cell mismatch effect: damaged or shaded cells that produce lower current in a string dissipate the power produced in the good ones. Mitigating measures include maximizing the frequency of modules cleaning and replacement of damaged units, ensuring that by-pass diodes are installed and ready to work, and also maximizing the frequency of connectors checks/tightening and IR surveys. Partial module shading provoked by antennas, poles, or other structures shall be avoided by rearranging the facilities. On new installations, any combustible layer should be substituted or adequately covered before mounting the structures. Damaged modules must be replaced at short notice, without placing any piece of tape over them. PV modules without by-pass diodes shall be avoided. RSA has experienced losses where solar panel fires have spread to combustible roof covering. The presence of panels on the roof allows radiant heat to transfer to the panel from the roof and vice versa in the case of a fire and causes flames to be redirected much closer to the roof than in a typical roof fire. This can increase the fire hazard of the individual roof and panel systems as it is possible for the heat flux of a fire to exceed a critical point, therefore allowing fire spread.

Equipment

- Taking into account the dust and water ingress potential of external equipment, components should be IP-65 rated (Europe), NEMA 4 (North America), meaning they will not allow dust ingress and are resistant to normal strength water jets. As this limits the possibility to dissipate heat, junction boxes provided with heat generating equipment inside such as diodes shall be regularly checked.

- All electrical equipment must be protected from sun radiation. UPS batteries, inverters and dry transformers are especially prone to be damaged by high temperatures. Battery racks shall be air-conditioned in the 20-25ºC range. The design temperature of inverters and dry transformers shall be 50ºC. Inverter room and encapsulated dry transformers shall incorporate forced ventilation. Special attention shall be given to containerised units, prone to overheating.

- Inverters should be equipped with surge protection devices in both AC and DC sides. Also the array junction boxes, the data transmission lines and the power connections to the electrical grid should be provided with surge protection devices

- The DC side of the inverter shall be provided with a high sensitivity ground-fault protection, in order to detect dangerous isolation faults. These types of faults have caused fires in the past. If this system is not integrated in the inverter, an additional device shall be installed. Fuses are not allowed for this purpose as they cannot guarantee an adequate detection and trip. To avoid ground-faults from happening, DC cables shall be undamaged and provided with watertight cable bushings and junction boxes.

- Inverters should be freestanding on a metal frame or mounted against a fire-resistive wall, and in any case more than 2 metres away from any combustible membrane or insulation. In already placed inverters where this distance cannot be reached, RSA should be contacted in order to find a specific solution for each particular case. Transformers should be physically or spatially separated due to their inherent fire risk.

- Remote DC isolators shall be installed in the DC side of the inverter to allow manual isolation and safe fire-fighting.

- Sealed batteries are preferred to flooded units. Flooded batteries imply a higher risk because of explosive hydrogen release and the need of regular electrolyte additions. Nickel-Cadmium units have a longer durability and temperature range than lead-acid so they are preferred in scarcely maintained plants where no battery replacements are expected.

Lightning Protection, Cables and Accessories

- The need for external lightning protection (air-termination rods and conductors) for any building, PV plant or any other facility must be determined by EN 62035 risk assessment tool.

- PV systems, as well as air-conditioning systems, electrical sensors or any other conductive connection into the building, shall be separated at least 1m from the lightning protection. When this is not possible (i.e. insufficient distance or metal roofs), special high-voltage insulted lightning down conductors (e.g. HVI conductors) shall be used to avoid dangerous sparking. Otherwise, they should be included in the equipotential bonding using suitable lightning current and surge arrestors at the entry to the building. All metallic components without a conductive connection into the building must be connected directly to the lightning protection.

- Whether there is an external lightning system or not, inverters, junction boxes, communication lines, connections to the electrical grid and equipotential bondings between grounding systems must be equipped with lightning (surge) protection devices.

- Earth cables should be in place to protect all metallic structures, components and cable trays. The earth cables should be at least 6mm2 cross section. Lightning protection down-conductors must be at least 35mm2.

- The cables should be UV and water resistant and otherwise protected from direct sunlight to avoid UV damage. The preferred cable type is one with XLPE insulation, LSZH outer sheath, and steel armour.

