ID	Method	Component	Risk list
1.	Risk factors	Photovoltaic panel	The presence of cracks and fissures in solar panels can generate hot spots, resulting in a reduction in energy generation efficiency in the affected area and increasing the risk of fires.
2.	Risk factors	Photovoltaic panel	Accumulated dirt on the surface of solar panels can cause shaded areas on the panel and reduce the amount of captured sunlight, resulting in a decrease in the efficiency of electricity generation.
3.	Risk factors	Photovoltaic panel	Internal corrosion of the panels due to exposure to extreme weather conditions or the use of inadequate materials results in the deterioration of solar cells and a decrease in the ability to convert sunlight into electricity.
4.	Risk factors	Photovoltaic panel	Theft of solar panels or their components results in financial losses, system malfunctions, and hampers energy generation efficiency.
5.	Risk factors	Photovoltaic panel	Obstruction of solar panels by hail can lead to physical damage to system components, creating new circuit paths, resulting in short circuits, fires, and a reduction in energy generation efficiency.
6.	Risk factors	Photovoltaic panel	Inadequate operating conditions, such as temperature, humidity, and voltage above technical specifications, can result in reduced energy production, decreased panel lifespan, and increased failures due to environmental factors.
7.	Risk factors	Photovoltaic panel	Adverse or extreme weather conditions, such as snowstorms, hailstorms, windstorms, and hurricanes, can cause physical damage to solar panels, resulting in partial or total loss of device functionality.
8.	Risk factors	Photovoltaic panel	Manufacturing defects can cause electrical contact between photovoltaic cells, altering the characteristic current-voltage curve of the module, resulting in negative impacts on the panel's performance.
9.	Risk factors	Photovoltaic panel	Oxidation of solar panels due to poor-quality materials or exposure to the elements can affect the panel's surface and generate an oxide layer, resulting in reduced energy storage.
10.	Risk factors	Photovoltaic panel	Exposure of the photovoltaic panel in high humidity (>0.85%) locations can lead to corrosion of panel components, resulting in physical damage to metallic parts of the panel, such as electrical contacts and mounting structure.
11.	Risk factors	Photovoltaic panel	The exposure of the photovoltaic panel in high humidity (>0.85%) locations can cause loss of encapsulant adhesion and allow greater moisture penetration into the module, resulting in damage to the cells and reduced energy efficiency of the panel.
12.	Risk factors	Photovoltaic panel	The use of inadequate tools during maintenance of panel connectors can lead to breakage of cable connections, resulting in current leakage and increased risk of fires.
13.	Risk factors	Photovoltaic panel	Placing the panel in shaded areas can reduce current production, thereby decreasing electricity generation.
14.	Risk factors	Photovoltaic panel	Failure in the soldering of photovoltaic module components can increase contact resistance, resulting in reduced energy generation efficiency.
15.	Risk factors	Photovoltaic panel	Oversizing of direct current (DC) or alternating current (AC) can cause overload on the solar panel, leading to the burning of components connected to the panel and a reduction in the system's lifespan.
16.	Risk factors	Photovoltaic panel	Photovoltaic modules with low-quality materials can generate shaded areas on the panel surface, resulting in a reduction in the amount of generated energy and a decrease in panel lifespan.
17.	Risk factors	Photovoltaic panel	Incorrect installation of inverters can lead to overvoltage in the alternating current (AC), impairing the operation of solar panels and reducing energy generation efficiency.
18.	Risk factors	Photovoltaic panel	Failure in connectors and junction boxes of solar panels can allow moisture ingress, accelerating corrosion and increasing the risk of short circuits in system components.
20.	Risk factors	Photovoltaic panel	The use of inappropriate materials during maintenance, such as abrasives, can cause physical damage to the surface of the panel, resulting in cracks or fissures that compromise energy generation.
21.	Risk factors	Photovoltaic panel	Theft of photovoltaic panels by malicious individuals can cause financial losses to the system owner, posing a significant risk.
