WECC Breaker Failure Requirements for RAS

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Breaker Failure and RAS

- RAS objectives are centered on BES performance
- RAS are designed to mitigate the effects of single or multiple contingencies (TPL-002, TPL-003, or TPL-001-4 P1-P7), including extreme events (TPL-004, TPL-001-4 beyond P7)
- TPL contingencies (mostly) involve clearing faults
- RAS do not clear faults (SPS and RAS definitions)
- RAS designed to meet performance requirements of TPL standards that then experience a single RAS component failure must still satisfy the TPL performance requirements

Breaker Failure and RAS

Per NERC (more later)

- TPL-001-4 does not specify a RAS-associated breaker failure as a contingency
- Breakers performing RAS actions do not operate to clear faults
- Breakers are not RAS components

So, a breaker that fails to perform a RAS function is not a RAS failure? It is also not a studied outage (at least per TPL-001-4).

RAS Failures

“Normal” Events

PRC-012-0 R1.3 . . . demonstrate . . . that a single SPS [RAS] component failure, when the SPS [RAS] is intended to operate, does not prevent the interconnected transmission system from meeting the performance requirements defined in Reliability Standards TPL-001-0, TPL-002-0, and TPL-003-0.

Extreme Events

TPL-004-0(i)a Table 1, Category D, Note 12. Failure of a fully redundant Remedial Action Scheme to operate when required

. . . and Note 13. Operation, partial operation, or misoperation of a fully redundant Remedial Action Scheme in response to an event or abnormal system condition for which it was not intended to operate

RAS Failures, TPL-004-0(i)a

- Under TPL (-0) standards, fully redundant RAS failure or unintended operation may convert a Category B or C event into an extreme event (Category D, mitigation not required)
- Note 12 describes a multiple failure of the RAS, in addition to whatever single or multiple System contingency the RAS is intended to mitigate
- Note 13 describes a RAS misoperation when no RAS operation was intended; it does not include RAS misoperations when operation was intended
- Notes 12 and 13 are not carried forward to TPL-001-4

RAS Failures, TPL-001-4

- All TPL-001-4 Table 1 events are associated with element opening without a fault (single contingency) or fault clearing (single or multiple contingency), not with RAS operations that follow fault clearing or element opening
- TPL-001-4 does not address failure of a RAS-associated breaker or require study of that event
- Under TPL-001-4, a RAS single component failure is not the next System contingency

NERC RAS Components

NERC (Glossary + PRC-005 list) defines a **Protection System** as

- **Protective** relays which respond to electrical quantities,
- Communications systems necessary for correct operation of **protective** functions
- Voltage and current sensing devices providing inputs to **protective** relays,
- Station dc supply associated with **protective** functions (including station batteries, battery chargers, and non battery-based dc supply), and
- Control circuitry associated with **protective** functions through the trip coil(s) of the circuit breakers or other interrupting devices.
- Breaker close coils for reclosing applications that are an integral part of a RAS

But perhaps this list is not really exhaustive for **RAS** components??

NERC RAS Components??

- NERC PRC-005 Applicability essentially calls RAS a subset of Protection Systems and includes many RAS components in the maintenance tables
- RAS controllers (if not in the form of protective relays) are not mentioned
- NERC doesn't do it, but it almost seems intended that the RAS controller is a RAS component, but not a Protection System component
- Not usually breaker close coils
- Not breaker components other than trip/close coils

Prospective NERC Requirements

- Present NERC RAS sdt is trying to keep the functions of the requirements from the PRC-012 – PRC-017 standards and apply them to appropriate functional entities
- Single RAS component failure (derived from PRC-012-0 R1.3) likely to remain in place (with some wording but no significant application changes)
  - Seems to be controversial only for NPCC Type 3 schemes (analogous to WECC LAPS)

NERC RAS Breaker Failures

- RAS single component failures must not prevent achieving intended system performance, but . . .
- Breakers are not RAS components, so . . .
- BF within RAS is presently not specifically covered by any universally applicable NERC standard.
- These conclusions are unlikely to change with the new NERC RAS standard under development.
- Check back in if NERC starts regulating equipment maintenance for breakers, transformers, capacitors, etc.

Regional Industry Practices

NPCC Directory 7 design requirements include quite rigorous redundancy expectations for Type I schemes (roughly analogous to WECC WAPS), e.g.

- Separate, non-adjacent racks for Schemes A and B
- Separation of control wiring in alternate raceways or by fire barrier for Schemes A and B

NPCC Breaker Failure Expectations

5.14 Provision for Breaker Failure Criteria

Type I SPS shall include breaker failure protection for each circuit breaker whose operation is critical to the adequacy of the action taken by the SPS with due regard to the power system conditions this SPS is required to detect. The following are options for breaker failure protection:

- 5.15.1 A design which recognizes that the breaker has not achieved or will not achieve the intended function required by the SPS and which takes independent action to achieve that function. This provision needs not be duplicated and can be combined with conventional breaker failure schemes if appropriate.
- 5.15.2 Overarming the SPS such that adequate action is taken even if a single breaker fails.
- 5.15.3 The redundancy afforded by actions taken by other independent schemes or devices.