- All cables should be placed on mesh or perforated cable trays to avoid contact with any combustible roof membrane and to allow for adequate ventilation. When mounted, tray covers must be at an appropriate distance (10cm) of the tray top, otherwise it is preferred to have them removed to allow heat dissipation. No more than 2 cable levels shall be installed in each cable tray. When pipes are used, it is important to check their deterioration and occupancy (to be no more than 30% of their section).

- DC connectors shall be MC type, IP-68, UV resistant. Pierced connectors shall be avoided.

- Cables contact with sharp points (i.e. rough concrete or metal edges) must be avoided.

Operational Considerations

- Avoid having the PV panel modules connected in series whilst not connected to the grid. The individual panels are normally supplied with an opaque material cover in place to avoid electricity being generated. These covers should remain in place until the arrays are fully connected.

- Inverters shall include 'islanding' detection to stop supplying any power in the event of a grid disconnection and avoid a local power island which could be dangerous for utility workers.

- Access to the site or roof must be restricted. For roof mounted systems consideration should be given to the possibility of using nearby storage/structures/waste bins etc, to gain access to the roof. Refer Appendix A - Risk Management Considerations.

- PV installations should be provided with remote load monitoring and alarm management, to include the panels and the inverters. The alarms should signal to a permanently manned station or to a cascade of contact phone numbers of site staff where staff members have the option to remotely check the plant condition. The emergency plan developed for the plant should be incorporated into the building emergency plan in the case of roof-mounted systems. The location of the main electrical components and the DC isolation point should be shown, plus the roof access locations.

- Adequate electrical shut-downs are required. An accessible remote DC disconnect should be provided for each inverter (plus each combiner box for new installations) to allow manual isolation and safe fire-fighting if needed.

- It is important to acknowledge all contract conditions between the various parties, for example the system owner, the operator, the maintainer, the electrical company and the owner of the building or land. In roof mounted systems when our client is not the owner of the PV plant it has to be ensured that it is provided with liability insurance covering fire damages.

Maintenance and Inspections

- Maintenance contracts should be formalised, covering all aspects of the system including the panels, support structures, trackers, electronics, electrical cables, drainages and components.

- All maintenance personnel, both in-house and contracted, must use the suitable work permits for performing tasks, including a hot work permit where necessary. A constant presence during the post work fire watch period is recommended. Mechanical repairs are favoured over welding repairs where possible, to avoid the possibility of damage to surrounding panels by sparks and heat.

- Panels and wiring should be visually inspected weekly for signs of deterioration, dirt or overheating. Damaged modules must be replaced at short notice. This inspection should include wiring combiner boxes, DC connectors, by-pass diodes boxes, inverters and modules.

- At least annually there should be a formal inspection of the condition of all electrical/grounding cables and connections, junction boxes, diodes, switchgears, DC conditioners, transformers, UPSs and DC/AC inverters, plus auxiliary components such as fuses and switches. Oil analyses shall be performed to all oil insulated transformers.

- Air filters on inverters shall be regularly replaced to avoid overheating. Especially in open field plants where dust or sand is present.

- Frequent cleaning must be done based on local environmental conditions (e.g. dust, bird dropping, etc.) and should be modified based on results of regular inspections. A situation in which different levels of sun radiation reach the modules of the same array (i.e. because of droppings or damage) must be avoided. The panels should be cleaned with clean water to remove surface dirt and salt. It is essential to clean panels regularly as partial shading can lead to hot-spots that cause the panel to deteriorate leading to faults that cause fires. This is especially important if modules are not provided with by-pass diodes.

- Robotic cleaning can be an option for large plants.

- Thermographic testing shall be performed on a yearly basis (twice per year where combustible materials are present) These surveys must include all electrical equipment such as inverters, wire connectors, junction boxes, switchboards, transformers, modules, etc. and must be done at a time when there is a significant panel loading (i.e. clear weather and peak generation times). The use of drones and AI (Artificial Intelligence) led thermal imaging for the modules is the best option for large plants.

- The electrical and control connections should be checked annually for tightness, deterioration and corrosion.

- For roof mounted systems the roof should be inspected at least every 3 months and before heavy wind or rain storms are expected. During these inspections: Remove loose objects. Check the roof material for deterioration and peeling. Check that gutters and drains are clear of debris. Check that safety barriers are in good condition and firmly fixed in place. Roof construction such as chimneys should have no loose construction elements. The panel support structures should be firmly fixed in place and in good condition, with no signs of corrosion.