22.	Risk factors	Photovoltaic panel	Malicious individuals may steal photovoltaic panels and their components, resulting in financial losses for the system owner and potential accidents on-site.
23.	Risk factors	Photovoltaic panel	Sabotage of the electrical grid can disrupt the production and distribution of energy from photovoltaic panels, leading to financial losses, energy theft, and panel damage.

24.	Risk factors	Photovoltaic panel	Theft of solar panels or their components; Accumulation of dirt, dust, and debris on the panel surface; Sabotage by malicious individuals; Failure to maintain the panels; Incorrect installation or use of low-quality materials; Malfunctioning of system components; Adverse weather conditions such as hailstorms, strong winds, and storms; Improper use or overload of voltage or power; Manufacturing defects; Issues with the electrical grid connected to the panels.
25.	Risk factors	Photovoltaic panel	Inadequate operating conditions can result in overvoltage or undervoltage in the alternating current that powers the panels, reducing their lifespan and increasing maintenance costs.
26.	Risk factors	Photovoltaic panel	The burning of the inverter can prevent the conversion of stored energy by the panel into direct current (DC), resulting in the absence of energy generation and storage.
27.	Risk factors	Photovoltaic panel	Improper installation of inverters and inadequate configuration of their communication protocols can decrease energy generation efficiency.
28.	Risk factors	Photovoltaic panel	The use of high-voltage inverters carries the risk of system overload, which can lead to the burning of photovoltaic modules.
29.	Risk factors	Photovoltaic panel	Preventive maintenance performed by inexperienced professionals can damage the electrical and mechanical components of the panel, resulting in reduced efficiency and system safety in energy generation.
30.	Risk factors	Photovoltaic panel	Inefficient diagnosis of faults in photovoltaic panels can lead to interruptions in energy generation, reducing system efficiency and increasing corrective maintenance costs.
31.	Risk factors	Photovoltaic panel	Reduction in system efficiency; Panel burnout; Panel degradation; Reduction in panel yield; Reduction in energy storage; System malfunction.
32.	Risk factors	Photovoltaic panel	Exposure of solar modules to high temperatures and high voltage levels can result in Potential Induced Degradation (PID), leading to defects in semiconductor materials and decreasing panel efficiency.
33.	Risk factors	Photovoltaic panel	Lack of regular cleaning and maintenance can accelerate the degradation of photovoltaic panels, resulting in reduced energy conversion efficiency.
34.	Risk factors	Inverter	Inverter failure can disrupt the energy transfer to the grid and equipment, rendering the entire system useless.
35.	Risk factors	Inverter	Inverter overheating, due to malfunction, can lead to rapid deterioration of its components, resulting in fires and frequent equipment replacement.
36.	Risk factors	Inverter	Installing the inverter in an unsuitable location with direct exposure to sunlight can increase its temperature, resulting in accelerated degradation and, in extreme cases, overheating and burnout.
37.	Risk factors	Inverter	Improper connection between the string cables and the inverter can cause electrical connection failures, leading to equipment shutdown and difficulties in identifying electrical arcs.
38.	Risk factors	Inverter	Defective RS485 indicator LEDs can erroneously indicate the equipment's operating status, resulting in a series of failures such as overvoltage, overheating, and inverter errors, which can lead to inverter burnout.
39.	Risk factors	Inverter	The theft of the inverter can interrupt the energy transfer to other devices due to the absence of the equipment, resulting in a complete system shutdown and financial losses.
40.	Risk factors	Inverter	Excessive distance between the communication network and the inverter can cause a significant potential difference between the locations, resulting in interference with the communication signal.
41.	Risk factors	Inverter	Undersizing the communication speed of the inverter and the network can lead to more retransmissions, resulting in lower inverter efficiency.
42.	Risk factors	Inverter	Failure to change the default passwords established by the manufacturer can simplify access to the inverter's data, increasing the likelihood of unauthorized breaches and potential information theft.
43.	Risk factors	Inverter	Intrusion into the wireless network of the photovoltaic inverter can allow unauthorized and real-time access to all equipment information, including operational and performance data, enabling the installation of malware and malicious software.
