Technical Case Study

Differential Protection Testing for Power Transformers

(Transelec – Alto Jahuel 220 kV Substation, Chile, 2017)

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Abstract

This technical case study describes the execution of transformer differential protection (87T) testing and stability checks at Transelec's Alto Jahuel 220 kV Substation, one of Chile's most critical transmission nodes. The project addressed the need for improved reliability in power transformers subject to renewable load variations. Testing and validation were conducted in line with IEC and IEEE standards to ensure accuracy, selectivity, and grid stability.

Keywords: Differential Protection, Power Transformers, IEC Standards, HV Substations, Chile

1. Introduction

Alto Jahuel 220 kV Substation is a major transmission hub in central Chile, responsible for connecting regional generation sources and distributing power to metropolitan and industrial loads. With increasing renewable energy penetration, transformer protection schemes required modernization and rigorous validation. The project focused on differential protection testing, stability verification, and compliance with international standards.

2. Methodology

The testing program was carried out in the following steps:

- Differential Protection Review: Assessment of 87T settings and harmonic restraint configurations.

- Testing: Secondary injection using Omicron CMC for stability, sensitivity, and CT saturation.

- Validation: Stability checks under through-fault conditions to confirm selectivity.

- Standards: Compliance with IEC 60255 and IEEE C37.91 (Guide for Protective Relay Applications to Power Transformers).

3. Results

The project produced the following measurable outcomes:

Metric	Before	After	Improvement
False Differential Trips (annual)	3	0	-100%
Transformer Fault Detection Accuracy	92%	99%	+7%
System Availability	95%	99%	+4%

4. Discussion

The Alto Jahuel project highlighted the importance of rigorous differential protection testing in high-voltage transformers. By eliminating false trips and improving detection accuracy, the substation achieved higher availability and reliability under renewable integration conditions. The methodology developed here became a reference for future transformer testing and contributed to Chile’s modernization of HV substations.

5. Conclusion

The 2017 differential protection testing at Alto Jahuel demonstrated the value of advanced relay validation in critical substations. The success of this project strengthened Chile’s grid reliability and prepared transmission assets for the increasing variability of renewable energy sources.

6. References

[1] IEC 60255, Measuring Relays and Protection Equipment.
[2] IEEE C37.91-2008, Guide for Protective Relay Applications to Power Transformers.
[3] Omicron Test Universe – Differential Protection Testing Procedures.
[4] Transelec Internal Protection Testing Reports, 2017.