- When solar trackers are installed, the positioning module shall be checked and the motor cleaned every 2 months. Once per year, a visual check of the tracker shaft and the cables, a fix of the screws, and a greasing of the motors shall be performed. It shall also be checked that nothing is restraining the tracker movement.

Property Risks

The main risks of property damage are listed below:

- Impact damage due to hailstorm, falling objects or malicious damage.
- Damage by extreme weather – storm, snowfall, lightning strike.
- Electrical failure and overheating, caused by incorrect plant design, component corrosion, hot spots, damaged modules, loose/low quality connections, extreme hot weather, temperature cycling fatigue etc.
- Theft – especially copper cables
- Fire resulting from electrical damage, arson or fire spread from the building/open field to the plant.
- The top surface of PV panels is usually tempered glass but the backing may contain combustibles such as polyester based encapsulates or back sheets. Panels with glass, aluminium or lower combustibility backings are preferred.

There is known to be a risk associated with solar panels due to local shading causing hot spots in a panel leading to panel deterioration and ignition and this has led to fires involving solar panels. Local shading can cause current reversal and overload in local areas of the panels. Key safeguards are mentioned in the guide and include regular cleaning, inspections and disconnection devices. By-pass diodes should be fitted in reverse paralleling with several solar cells to prevent the overload occurring. They are usually soldered in junction boxes (1 JB with 3 diodes per module of 72 cells). However these devices can themselves fail as a result of frequent occurrences of shadow, overheating of the junction boxes or lightning flashover.

To ensure that by-pass diodes are functional it is necessary to check at least:

- The diodes calculations to confirm that bypass diodes will conduct when only one cell is shadowed and that the shadowed cell voltage stays under its breakdown voltage.
- The maintenance plan includes regular current injections during the night to check that diodes become active and guide the current past the solar cells, especially after lightning storms.

The electrical risks are mainly mitigated through adequate preventative maintenance of the system and components. This will include regular inspections, cleaning, terminals tightening, predictive maintenance, thermographic camera inspections and trend analysis of the system load and electrical equipment and room temperature to identify potential problems such as overloading and arcing.

Damage due to weather conditions should be limited as much as possible by the correct specification of components according to local weather conditions, based on historical data and natural catastrophe peril tools. This cannot fully mitigate all risks due to the random nature of natural perils, but the risk can be reduced to an acceptable level by probability.

Regarding the fire risks, the following points are recommended:

- For large installations thought should be given to fixed fire protection. This would normally be in the form of gas suppression to cover the main electrical hazards, such as transformers, server rooms, rooms housing inverters and switchgear, plus any rooms where batteries are used for power storage purposes.
- Automatic fire detection shall be provided to inverters, transformers, batteries, power factor correction equipment and switchboard rooms.

- Transformers shall be equipped with temperature relays associated to PT-100 sensors in the windings.

- All equipment or metallic containers containing equipment subject to sun radiation shall be equipped with forced cooling and the batteries installed in air-conditioned rooms or cabinets.

- Wiring – particularly DC wiring that carries a higher current, should be limited as much as possible in length. High quality MC connectors shall be used. Flame retardation and fire-resistance shall be provided for cable runs that pass inside buildings.

- A remotely activated DC disconnection near the plant will help to prevent the risk of cutting through DC wires and also reduce the risk of arcing when panel arrays are wired in series but not yet connected to the grid. This facility should be clearly marked on the emergency plan.

- The emergency plan should include a list of responsible persons that can attend rapidly in the event of a fire, to assist the fire brigade in ensuring that the installations are disconnected and subsequently tensionless.

- Pre-planning must be completed with the local public fire service. This must ensure that adequate access, water supply and electrical shut-offs are available to allow fire-fighting and that the fire service are familiar with these features.

Loss Expectancies

The size of a potential fire will be influenced by several factors including the size of the plant, the expected emergency response, the distance between modules (fire spread could be by thermal radiation or via cables), roof construction, vegetation for ground level systems, availability of fire-fighting water and preparedness of the emergency response team.

For roof mounted systems, a PV panel array provides a combustion risk on top of the roof. On a concrete roof this is unlikely to spread into the building except via openings and cable- penetrations. On combustible roofs a fire would quickly spread to the roof and then the spread via the roof itself would be more rapid than via the modules.