44.	Risk factors	Inverter	The absence of an intrusion detection system, such as alarms and sensors, can prevent the identification and monitoring of inverter breaches, allowing silent access to the data.
45.	Risk factors	Inverter	Overvoltage that exceeds the specified technical limit can cause damage to the inverter components, resulting in malfunction or even equipment burnout.

46.	Risk factors	Inverter	The absence of integrity verification and failures in non-standardized software loading processes can enable data manipulation or deletion, resulting in loss of accuracy, consistency, and reliability of the performed update.
47.	Risk factors	Inverter	The absence of cryptographic keys or the use of manufacturer default keys can seriously compromise data security, resulting in unauthorized access and theft of sensitive information.
48.	Risk factors	Inverter	Problems in cable connections and crimps can cause electrical resistance, resulting in energy losses and decreased system efficiency.
49.	Risk factors	Inverter	Lack of maintenance of electrical protections, including circuit breakers and fuses, can result in insulation failures and electric current leakage.
50.	Risk factors	Inverter	Lack of maintenance and cleaning of the inverter's fan, grille, and heat exchanger can interfere with proper heat dissipation and increase the internal temperature of the equipment, resulting in automatic shutdown of the inverter.
51.	Risk factors	Inverter	Lack of overall maintenance of the photovoltaic inverter, including detection of component damage or breakage, can interfere with energy conversion and overall equipment operation, resulting in shutdown, performance reduction, power loss, or, in extreme cases, fires.
52.	Risk factors	Inverter	Tapping into the communication network can allow control over multiple inverters connected to the bus, resulting in possible manipulation of control signals sent to the inverters.
53.	Risk factors	Inverter	Failure to verify the authenticity of the software load by the inverter can allow the installation of tampered versions of the firmware, resulting in unauthorized and malicious access to private information and enabling the transmission and receipt of unauthorized data.
54.	Risk factors	Inverter	Improper installation or repositioning of the photovoltaic inverter can result in electrical shock hazards for the installer and loss of functionality of electrical components.
55.	Risk factors	Inverter	Inadequate cable diameter can lead to voltage drop and reduce current conversion efficiency, resulting in power loss in the system.
57.	Risk factors	Inverter	The presence of a malicious file in the software load can compromise the operation of management software responsible for controlling the inverter, such as Aurora Manager, resulting in improper control and management of inverter information.
58.	Risk factors	Inverter	Improper installation of network communication, such as installing two RS485/Modbus-RTU masters on the same network, can lead to network intermittence, resulting in inverter malfunction and interruption of power supply.
59.	Risk factors	Inverter	Incorrect installation of communication cables alongside power cables can result in confusion and reversal of cable connections, resulting in malfunction of the entire network.
60.	Risk factors	Inverter	Not following manufacturer guidelines and technical standards can lead to inadequate sizing of the inverter's electrical current, resulting in the risk of electrical discharge and fires.
61.	Risk factors	Inverter	Inadequate current sizing can cause unintentional tripping of the circuit breaker, resulting in power supply interruption, equipment damage, and electrical hazards for professionals responsible for maintaining the photovoltaic system.
62.	Risk factors	Inverter	Inadequate inverter sizing can reduce the energy generation capacity of the photovoltaic system, resulting in lower efficiency in capturing sunlight and, consequently, generating electrical energy.
63.	Risk factors	Inverter	Installing inverters vertically with an inclination greater than 5° can impede proper heat dissipation from the components, leading to equipment overheating and increased fire risk.
64.	Risk factors	Inverter	Improper inclination of the inverter (greater than 5° vertically) can result in power loss, reducing the efficiency of the photovoltaic system.
65.	Risk factors	Inverter	Installing the inverter in locations with high humidity and inadequate cable sealing can allow electrical current leakage, resulting in low equipment insulation resistance, risk of electric shock, and accelerated corrosion of electrical components, reducing the equipment's lifespan.
