

Scope of Work (SOW)

Arc Flash Hazard Study for NSF Inouye Solar Telescope

1. Project Overview

This Scope of Work (SOW) outlines the methodology and deliverables for conducting an Arc Flash Hazard Analysis (AFHA) at the NSF's Inouye Solar Telescope, located within Haleakala Observatory on the summit of Haleakala, on the island of Maui. The objective is an update to the existing arc flash study conducted in 2021 to identify additional or changed electrical arc flash hazards, ensure compliance with NFPA 70E and IEEE 1584, and protect personnel operating or working near energized electrical equipment.

This Observatory includes a mix of office space, laboratories, and specialized research equipment, requiring an arc flash study tailored to diverse operating conditions and varying electrical loads.

2. Objectives

- Identify and quantify arc flash and shock hazards associated with the electrical distribution system.
- Provide appropriate arc flash labeling and PPE recommendations to protect research staff, maintenance personnel, and contractors.

3. Standards & References

Study and Deliverables will be in compliance with:

- **NFPA 70E** – Standard for Electrical Safety in the Workplace
- **IEEE 1584-2018** (Arc Flash Calculation Methods)
- **IEEE 1584.1-2022** – Guide for Performing Arc Flash Hazard Calculations
- **OSHA 29 CFR 1910** – Occupational Safety and Health Standards
- **NEC** – National Electrical Code (Latest Adopted Edition)

3. Scope of Services

3.1 Site Assessment & Data Collection

- Review provided Arc Flash Study Report from 2021
- Review provided and current As-Built Drawings and Panel schedules for Facility Electrical System including Telescope Enclosure.
- Conduct a site walkthrough of all electrical equipment rated 50V and above, including but not limited to:
 - Switchgear, switchboards, panelboards, transformers,
 - Facility subpanels and equipment interfaces
 - UPS systems and backup generators
- Verify the following data as needed based on review of the provided as-built drawings and the standards referenced in [3. Standards & References](#):
 - Single-line diagrams
 - Breaker types and settings, fuse data
 - Cable sizes, lengths, and conduit routing
 - Equipment nameplate information
 - Utility fault data and transformer impedance

3.2 System Modeling

- Create or update an electrical system model using software such as **SKM PowerTools**, **ETAP**, or **EasyPower**.
- Document all explicit assumptions, data quality and validation steps taken.
- Include all relevant equipment up to and including downstream panelboards feeding observatory equipment.

3.3 Short Circuit Analysis

- Perform a short-circuit analysis at each relevant bus or panel.
- Compare calculated fault currents to equipment withstand ratings.
- Identify any underrated or at-risk equipment for further mitigation.

3.4 Protective Device Coordination

- Review current protective device settings.

- Develop time-current characteristic (TCC) curves to evaluate coordination between devices.
- Recommend changes to device settings where coordination or arc energy reduction is feasible.

3.5 Arc Flash Hazard Analysis

- Conduct arc flash hazard calculations using **IEEE 1584-2018** methods.
- Calculate:
 - Incident energy (cal/cm²)
 - Shock Approach Boundaries (Restricted and Limited).
 - Arc flash boundaries
 - Required PPE categories
- Analyze normal and abnormal operating scenarios, including backup modes.

3.6 Labeling

- Where necessary provide new or updated customized arc flash and electrical hazard labels for applicable electrical equipment.
- Labels to include:
 - Incident energy level
 - Arc flash boundary
 - PPE category and equipment-specific notes
 - Equipment ID
 - Working Distance
 - Upstream Protection
 - Voltage
 - Limited Approach / Restricted Approach
 - Date of Study
- Provide digital and hard copy versions of labels for installation by the facility personnel.

3.7 Reporting

- Deliver a comprehensive report including:
 - Executive summary
 - List of changes and or marked up copy of the as built Single-line diagrams that corresponds to the analysis..
 - Equipment inventory list used in the analysis.
 - Fault current, coordination, and arc flash results
 - Facility Deficiencies needing attention or mitigation

- Model validation steps and data sources.
- Include supporting appendices: TCC plots, calculation worksheets, and model data

4. Deliverables

- **Arc Flash Study Report** (PDF and editable formats)
- **Protective Device Coordination Curves**
- **Printed and Digital Arc Flash Labels**
- **PPE Category Summary Table**
- **Digital Electrical System Model File**
- **Data Retention and Traceability Plan**
- **QA Verification Checklist**
- **Recommendations for Arc Flash mitigation and additional training.**

5. Client Responsibilities

- Provide access to electrical rooms, observatory facilities, equipment and restricted areas.
- Make available:
 - DKIST Electrical Power Distribution System Studies Rev 0 Sealed (1) from M3 Eng dated 4/30/2022
 - Existing single-line diagrams and panel schedules (see Attachment A for list of documents provided)
 - Utility service data (if required)
- Designate a facility contact for coordination and escort
- Approve equipment setting changes prior to implementation

7. Schedule

Milestone	Date
Project Kickoff	[Insert Date]
Site Walkthrough & Data Collection	[Insert Date]
Draft Study Report	[Insert Date]
Final Report & Label Delivery	[Insert Date]

8. Exclusions

The following services are **excluded** from this scope unless otherwise agreed upon:

- Infrared thermography or load testing
- Physical installation of arc flash labels
- Electrical equipment maintenance or upgrades
- Remediation of coordination issues or protective device replacement
- Power quality or harmonic analysis
- Detailed risk assessments for experimental research apparatus

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Attachment A

List of Drawings / Documents Provided

1. 09077 - DKIST Electrical Power Distribution Systems Studies Rev0 Sealed date 4/30/2022
2. DKIST Electrical Drawing Master 20241126 (17 sheets)
3. DKIST Electrical Power Drawing Master 20241126 (16 sheets)
4. Electrical Panel Schedules Redline 20260126 (81 sheets)
5. DKIST EG Master 20220727 (7 sheets)
6. Grounding Plan E718 20250305 (1 sheet)
7. Grounding Plan E719 20250305 (1 sheet)
8. Grounding Plan E720 20250305 (1 sheet)