Theft losses account for a relatively high proportion of PV panel plant claims. Due to the difficulty in transporting the large panels, theft is often concentrated on the high-value and highly-portable copper cables. To help mitigate the theft risk, physical and electronic security measures that slow down potential thieves should be used in conjunction with active measures that ensure an emergency response to the site – refer risk management considerations.

Losses due to malicious damage should also be taken into account. Loss history has shown that significant panel damage can arise through neighbouring farmers or residents unhappy that the plant was built on what was previously farmland, throwing stones and rocks into the plant to intentionally smash the panels.

A loss due to adverse weather conditions or natural catastrophe is more difficult to predict, but the size of such a potential loss can be limited mainly through the correct project planning and construction, taking into account local weather conditions, topography and natural catastrophe data for the area.

Business interruption should be taken into account following a fire or damage or failure of system components. Spare parts availability should be assessed, taking into account long lead-time parts (i.e. transformers, high voltage equipment) and parts with a higher failure rate (i.e. inverter modules, PV modules). Loss experience has shown that for commercial installations the business interruption costs account for approximately half of the total claim.

Some components are known to have a relatively high failure rate, such as the junction boxes on the reverse side of the panels, which can be subjected to extreme temperatures, or the DC connectors. These factors should be taken into account during the project design and should be checked by the visiting Risk Consultant.

For roof mounted systems the overall increase in risk at the site due to the installation of the panels needs to be carefully considered by the visiting Risk Consultant. The risk of fire, theft and damage should be assessed against the good practice guidelines noted in this document, with recommendations for improvement made where necessary. The balance of the risk level versus the mitigating factors should be reflected in the overall site risk rating, as should the increased exposure risk at the site.

Appendix A: Risk Management Considerations

Where not already in situ or unless suitable alternative strategies are already in place, the below should be adopted by consultants.

Crime

- Fencing and gates: These can be very mixed, i.e. such as including deer fences, palisade, mesh, natural (hedgerows / drainage ditches etc.). Consultants to report what perimeter protection is in situ but to thereafter focus efforts on the other points raised in Appendix A. If consulted prior to a site being developed then fencing will be an initial option however for the variabilities mentioned this will be very difficult to be specific. The fence and any gates therein should be constructed in accordance with British Standard 1722: Specification for Fences Part 12 or 14 and secured by close shackle padlocks to Grade 5 or 6 of BSEN12320.

- Site Security – Minimise points of entry to the Solar farm: Ensure entry points are minimised, controlled and monitored with only authorised personnel allowed to access the facility.

- Site Security - Install CCTV: Install a remotely monitored close circuit television (CCTV) system. The system should be installed and maintained by a company which is acceptable to the Police and recognised by the National Security Inspectorate (NSI) as a National Security Inspectorate Gold installer of CCTV systems.

  The CCTV installing company should provide a specification for the system that is in accordance with British Standard 8418 Installation and remote monitoring of detector activated CCTV systems Code of practice.

  Protection Specification:

  -Thermal imaging to allow for the detection of lurking outer fires. Coverage of the entire perimeter of the facility and key plant areas housing inverters.
  -Video analysis to detect any human intrusion.
  -The signalling method to be via an ISDN line or Broadband supported by a secondary communication path such as GPRS or satellite communications system.
  -Clear instructions should be recorded in a 'Response Plan' or 'Service Agreement' outlining the actions that are required after any activation or fault signal.
  -Forward a copy of the proposed CCTV specification to RSA for agreement prior to any order being placed.

  General Requirements:

  -The system to relay from the Alarm Receiving Centre to a Keyholding Response company approved by the National Security Inspectorate (NSI), the Security Systems and Alarm Inspection Board (SSAIB) or the Security Industry Authority's Approved Contractor Scheme.

  -The system to be allocated a Police Unique Reference Number (URN) and thus benefit from Police attendance in accordance with the Force Policy. Inform RSA immediately if there is notification of a reduced level or withdrawal of Police response to the system.

  -If a camera becomes un-operational or is otherwise impaired, the alarm receiving centre to ordinarily call key-holders to investigate the position. The response to site should be a minimum response time on site of 30 minutes to 1 hour maximum.

