



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study : Ph.D.

Thesis Title: **Ergonomic design interventions for ensuring OSH of the workers engaged in Floating Solar PV installation and maintenance.**

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Thesis Submitted to the Department/ Center : Design

Date of completion of Thesis Viva-Voce Exam : 3rd October 2023

Key words for description of Thesis Work : renewable energy, OSH, co-design, design interventions, sustainable development goals

SHORT ABSTRACT

Climate change concerns have prompted a concerted global push towards generation of renewable energy. Within the ambit of the solar photovoltaic industry, floating solar photovoltaic (FSPV) projects are growing in number in India. As a result, a large population of fixed term workers with little or no experience or training are engaged in jobs related to installation and maintenance. While working in these new kinds of workplaces, there are likely to be several human-machine mismatches giving rise to ergonomic issues. As a result, these workers are exposed to emerging occupational health and safety (OSH) risks that can have both short term and long-term health effects as well as direct & indirect costs. Immediate attention for mitigation of these risks must be an important priority for all stakeholders. Little or no research has been conducted covering these OSH dimensions in the FSPV sector. In this backdrop, a comprehensive literature review using the PRISMA method was carried out which revealed several knowledge gaps and possible design opportunities. The aim of this research was to investigate and measure the specific nature of OSH risks faced by the workers engaged in FSPV projects and to design context specific solutions from an ergonomics design perspective for risk mitigation. Objectives were defined and field studies were undertaken after obtaining approval of the ethics committee, informed consent, and permission from participating organizations. In accordance with the objectives, literature review and exploratory field studies in India were carried out. Twenty different OSH risks were identified and measured at two FSPV sites in India based on severity and vulnerability using a risk perception questionnaire developed during the research work. Stakeholders such as safety managers (n=30) and FSPV workers (n=53) participated in the studies. In addition, discomfort glare, socio-demographic and environmental parameters at both the sites were also measured. The top five risks identified include falling into water, heat stress, electrocution, solar radiation, and slips/falls on the floating platform. Discomfort glare was also identified as a severe risk factor. In a collaborative study, cross-cultural studies on OSH risk perception and socio-demographic

aspects (age, weight, height, income & work experience) were carried out amongst solar PV workers (n=135) engaged in Saudi Arabia and India. Findings indicated differential risk perceptions across the countries towards the same kind of risk and correlation of socio-demographic factors with risk factors. Hence, this part of the research work explored the dimensions of cultural ergonomics in reference to solar photovoltaics projects as a maiden effort. In accordance with the risks identified in the very-high and high categories, design concepts were developed using three methodologies namely, hierarchy of controls, Co-design, and bow-tie risk analysis. Innovative and novel design concepts resulted from the three methods and CAD models were developed to address the contextual risks. Discomfort glare was found to be a severe risk factor requiring immediate attention. A prototype of an anti-glare and anti-UV eye protector named GlareSafe was developed to address the risk of discomfort glare and UV radiation. The eye protector was positively validated on the parameters of productivity in visual tasks, reduction in discomfort glare and usability through field studies. The product also addresses contextual requirements such as hydration, wiping of sweat and preventing PPE loss in water. Flowing from this design, a proposed framework of Compliance through Design (CtD) is an output of this research work. Several other novel design concepts such as floating fence, redesigned floater, maintenance board and maintenance mirror were validated through a questionnaire study where solar PV engineers compared the existing design/working condition with the proposed concept(s). Significant improvement and benefits were perceived in favor of the proposed design concepts. Most of the design concepts are low cost and can be adopted by the stakeholders to avoid direct and indirect costs related to negative OSH events. The findings of this maiden study add new knowledge in the identification of OSH risks in the FSPV sector, measurement of OSH risk perception, socio-demographic profiling of FSPV workers, development of novel design concepts and framework for implementation of a design strategy. Application of design as a risk mitigation strategy is a major dimension of this work and is ultimately expected to add to the safety quotient in FSPV projects. This research is also aligned to the Sustainable Development Goals (3,8,7 & 13) of the UN. The various facets of this present research will certainly be beneficial to safety managers, FSPV project developers, FSPV workers, policy makers, design researchers, industrial designers, ergonomists, and other related stakeholders.