



**Document B-1**

**Guide for the Application of  
Auto-reclosing to the Bulk Power  
System**

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**Notes:**

Terms in bold face type are defined in the *NPCC Glossary of Terms*. Italicized terms are defined in Section 3.0 of this Guideline.

The terms **auto-reclosing**, **high-speed auto-reclosing** and **synchronism-check** are defined in the Glossary. These terms are included in the definition list (Section 3.0) of this document for reference only, in order to make the document easier to read.

## 1.0 Objectives

The purpose of this document is to establish guidelines for the application of **auto-reclosing** facilities to circuit breakers on the NPCC **bulk power system**. This document is not intended to provide guidance for the operation of the **bulk power system** in matters of **reclosing**, such as enabling or disabling **auto-reclosing** or providing for *manual* closures following *automatic* tripping of an **element**.

## 2.0 Introduction

**Auto-reclosing** should be applied for the purpose of restoring transmission lines to service subsequent to *automatic* tripping of their associated circuit breakers due to electrical **faults**. Experience of the NPCC member companies indicates that many **faults** on the bulk power overhead transmission system are temporary. In the absence of **auto-reclosing**, longer duration **outages** could be experienced unnecessarily. Successful **auto-reclosing** can enhance **stability** margins and overall system **reliability**. However, **auto-reclosing** into a permanent **fault** may adversely affect system **stability**, hence due consideration must be given to this aspect of any application.

## 3.0 Definitions

- 3.1 **Auto-reclosing**<sup>1</sup> is the *automatic* closing of a circuit breaker in order to restore an **element** to service following *automatic* tripping of the circuit breaker. **Auto-reclosing** does not include *automatic* closing of capacitor or reactor circuit breakers.
- 3.2 **Breaker reclosing time** is the elapsed time between the energizing of the breaker trip coil and the closing of the breaker contacts to reestablish the circuit by the breaker primary contacts on the **reclose** stroke.
- 3.3 **High-speed auto-reclosing**<sup>2</sup> refers to the **auto-reclosing** of a circuit breaker after a necessary time delay (less than one second) to permit fault arc deionization with due regard to coordination with all **relay** protective systems. This type of **auto-reclosing** is generally not supervised by voltage magnitude or phase angle.

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<sup>1</sup> See note on Table of Contents Page.

<sup>2</sup> See note on Table of Contents Page.

- 3.4 *Delayed **auto-reclosing*** refers to the **auto-reclosing** of a circuit breaker after a time delay which is intentionally longer than that for **high-speed auto-reclosing**.
- 3.5 **Synchronism-check**<sup>3</sup> refers to the determination that acceptable voltages exist on the two sides of the breaker and the phase angle between them is within a specified limit for a specified time.
- 3.6 *Multiple-shot **auto-reclosing*** refers to the **auto-reclosing** of the circuit breaker(s) more than once within a predetermined **reclosing** sequence.
- 3.7 *Blocking* refers to the *automatic* prevention of an action following specific **relay** tripping operations.
- 3.8 *Single-pole **auto-reclosing*** refers to the **auto-reclosing** of one pole of a circuit breaker following a designed single-pole trip for single-phase-to-ground **faults**.
- 3.9 *Manual* refers to either local or remote switching operations that are initiated by an operator.
- 3.10 *Automatic* refers to either local or remote switching operations that are initiated by **relay** or control action without the direct intervention of an operator.
- 3.11 *Lockout* refers to the complete disabling of the reclosing sequence until reset.

#### **4.0 Common Considerations to High-Speed and Delayed Auto-reclosing**

##### **4.1 *Blocking of Auto-reclosing***

4.1.1 **Auto-reclosing** should be blocked during the reception of a direct transfer trip signal.

4.1.2. **Auto-reclosing** should be blocked, or not be initiated, following any *manual* operation of a circuit breaker.

##### **4.2 *Turbine-Generator Considerations***

*Manual* closing or **auto-reclosing** at line terminals that are in electrical proximity to turbine-generators may subject them to excessive shaft torques and winding stresses with resultant loss of life of the turbine-generator system. Another consideration is the electrical/mechanical stress on the electrical insulating system (stator and rotor) as well as on the endcaps, also called “retaining rings (rotor).” These effects should be studied and evaluated before **auto-reclosing** is applied or in some circumstances, not applied. It is preferable to re-**energize** a line at a

terminal remote from the generator bus, and then **auto-reclose** or close at the generator end. The **auto-reclosing** at the generator end should be supervised by **synchronism-check** function as required.

#### 4.3 Circuit Breaker Capability

4.3.1. The design and implementation of **auto-reclosing** system should consider the circuit breaker capability.

4.3.2. **Auto-reclosing** times and sequences should be selected with due regard to circuit breaker interrupting capability, duty cycle, derating, voltage withstand capability, resistor thermal capability, and overall breaker design.

