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فرم خلاصه انگلیسی طرح / پروژه

**Project Title:** Compilation of standard for photovoltaic modules - test methods to identify potential induced degradation of crystalline silicon modules

<b>Department:</b>	Development Plan for Technologies and Studies Related to Solar Energy	<b>Employer:</b>	Niroo Research Institute
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#### Keywords:

Photovoltaic Module, Potential Induced degradation, Delamination, Performance Loss, Current Leakage, Photovoltaic Power Plant Voltage, Standard, Test Procedure

#### Project Necessity:

Solar energy has emerged as a promising field for power generation in recent years, attracting significant investment, primarily directed towards silicon photovoltaic modules. This substantial investment has led to rapid technological advancements and a simultaneous decline in prices, resulting in a remarkable growth in the installed capacity of these systems worldwide in recent years. In Iran as well, supported by government initiatives and a reduction in the overall cost of photovoltaic systems, we have witnessed a significant increase in the country's installed capacity.

Amidst the efforts to expand installed capacity and localize parts of the production chain, it is crucial to prioritize quality. Neglecting this aspect will not only lead to the squandering of investments but also result in the loss of social capital. To achieve this goal, the Power Research Institute has been striving since the early 1990s to elucidate the significance of testing and standardization for policymakers and investors, encouraging their involvement in this sector. One notable example of these efforts is the initiative to establish a reference laboratory for photovoltaic modules and inverters in the country.

Among photovoltaic module tests, sample testing is of paramount importance for the country. In this regard, performance tests, electroluminescence inspection, insulation tests, and identification of potential-induced degradation (PID) in crystalline silicon modules are prioritized. The procedures for performance tests and insulation tests are outlined in the IEC 61215 product type standard, and the corresponding national standard has been developed.

Additionally, the IEC 60904-9 standard defines the specifications and procedures for solar simulators and device classification, and the corresponding national standard has been designated as 9-14115. Furthermore, the national standard for electroluminescence testing, 13-14115, has been developed based on the IEC 60904-13 standard. Notably, the national standard for identifying PID in crystalline

This test, with its associated standard IEC 62804-1, falls under the category of supplementary standards and is frequently referenced by panel buyers and manufacturers. It is also part of the Power Research Institute's photovoltaic laboratory development plan. Due to its nature, this test is crucial for utility-scale power plant developers. Considering the growth of such power plants in Iran and the impact of potential-induced degradation (PID) on power plant performance, conducting this test domestically and developing its national standard is essential for the advancement of the country's photovoltaic industry. Additionally, the IEC 62804-1 standard has been mandated by SAZBA as part of the standards attached to power purchase agreements (PPAs), making it mandatory. Consequently, this project aims to develop two standards, IEC 62804-1 and IEC 62804-1-1, related to this test.

### **Project Goals:**

Compilation of standards related to destruction due to potential for use in the laboratory of photovoltaic modules, the references of which are the following two standards:

- IEC/TS 62804-1:2015, Photovoltaic (PV) modules- Test methods for the detection of potential-induced degradation- Part 1: Crystalline silicon
- IEC/TS 62804-1-1:2020, Photovoltaic (PV) modules- Test methods for the detection of potential-induced degradation- Part 1: Crystalline silicon- Delamination

### **Abstract:**

This project was conducted in four phases with the aim of developing two national standards in the field of potential-induced degradation (PID). The first standard pertains to test methods for detecting PID in photovoltaic modules, while the second standard focuses on test methods for detecting PID-related delamination in photovoltaic modules. In addition to developing these standards, this project delved into the nature of PID and explored the following topics:

- Investigation of Potential-Induced Degradation (PID)
- Kinetics of PID in Crystalline Silicon Photovoltaic Modules
- Detection of PID in Laboratory and Power Plant Settings
- Prevention and Mitigation Strategies for PID
- Delamination Degradation
- Influence of Delamination on Module Performance

## **Steps and Methodologies:**

### Phase 1: Review and Collection of Documentation

#### Activities:

- Review of standards, articles, documents, and available resources related to the national standard "Photovoltaic modules - Test methods for detecting potential-induced degradation - Part 1: Crystalline silicon"
- Review of relevant testing equipment
- Review of the test procedure
- Review of the reporting procedure

### Phase 2: Development of the National Standard

#### Activities:

- Drafting the national standard "Photovoltaic modules - Test methods for detecting potential-induced degradation - Part 1: Crystalline silicon"
- Identifying experts in the field of testing
- Corresponding with experts and obtaining their feedback
- Carrying out the standard approval process in the expert committees and the relevant specialized committee in the Ministry of Energy

### Phase 3: Review and Collection of Documentation for Delamination Testing

#### Activities:

- Review of standards, articles, documents, and available resources related to the national standard "Photovoltaic modules - Test methods for detecting potential-induced degradation - Part 1-1: Crystalline silicon - Delamination"
- Review of relevant testing equipment
- Review of the test procedure
- Review of the reporting procedure

### Phase 4: Development of the National Standard for Delamination Testing

#### Activities:

- Drafting the national standard "Photovoltaic modules - Test methods for detecting potential-induced degradation - Part 1-1: Crystalline silicon - Delamination"
- Corresponding with experts and obtaining their feedback
- Carrying out the standard approval process in the expert committees and the relevant specialized committee in the Ministry of Energy

**Main Results (technical outputs, patents, papers, books, reports, etc.):**

**Achievements of this project:**

- **Development of the national standard "Photovoltaic modules - Test methods for detecting potential-induced degradation - Part 1: Crystalline silicon" with national number 23612-1**
- **Development of the national standard "Photovoltaic modules - Test methods for detecting potential-induced degradation - Part 1-1: Crystalline silicon - Delamination" with national number 23612-1-1**