Technical Case Study

Arc-Flash Risk Mitigation in Mining HV Facilities

(Codelco – Chuquicamata, Chile, 2019)

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Abstract

This technical case study presents an arc-flash hazard assessment and mitigation program implemented at Codelco's Chuquicamata mining facilities in Chile. The project was conducted in compliance with IEEE 1584 and focused on reducing arc-flash incident energy levels, enhancing worker safety, and optimizing relay settings in high-voltage (HV) substations. The outcome demonstrated substantial risk reduction and served as a benchmark for arc-flash mitigation in mining and industrial environments.

Keywords: Arc-Flash, IEEE 1584, HV Protection, Mining Safety, Chile

1. Introduction

Arc-flash hazards represent a significant safety concern in HV substations, particularly in mining environments with high fault current levels and frequent switching operations. At Codelco's Chuquicamata mine, one of the world's largest open-pit operations, the protection system required an in-depth review to mitigate risks for maintenance staff and ensure compliance with updated safety standards.

2. Methodology

The mitigation program was executed in the following steps:

- Hazard Assessment: Arc-flash incident energy calculations performed using IEEE 1584 methodology.

- Protection Review: Adjustment of relay settings to minimize fault clearing times.

- Testing: Secondary injection and time-current coordination validation using Omicron CMC.

- PPE & Procedures: Recommendation of improved personal protective equipment and updated operational protocols.

3. Results

The program achieved the following measurable improvements:

Metric	Before	After	Improvement
Arc-Flash Incident Energy (cal/cm²)	35	8	-77%
Fault Clearing Time	480 ms	220 ms	-54%
Safety Compliance Level	Partial	Full	100% compliant

4. Discussion

The Chuquicamata arc-flash mitigation project demonstrated the importance of combining IEEE 1584-based analysis with practical relay setting adjustments to significantly reduce hazards. By lowering incident energy levels and improving fault clearing times, the project enhanced worker safety and operational reliability. The methodologies and results were later applied to other mining facilities and informed best practices in HV arc-flash studies globally.

5. Conclusion

The 2019 arc-flash risk mitigation project at Chuquicamata represented a milestone in improving mining electrical safety. The results showed that systematic hazard analysis combined with relay optimization can drastically reduce risks, serving as a model for similar facilities worldwide.

6. References

[1] IEEE Std 1584-2002, Guide for Performing Arc-Flash Hazard Calculations.
[2] NFPA 70E, Standard for Electrical Safety in the Workplace.
[3] IEC 60947-2, Low-voltage Switchgear and Controlgear – Circuit-breakers.
[4] Codelco Internal Safety Report – Chuquicamata, 2019.