#### 4.4 Number of Operations

*Multiple-shot auto-reclosing* systems should be designed considering the breaker operating time, available stored energy for breaker operation, and **system stability** margins.

#### 4.5 Breaker Failure Operations

4.5.1. High speed **Auto-reclosing** time delay should be coordinated with breaker failure trip time including any remote clearing time.

4.5.2. **Auto-reclosing** following breaker failure operation should not occur until the failed breaker is isolated.

#### 4.6 Other System Elements

Risks versus benefits should be evaluated before applying **auto-reclosing** following **faults** on transformers, enclosed busses, **cables**, etc. For these types of system **elements**, it is generally not advisable to **auto-reclose** since the probability of a **fault** being permanent is high and the probability of aggravating equipment damage is increased. Under specific circumstances, however, the benefits of **auto-reclosing** may justify its use.

Caution also should be taken when applying **auto-reclosing** following **faults** on lines that terminate with or include transformers, enclosed busses, **cables**, etc. In these situations the same precautions should be applied unless means are provided to differentiate between **faults** on the line from **faults** on the transformer, enclosed bus, or **cable**, and to supervise **auto-reclosing**.

#### 4.7 Multiple Circuit Breaker Line Termination

The recommended mode of **auto-reclosing** at a terminal with more than one breaker per line is to **auto-reclose** with a preselected breaker. Following successful **auto-reclose** operation, the other breaker(s) associated with the line at that terminal may be **auto-reclosed**. Since simultaneous closing of two or more breakers is difficult to achieve, **auto-reclosing** into a permanent **fault** by more than one breaker at the same line terminal could result in the **fault** being maintained on the system for a longer than intended period, and may be followed by an incorrect breaker failure operation for certain **relay** designs. In addition, the severity of the system **disturbance** may be increased.

#### 4.8 Line Connected Shunt Capacitor

It is preferable that **reclosing** of line circuit breakers be completed before closing (normally by operator action) the shunt capacitor breaker.

### 5.0 High-Speed Auto-reclosing Considerations

#### 5.1 Tripping Requirements

**High-speed auto-reclosing** should be initiated only if all terminals of the line are tripped without intentional time delay for line **faults**.

#### 5.2 Stability Considerations

When **high-speed auto-reclosing** is under consideration as a means for increasing the **transient stability** margin of a system, restoring service to critical **loads**, or restoring needed system interconnections, it should be recognized that there is a risk as well as a possible benefit associated with its use. The risk is that **stability** may be endangered rather than benefited if a line is **auto-reclosed** into a permanent **fault**. **Stability** studies should indicate whether or not the use of **high-speed auto-reclosing** should be restricted.

#### 5.3 Out-of-Step Conditions

Since **high-speed auto-reclosing** is generally unsupervised, it should be *blocked* following an out-of-step **relay** operation.

#### 5.4 Switching Surge Considerations

**High-speed auto-reclosing** should not be used where transient voltage analysis studies indicate that **high-speed auto-reclosing** may produce switching **surge** magnitudes exceeding the equipment design levels.

## 6.0 Delayed Auto-reclosing Considerations

### 6.1 General Use

*Delayed auto-reclosing* may be used following design analysis and may be preferable to **high speed automatic reclosing**.

### 6.2 Frequency, Phase Angle and Voltage Considerations

**Synchronism-check relays** should be used where analysis shows that for credible system conditions there may be harmful effects on the system due to excessive frequency differences, phase angles, or voltage magnitudes across the closing breaker.

When applying **synchronism-check relays**, appropriate consideration should be given to avoiding excessive restriction on breaker **auto-reclosing** or on *manual* closing, which may be particularly challenging to the operator, following major system **disturbances**.

It may be necessary to employ means to ensure undesired **auto-reclosing** modes do not take place. For example, dead-line **supervision of auto-reclosing** or *manual* closing may be used where harmful effects on the system would result from connection of **energized** facilities.

### 6.3 Auto-reclosing Time Considerations

A time delay should be used, as determined by **stability** studies, to allow damping of system oscillations following a **disturbance**. If **stability** studies are not available, a 15-second time delay appears to be conservative for most systems. Following the initiation of an **auto-reclosing** sequence, **auto-reclosing** attempts should be prevented after a predetermined time period. This time period should not prohibit completion of the **auto-reclosing** sequence and must include circuit breaker **fault clearing** time, **synchronism-check** timing and **protective relay** and control system response times. To prevent unexpected operation, the **auto-reclosing** sequence must be completed or go to a *lockout* state prior to the commencement of operator-initiated switching. Re-arming of the **auto-reclosing** scheme may be achieved by *automatic*, *manual* or remote methods.

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Prepared by: Task Force on System Protection.

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Reference: *NPCC Glossary of Terms*