

SAFETY RISKS AND MEASURES IN THE MAINTENANCE AND CLEANING OF SOLAR PANELS

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Abstract

The growing global demand for energy has led to increased adoption of renewable energy technologies, especially solar power systems, due to their sustainability and environmental benefits. However, the operation and maintenance of solar panels—particularly cleaning processes—introduce a variety of safety risks. This article examines these risks in detail, focusing on mechanical hazards, electrical dangers, and environmental factors involved in maintaining rooftop and building-integrated photovoltaic (BIPV) systems. The paper highlights the importance of preventative maintenance, such as regular inspection for mechanical damage, electrical system checks, snow removal, and cleanliness of panels. Particular emphasis is placed on risks associated with working at heights, including falls, improper use of tools, and weather-related hazards such as slippery surfaces or high UV exposure. Furthermore, damage to equipment during cleaning or servicing is a critical concern that can reduce panel efficiency or lead to complete system failure. The study presents mitigation strategies, including personal protective equipment (PPE), system shutdown procedures, and specialized safety training. It advocates for integration of safety practices into standard building codes and emphasizes the necessity of updating regulations, such as SNIP 2.01.07-1996, to reflect current technologies. The paper concludes that systematic training, proper equipment handling, adherence to safety protocols, and regular maintenance scheduling are essential for reducing occupational hazards and prolonging the lifespan and performance of solar systems.

Keywords: solar energy, renewable energy, maintenance safety, photovoltaic systems, electrical hazard, fall protection, building regulations, SNIP standards, rooftop work, environmental safety

Introduction. The modern era demands an increasing amount of energy consumption, which continues to grow annually. As traditional fossil fuel resources like oil, coal, and gas face depletion and environmental criticism, renewable energy sources—particularly solar, wind, and geothermal—are becoming essential alternatives. Among them, solar energy is particularly suitable for regions with abundant sunlight. However, the integration of solar technologies into buildings must strictly comply with local construction and safety standards. The primary aim of this

study is to analyze existing regulations, identify safety hazards, and develop recommendations for safe maintenance and cleaning of installed solar panels. Additionally, this research evaluates the structural impact on buildings and proposes engineering calculations to ensure load compliance during installation and servicing.

Risks During Preventive Maintenance of Solar Panels

Electric Shock: Solar panels generate electricity, and working with connected systems poses a serious risk of electrocution.

Short Circuits and Fires: Improper handling of electrical components may result in short circuits, overheating, or fires.

Mechanical Hazards. Falls from Height: Solar panels are commonly installed on rooftops or high platforms, increasing the risk of falling.

Tool-Related Injuries: Mishandling tools can cause physical injuries during installation or cleaning.

Climatic Hazards. Slippery Surfaces: Wet or icy roofs make movement dangerous. **UV Exposure:** Long-term exposure to sunlight can cause heatstroke or sunburn.

Equipment Damage Risks. Mechanical Damage to Panels: Using inappropriate tools during cleaning may cause cracks or scratches. **Seal or Coating Damage:** Damaging the surface integrity may reduce efficiency or render the system inoperative.

Risk Mitigation and Safety Measures.

Electrical Safety. Always disconnect the system before beginning work. Use dielectric gloves, insulated tools, and anti-shock footwear.

Fall Prevention. Use safety harnesses, guardrails, and anchor points. Limit access and mark zones near roof edges.

Weather Precautions. Postpone work in rain, snow, or extreme heat. Wear UV-protective clothing, sunglasses, and schedule breaks in the shade.

Panel Handling and Equipment Use. Use soft, non-abrasive materials for cleaning. Perform visual and technical inspections routinely.

Training and Emergency Preparedness. Ensure workers are trained in electrical and height safety protocols. Conduct regular fire and emergency drills [2].

Regulatory Considerations. Based on the risks outlined, it is necessary to revise and expand national construction regulations, such as SNIP 2.01.07-1996 “Loads and Impacts,” which govern design parameters for building loads. Updated standards should address modern solar technology, including BIPV systems, their anchoring mechanisms, and the dynamic loads introduced by maintenance activities. Integrating maintenance procedures into building codes will enhance occupational safety and system longevity.

Conclusion. Ensuring safety during solar panel maintenance requires a comprehensive approach that accounts for electrical, mechanical, environmental, and

structural risks. Preventive strategies—including system shutdowns, PPE use, secure anchoring systems, and updated training protocols—can significantly minimize accidents. Incorporating such measures into national building regulations and safety codes is critical for supporting the sustainable and safe expansion of renewable energy infrastructure. Furthermore, adopting a proactive culture of safety in the renewable energy sector contributes not only to the physical protection of workers but also improves system performance and operational efficiency. As solar panel technology evolves and becomes more widely implemented, maintenance workers will require continuous education on updated risks and mitigation techniques. Encouraging collaboration between policymakers, engineers, safety experts, and equipment manufacturers is crucial to developing industry-specific standards that reflect real-world operational contexts.

Investment in smart monitoring technologies, such as remote diagnostics and predictive maintenance systems, can help detect performance issues before they become critical failures. Similarly, the development of training simulators and virtual reality safety environments can prepare technicians for high-risk conditions in a controlled setting. Ultimately, achieving long-term sustainability goals depends not only on clean energy production but also on creating a safe, well-regulated, and resilient workforce capable of maintaining such systems over decades of operation.

Foydalanilgan adabiyot

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