66.	Risk factors	Inverter	Overheating and electrical arcs raise the temperature of the components, exceeding technical limits, causing premature wear, failures, and reducing the efficiency and lifespan of the equipment.
67.	Risk factors	Inverter	Aging of inverters and their components over time can result in wear and tear due to equipment usage, resulting in malfunctions and costs associated with corrective maintenance.

68.	Risk factors	Inverter	Lack of regular maintenance on inverter components, such as the fan, grille, heat exchanger, and filter, can lead to dust accumulation in the equipment, resulting in reduced cooling efficiency, shortened inverter lifespan, and increased costs of corrective maintenance.
69.	Risk factors	Gateway (ModBus TCP)	Overheating of the gateway beyond the limits specified in the technical specification can lead to accelerated degradation of electronic components, resulting in reduced equipment efficiency and increased fire risk.
70.	Risk factors	Gateway (ModBus TCP)	Improper installation of the inverter can compromise the functionalities and integrity of the gateway, resulting in overall poor performance of the photovoltaic system.
71.	Risk factors	Gateway (ModBus TCP)	Defective indicator LEDs on the gateway can provide incorrect indications of its operation, resulting in failures that compromise both efficiency and hardware integrity.
72.	Risk factors	Gateway (ModBus TCP)	Theft of the inverter hardware can disable the ModBus TCP to RTU protocol conversion, which is essential for integrating equipment that uses different protocols, impairing communication and plant security.
73.	Risk factors	Gateway (ModBus TCP)	Lack of a firewall, such as proxy, can allow unauthorized external connections and reduce the effectiveness of traffic filtering, resulting in access to specific network information unprotected by security measures.
74.	Risk factors	Gateway (ModBus TCP)	A damaged connection cable can result in the loss of internet connectivity via cable, preventing software updates and impairing equipment operation.
75.	Risk factors	Gateway (ModBus TCP)	Using manufacturer default keys on the gateway can make it easier for hackers to gain unauthorized access to data, compromising the security and privacy of that information and enabling data theft.
76.	Risk factors	Gateway (ModBus TCP)	Intrusion into the wireless network can allow unauthorized and real-time access to all gateway information, compromising its security and privacy, as well as enabling the installation of malware and malicious software.
77.	Risk factors	Gateway (ModBus TCP)	The lack of source authentication mechanisms, such as IP spoofing, can allow the forgery of source IP addresses from other hosts, resulting in unauthorized access to confidential data associated with those IP addresses.
78.	Risk factors	Gateway (ModBus TCP)	The use of weak authentication and encryption can enable desynchronization attacks on TCP communication and allow the hijacking of third-party connections, resulting in access to sensitive information and compromising network security.
79.	Risk factors	Gateway (ModBus TCP)	The use of predictable initial sequence numbers can lead to TCP sequence number prediction, allowing the generation of malicious packets targeted at a specific host, resulting in network traffic manipulation, information theft, injection of fake packets, or even denial of service (DoS) attacks.
80.	Risk factors	Gateway (ModBus TCP)	The lack of firewall protection on open TCP ports can allow attempts from malicious IP addresses, which can result in network intrusions and compromise system security.
81.	Risk factors	Gateway (ModBus TCP)	The absence of encryption in communication can enable source routing, allowing an attacker to monitor and intercept communications on the network, gaining access to confidential information and compromising overall network security.
82.	Risk factors	Gateway (ModBus TCP)	The presence of unprotected ports can enable an attacker to launch attacks such as DoS (Denial of Service) on the router, causing the equipment to "reload" and potentially resulting in data loss.
83.	Risk factors	Gateway (ModBus TCP)	A DoS attack or large-scale transmission of SYN packets with forged IP addresses can cause the opening of a server port, rendering it inoperable.
84.	Risk factors	Gateway (ModBus TCP)	The lack of verification of authenticity and integrity in the software loading process can lead to data deletion or alteration, reducing the accuracy, consistency, and reliability of the update.
85.	Risk factors	Gateway (ModBus TCP)	Inadequate maintenance on the gateway can alter its settings, resulting in operational failures and potential security breaches.