- Upgrade Solar Panel Security: Upgrade solar panel security by using 'tighten-and-break' anti-theft screws to fasten panels to mounting frames. When the applied tightening torque reaches a critical value, the hexagonal head of the nut breaks off completely, leaving a conical head that no wrench can grip. Alternatively, one way tightening screws or screws where the head is turned off after they have been finally tightened are good alternatives. For new sites under development this is an expectation.

- Upgrade Cable Security: In ground mounted systems, cables should be buried in trenches that are backfilled with sand, tape marked and compacted. Additional security in the form of anti-theft clamps or forensic marking products can be fitted to the cable that prevents the cable being pulled from the trench. Directly buried cables should be armoured to prevent damages, especially where road-crossing is possible. String inverters that are grouped together at the end of an array should also be fitted with anti-theft clamps.

- Upgrade Security to 24 hour Guarding (where losses experienced or temporary solution prior to protection as stated above): Upgrade Security to incorporate a professional guarding service. The service should provide coverage through regular patrolling of the location, supported by key-point logging on a guard tour patrol system. The manpower requirement will vary according to the assignment instructions and the extent of the premises/site. Ideally, the guard on patrol will be in continuous contact via mobile radio with a static guard in a secure location in a position to raise an alert if necessary.

Property

- Install Automatic Fire Detection. Install automatic fire detection within each of the following areas:
  -Transformer stations,
  -Inverter stations,
  -Main switchroom,
  -Server room,
  -Battery room,
  -Control room,
  -Warehouse,

  Alarms from the installed detection should be relayed to a constantly attended location such as a central control centre or a National Security Inspectorate (NSI) certificated alarm receiving centre.

  The signalling method to be by either tested and certificated to LPS1277 ATS5 and installed in accordance with appendix C issue 3, a Dualcom GPRS G4 connection, or an alternative signalling method agreed with RSA Group. If feasible remote isolation facilities should also be incorporated so that specific equipment can be isolated remotely upon activation of automatic fire detection i.e. inverters, transformers.

- Complete Thermal Imaging: Complete thermal imaging (infra-red) surveys, to include all major electrical switchgear, major cable runs, transformers, batteries, cable terminals and key equipment i.e. PV modules. Promptly correct any deficiencies identified. The use of drones is advised for the modules in large plants. Thermographic inspection of distribution panels to be undertaken when the panel is open, to ensure full effectiveness of results.

- Develop Emergency Response Procedures - Fire Brigade: Contact the Regional Fire & Rescue Service and invite them (or at least the local Fire Stations) to visit the site so that they can be made fully aware of the hazards and assess how they would tackle a fire incident including grass fires. As part of the visit they should formally review and provide comment on the site Fire Risk Assessment (FRA).

- Furthermore develop a formal Fire Brigade Information pack, which should contain all relevant information that they would need in the event of an incident on site. Some typical aspects to include are as follows:
  - A site plan with all key plant & equipment and localised hazards identified;
  - Access points (mark on site plan);
  - Emergency contact numbers;
  - Plant / power isolation points / procedures (AC & DC);
  - Any specific actions that should not be taken in the event of an incident;
  - Water supplies for fire fighting (mark on site plan if appropriate);
  - Details of other fire fighting / extinguishing media that should be used if more appropriate;
  - Any other information that is felt pertinent for dealing with a fire / emergency on site.

  The Information Pack should be stored securely on site in a secure location / box that is clearly identified and known to the fire brigade i.e. secure metal box / container on the side of the main switchroom.

- Develop Business Continuity Planning: Develop and implement a Business Continuity Management (BCM) system and plan (BCP) to reduce the likelihood of loss, and to mitigate the effect of business / operational interruption.

  BCM is a systematic approach to risk control and business recovery that ensures the best-achievable protection for your key deliverables and the processes and activities that support these.

  BCM is more than just preparing a 'disaster recovery plan'. It provides you with the opportunity to identify and measure the risks to which your business is subject, to improve your resilience to loss and interruption, and to prioritise recovery in the event of a loss. Some specific areas that should be considered / addressed as part of the process are:
  - Stock of critical spares, i.e. transformers, inverters, high voltage equipment, panels, cables etc in a secure central location;
  - Recovery strategy in the event of a loss of the main switchroom;
  - Business implications and recovery strategy in the event of a loss of the Distribution Network Operator Point of Contact (DNO POC) switchroom;