

Rationale for the Use of Local and Remote (Zone 3) Protective Relaying Backup Systems

A Report On The Implications And Uses Of Zone 3 Relays



Prepared by the
System Protection and Control Task Force
of the
North American Electric Reliability Council

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Introduction

The Planning Committee requested the System Protection and Control Task Force to: “Study and report on the implications (pros and cons) of eliminating zone 3 relays.” This paper is presented in fulfillment of that charge.

Local and Remote Protective Relaying Backup Systems

The transmission protective relaying systems in North America are built with various levels of redundancy to ensure that fault conditions and equipment are quickly isolated from the system with minimal system disruption. The voltage level of the facilities, its criticality to the network, when it was built, the area of the country where it is located, the one-line configuration, dynamic stability considerations, and the characteristics of the system are all factors in how this redundancy is achieved. One method of adding backup protection is to have total redundancy at a substation such that any element failing will be backed up by another device at the substation. This method is referred to as local backup. Another method to provide the backup is to provide remote backup of failed elements by adjusting the sensitivity of the protective relays at all adjacent stations to detect faults that should be cleared by the local station with the failed protective element. This method is referred to as remote backup. Either method or a combination of the two is acceptable, and both have advantages and disadvantages.

Local Backup

For complete redundancy for local backup of the protective relaying system, redundant relays must sense every fault, and separate substation batteries, current transformers, voltage transformers, dc circuitry, and breaker trip coils must be used between the primary relaying elements and the backup relaying elements. As much as practical, physical separation is required between the primary relaying system and the redundant relaying system. To back up the failure of a circuit breaker, breaker failure circuitry must be used to initiate a trip signal to all circuit breakers that are adjacent to the failed breaker. On some bus arrangements, this requires transfer tripping to one or more remote stations.

Local Backup Advantages

The major advantages of local backup protective systems are:

- **Minimal system disruption** – For the failure of the local protective relays or the circuit breaker, local backup protection usually isolates a smaller portion of the transmission grid as compared to remote backup protection.
- **No effect on system loadability** – Local backup protection has no effect on the system loadability and is less susceptible to stable power swings.
- **Speed of operation** – Generally, local backup systems can be set to operate more quickly than remote backup systems.

Local Backup Disadvantage

The major disadvantage to local backup protection is the opportunity for a single event or component failure to disable both the primary and backup scheme if total redundancy and physical separation is not designed into the system. Significant care must be taken to ensure that no reasonable contingency would disable both the primary and secondary schemes. In addition to establishing physical separation of all circuit elements, total electrical separation is required for complete redundancy. Different current transformer windings, potential transformer secondary windings, batteries, dc control wiring, relays, and trip coils are required to achieve redundancy. It is difficult to predict all contingencies that could occur.

Remote Backup

When remote backup relaying is used, the relays at the remote station are set sensitive enough that they can detect all faults that should be cleared from their adjacent substation. Since the remote backup relaying shares no common elements with the relay system that has failed, inherent redundancy is achieved. The remote backup relaying is intentionally set with time delay to allow the local relaying enough time to isolate the faulted elements from the system prior to the remote terminals operating. The remote backup relaying covers the failure of a relay system and/or the failure of a circuit breaker.

Remote Backup Advantage

No common mode failures – Remote backup systems, because of their physical separation, have no common mode failure components.

Remote Backup Disadvantages

Remote backup often requires longer fault clearing times and that additional circuit elements be removed from the system to clear the fault. While the latter usually has no worse effect on the transmission system than does local backup relay operation, it does interrupt all tap load on all lines that are connected to the substation where the relay/breaker fails to operate.

The primary disadvantage of remote backup protection is that it can restrict the amount of load a circuit can carry under emergency conditions. Generally, relays designated as Zone 3 relays provide this remote backup function for phase to phase and three phase faults; however other relay designations may be used to provide the remote backup function.

Backup Usage in North America

Both local and remote backup systems are used in North America. While many of the local backup systems are fully redundant (have no single point failure mode), many are not. For instance, on some systems using local backup protection, a single battery and/or communication system is used. The degree to which local backup systems have single point failure possibilities varies widely. A significant cascading outage could result for a failure of these schemes to properly operate.

Generally, to some degree, remote backup systems have a dependability advantage over local backup systems; however system loading requirements have not universally allowed their use. Historically from a security perspective, there have been several cases where remote backup relays (Zone 3) have been involved in significantly expanding system outages by tripping due to unexpected loading during some system contingencies. Less obvious are many times that remote backup (Zone 3) relays have unintentionally operated to remove uncleared faults from the system or to halt cascading outages.

Compliance with recently developed NERC loadability guidelines and the relatively recent introduction of microprocessor relays that are less load sensitive should significantly mitigate any disadvantage of the use of remote backup relaying where it is presently used. Because of this, it would be impractical, unnecessary, and somewhat risky to prohibit the use of remote backup (Zone 3) relaying.

Conclusion

With proper segregation from the primary relaying system and with relay settings that are compatible with the recently published NERC loadability guidelines, remote backup systems (including Zone 3 relays) or local backup systems are acceptable for usage as redundant protection for electrical transmission systems.

System Protection and Control Task Force

Charles W. Rogers

Chairman / ECAR Representative

Principal Engineer

Consumers Energy Co.

W. Mark Carpenter

Vice Chairman / ERCOT Representative

System Protection manager

TXU Electric Delivery

John L. Ciuffo

Canada Member-at-Large

Team Leader – P&C / Telecom

Hydro One, Inc.

John Mulhausen

FRCC Representative

Florida Power & Light Co.

W. O. (Bill) Kennedy

Canada Member-at-Large

Principal Engineer

Alberta Electric System Operator

Joseph M. Burdis

MAAC Representative

Senior Consultant / Engineer, Transmission

and Interconnection Planning

PJM Interconnection, L.L.C.

Jim Ingleson

ISO / RTO Representative

Senior Operations Engineer

New York Independent System Operator

William J. Miller

MAIN Representative

Consulting Engineer

Exelon Corporation

Evan T. Sage

Investor Owned Utility

Senior Engineer

Potomac Electric Power Company

Deven Bhan

MAPP Representative

System Protection Engineer

Western Area Power Administration

Gary L. Kobet

Federal

Project Specialist – System Protection

Tennessee Valley Authority

Philip Tatro

NPCC Representative

Consulting Engineer

National Grid USA

Keith Orsted

Transmission Dependant Utility

American Transmission Co., LLC

Philip B. Winston

SERC Representative

Manager, Protection and Control

Georgia Power Company

Bob Stuart

NERC Blackout Investigation Team

Principal

Nexant, Inc.

Fred Ipock

SPP Representative

Senior Engineer – Substation Engineering

City Utilities of Springfield, Missouri

Tom Wiedman

NERC Blackout Investigation Team

Consultant to NERC

David Angell

WSCC Representative

System Protection & Communications Leader

Idaho Power Company

Jerome. (Skip) Williams

ECAR Alternate

Sr. Engineer

American Electric Power

Albert N. Darlington

FRCC Alternate

Consultant to FRCC

Local and Remote (Zone 3) Protective Relaying

Baj Agrawal

WECC Alternate

Principal Engineer

Arizona Public Service Company

Jon Daume

WECC Alternate

System Protection & Control Engineer

Bonneville Power Administration

Robert W. Cummings

Staff Coordinator

Director – Reliability Performance and Engineering

Support

North American Electric Reliability Council