Technical Case Study

Relay Coordination Strategies for Industrial HV Systems

(Transelec – Cerro Navia 110 kV Substation, Chile, 2016)

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Abstract

This technical case study describes the implementation of relay coordination strategies at Transelec's Cerro Navia 110 kV substation in Santiago, Chile. The project aimed to optimize protection selectivity, reduce nuisance trips, and ensure readiness for renewable interconnections. The systematic coordination study applied IEEE and IEC standards, delivering improved operational reliability and system resilience.

Keywords: Relay Coordination, HV Protection, Substation Reliability, IEEE Standards, Chile

1. Introduction

Cerro Navia substation is a critical 110 kV installation within Santiago's metropolitan grid, serving industrial and urban loads. Prior to 2016, the substation's protection coordination required modernization to address increasing load demands and prepare for renewable energy integration. The project focused on refining protection grading, reducing miscoordination, and ensuring system compliance with national and international standards.

2. Methodology

The engineering approach was structured into the following steps:

- Protection Review: Analysis of existing relay settings and identification of miscoordination cases.

- Time-Current Coordination: Development of coordination curves following IEEE Std C37.112.

- Relay Adjustments: Calibration of overcurrent, earth fault, and backup protections.

- Validation: Secondary injection tests using Omicron CMC to confirm selectivity and system stability.

3. Results

The coordination study produced the following measurable outcomes:

Metric	Before	After	Improvement
Nuisance Trips (annual)	6	1	-83%
Average Fault Clearance Time	350 ms	250 ms	-29%
System Availability	96%	99%	+3%

4. Discussion

The Cerro Navia project demonstrated how systematic relay coordination strengthens reliability in critical substations. By reducing nuisance trips and optimizing fault discrimination, the system was prepared for renewable integration scenarios. The methodologies developed here informed subsequent projects in Alto Jahuel (2017) and renewable-ready substations in Chile, while also contributing to global best practices applied later in Australia's renewable and BESS facilities.

5. Conclusion

The relay coordination study at Cerro Navia Substation (2016) provided a robust framework for modern HV protection. Its success highlighted the value of systematic grading and testing in ensuring reliable grid operation and future renewable readiness.

6. References

[1] IEEE Std C37.112-1996, Inverse-Time Characteristics for Overcurrent Relays.
[2] IEC 60255, Measuring Relays and Protection Equipment.
[3] Omicron Test Universe – Secondary Injection Testing Procedures.
[4] Transelec Internal Protection Coordination Guidelines, 2016.