86.	Risk factors	Gateway (ModBus TCP)	Disconnection or damage to cables or connections during maintenance can interrupt the gateway's communication with other network devices, resulting in data loss or the loss of important information stored in the gateway.
87.	Risk factors	Gateway (ModBus TCP)	Lack of technical skills and the use of inadequate tools during gateway maintenance can exacerbate existing device failures, resulting in accelerated deterioration of system integrity.

88.	Risk factors	Gateway (ModBus TCP)	Loss of data stored in the gateway during maintenance can compromise the integrity of information, affect system productivity and security, and result in financial losses and process disruptions.
89.	Risk factors	Gateway (ModBus TCP)	The lack of antivirus software updates can leave the gateway vulnerable to malware attacks, resulting in installation failures or installation in an environment where malware may gain access permission.
90.	Risk factors	Gateway (ModBus TCP)	The absence of authenticity verification for software loading can allow unauthorized access to firmware data and passwords, resulting in cyber data tampering and information breaches.
91.	Risk factors	Gateway (ModBus TCP)	Physical access to the gateway by malicious agents can enable the substitution of the device with tampered hardware, resulting in financial losses and unauthorized access to the original owner's data.
93.	Risk factors	Gateway (ModBus TCP)	The lack of verification of software authenticity and integrity can allow the installation of malicious software on the gateway, resulting in vulnerability and compromised security.
94.	Risk factors	Gateway (ModBus TCP)	Failures during software loading can cause service disruptions or security vulnerabilities in the gateway.
95.	Risk factors	Gateway (ModBus TCP)	The lack of standardization in software loading processes can lead to increased maintenance costs and time, resulting in decreased efficiency, security, and reliability of the system.
96.	Risk factors	Gateway (ModBus TCP)	The lack of software and firmware updates can leave the gateway vulnerable to known attacks that could be prevented through the application of security patches.
97.	Risk factors	Gateway (ModBus TCP)	Improper gateway installation and misconfiguration of network settings, drivers, and specific configurations can lead to communication issues between devices, resulting in data loss, delays in information transmission, and communication failures or interruptions.
98.	Risk factors	Gateway (ModBus TCP)	RS485 networks with incorrectly configured different Modbus addresses can lead to communication problems, such as duplicated responses to commands, interruptions, and failures in device communication.
99.	Risk factors	Gateway (ModBus TCP)	Natural aging of hardware, including cables, can result in communication failures from Modbus TCP to RTU protocol, leading to communication disruption or data packet loss.
100.	Hazop	Photovoltaic panel	Elevated ambient temperatures above specified limits can cause thermal stress on photovoltaic panels, resulting in physical damage and increased maintenance and replacement costs.
101.	Hazop	Photovoltaic panel	Extreme weather conditions, such as snowstorms, can lower ambient temperatures below specified limits, reducing the efficiency of photovoltaic panels and causing financial impacts on the solar power plant.
102.	Hazop	Photovoltaic panel	Increased ambient temperatures above specified limits can generate thermal stress on photovoltaic panels, resulting in physical damage and additional costs for maintenance and replacement.
103.	Hazop	Photovoltaic panel	Decreased ambient temperatures below specified limits can cause excessive cooling of photovoltaic cells, leading to breakage or cracking and reducing the efficiency of power generation from the panel.
104.	Hazop	Photovoltaic panel	Areas with high relative humidity (>0.85%) can cause water condensation inside photovoltaic cells, reducing thermal insulation and increasing the risk of electrical shocks.
105.	Hazop	Photovoltaic panel	Areas with high relative humidity can lead to oxidation and corrosion of cables in the photovoltaic power plant.
106.	Hazop	Photovoltaic panel	Lightning strikes can cause overvoltages in the photovoltaic power system, irreversibly damaging solar cells, leading to short circuits and fires.
107.	Hazop	Photovoltaic panel	Impact speed of hailstones exceeding 50 mph can cause microcracks or fissures in photovoltaic cells, reducing their mechanical strength and increasing the risk of short circuits in the system.
108.	Hazop	Photovoltaic panel	Excessive snow accumulation on photovoltaic panels can damage the solar cells, reducing the system's capacity to generate power.
109.	Hazop	Photovoltaic panel	Extreme weather conditions, such as strong winds above the specified limit, can result in panel detachment and internal damage to photovoltaic cells, resulting in reduced efficiency in power generation.
110.	Hazop	Inverter	Elevation of direct current above specified technical limits can generate overvoltage in the DC current, resulting in inverter shutdown and possible short circuits.
111.	Hazop	Inverter	Presence of defects in the inverter's electrical circuits can cause a decrease in DC voltage, resulting in insufficient input voltage to power the source during nighttime.

112.	Hazop	Inverter	Lack of electrical grounding can compromise protection against leakage currents and lightning strikes, resulting in equipment damage and electrical accident risks.
113.	Hazop	Inverter	Oversized installation of photovoltaic panels can result in lower output power than the input power, leading to prolonged operation of the inverter with lower efficiency and electrical energy loss.
114.	Hazop	Inverter	Elevation of alternating current above specified technical limits and inadequate infrastructure can generate overvoltage in the AC current, resulting in the shutdown of the photovoltaic inverter or burning of electronic equipment connected to the grid.
115.	Hazop	Inverter	Decrease in equipment's supply voltage can cause AC undervoltage, resulting in equipment operation interruption or burning of connected devices.
116.	Hazop	Inverter	Increased frequency above the technical specification limit, usually caused by an excess supply of energy compared to demand, can cause network disconnections, resulting in mass shutdowns of the photovoltaic inverter and connected equipment.
117.	Hazop	Inverter	Climate change, improper installation, and inadequate sizing can cause inverter overheating, resulting in a reduction in system-generated power and, in extreme cases, complete inverter shutdown.
118.	Hazop	Inverter	Excessive cooling of the inverter, often due to climate changes such as snowstorms, can cause temperature sensor failures and corrosion of metal components, compromising the proper functioning of the equipment and resulting in economic losses for the photovoltaic system.
119.	NCSF	Inverter	Absence of asset inventory and responsible definitions can compromise asset management, access authorization, and identification of accountable parties.
120.	NCSF	Inverter	Absence of software inventory can compromise software management and identification of owners.
121.	NCSF	Inverter	Absence of organizational communication mapping and data flow can hinder comprehensive device management and attacks against network services.
122.	NCSF	Inverter	Absence of threat monitoring processes and tools and lack of information classification can impede the detection of network security threats and effective information management.
123.	NCSF	Inverter	Absence of security requirements and controls for management can hinder the management and control of information security.
124.	NCSF	Inverter	Absence of standards for reporting incidents and response procedures can compromise incident response and management.
125.	NCSF	Inverter	Absence of defined roles and responsibilities can hinder the mapping, documentation, and handling of cybersecurity incidents.
126.	NCSF	Inverter	Absence of requirements for risk identification, assessment, and treatment plans can hinder the management of cybersecurity risks.
127.	NCSF	Inverter	Absence of vulnerability information and tools for system and network compliance analysis can hinder vulnerability management and compliance analysis.
128.	NCSF	Inverter	Absence of specialized forums for mapping cyber threats can hinder the management of such threats.
129.	NCSF	Inverter	Absence of identification and documentation of internal threats can compromise asset integrity.
130.	NCSF	Inverter	Absence of technical vulnerability management and restrictions on software installation can hinder the collection of information about these vulnerabilities and impede the definition of criteria for software installation.
131.	NCSF	Inverter	Absence of a risk treatment plan can hinder the definition of methods, processes, and controls for addressing information security risks.
132.	NCSF	Gateway (ModBus TCP)	Absence of asset inventory and responsible definitions can compromise asset management, access authorization, and identification of accountable parties.
133.	NCSF	Gateway (ModBus TCP)	Absence of software inventory can compromise software management and identification of owners.
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