NOTE: No distinction is made between Trip and Close operations

Other Regional RAS BF Expectations

- **SERC** – BF not mentioned
- **Reliability First** – BF not mentioned
- **MRO** – BF not mentioned
- **ERCOT** – BF not mentioned
- **FRCC** – BF not mentioned
- **SPP** – BF not mentioned

NOTE: These Regions do not consider system performance following BF related to a RAS operation

WECC RAS BF Requirements

NERC FAC-010 and FAC-011, WECC Regional variance

1.1. As governed by the requirements of [R2.6 or R3.3], starting with all Facilities in service, shall require the evaluation of the following multiple Facility Contingencies when establishing SOLs: . . .

1.1.4 The failure of a circuit breaker associated with a Remedial Action Scheme to operate when required following: the loss of any element without a Fault; or a permanent phase to ground Fault, with Normal Clearing, on any transmission circuit, transformer or bus section.

E1.1 references R3.3 (in FAC-011) and R2.6 (in FAC-010), which refers back to R2.3.1 and R2.3.2 (in FAC-010). These include both single and multiple contingencies in the analysis.

Note: This requirement

- applies to RAS-associated circuit breaker intended operation either after element opening without a fault or after normal SLG fault clearing on specified equipment
- is not tied to any RAS component failure
- does not increase the contingency level in TPL

WECC Breaker Failure Expectations

WECC RAS Design Guide (2006)

Failure of a circuit breaker to trip when called upon to trip by the RAS, even when equipped with dual trip coils, is considered a credible failure. Following are some common and acceptable methods to remediate such a failure:

- Over-operate RAS action, e.g. trip extra generation equivalent to the largest generator or generation site which may fail to trip.
- Initiate breaker failure protection. Breaker failure action usually operates additional breakers to isolate the stuck breaker while still performing the RAS action. Any additional tripping should not exacerbate the original power system problem that the RAS is designed to solve . . . .

The scheme designer is not limited to these methods to address failure of a breaker to trip. However, it should be shown that failure of a breaker to trip (or close) will still result in acceptable system performance.

NOTE: While emphasis is on tripping, both failure to Trip or Close are identified as problematic.

FAC Requirements for WECC

- FAC-010 and FAC-011, E1.1.4 imposes a RAS performance requirement following loss of an element without a fault or permanent SLG fault with normal clearing
- RAS performance following clearing of multi-phase faults not covered?
  - Probably not by FAC-010 or FAC-011, E1.1.4, but
  - WECC RAS Design Guide does not make a distinction between RAS actions following SLG or multi-phase fault clearing

WECC RAS BF Performance

NERC FAC-010 and FAC-011, WECC Regional variance E1.1 (and E1.1.4) retirement

- NERC drafting team is proposing retirement of FAC-010 and modification of FAC-011 and FAC-014 (comment period closed June 17)
- NERC requested input from WECC on disposition of the WECC variance
- Retirement would put WECC in line with other Regional practices (other than NPCC), which don't address BF for a RAS operation
- Project WECC-0113 FAC Retirement Drafting Team (webinar July 7, 2-4 pm)

WECC Variance: SLG vs LL, 3Φ Faults

If your RAS triggers to mitigate conditions following SLG permanent faults, what else might you need to do if the object was to also mitigate following multi-phase faults?

- For “slow” events, e.g. thermal overload, post-transient voltage, probably nothing extra
- For “fast” events, e.g. transient angular stability, added mitigation might be need, as determined by Planning studies (or maybe nothing extra, timing is the likely issue)

WECC Reliability Subcommittee

White Paper Discussion:

This requirement is addressed in NERC Reliability Standard PRC-012-0 R1.3, which requires that failure of a single component does not prevent the interconnected system from meeting required performance in the TPL Reliability Standards. It is also addressed in NERC Reliability Standard TPL-001-4 (Table 1) Category P4 and P5 contingencies, which specify system performance requirements for stuck breaker and protection system failures. Having a Regional Difference duplicating PRC-012-0 and TPL-001-4 Reliability Standards is redundant and unnecessary.

WECC RS White Paper

Is Breaker Failure addressed in PRC-012-0, R1.3?

- RAS components aren't presently specifically defined by NERC, but generally agreed that only the RAS controller is added to the Protection System definition and PRC-005 component list
- Circuit breakers aren't Protection Systems (or RAS) components under the Glossary or PRC-005
- NERC Standards and Glossary aren't consistent on whether RAS is a subset of Protection Systems
- PRC-012-0 R1.3 does not address failure of a breaker associated with a RAS

WECC RS White Paper

Is Breaker Failure addressed in TPL-001-4, Table 1, Category P4 and P5?

- P4 (Fault plus stuck breaker) and P5 (Fault plus relay failure to operate) specify system performance requirements for stuck breaker or specified relay failures
- Both P4 and P5 both apply only to clearing SLG Faults, but RAS are never intended to clear faults (see original and proposed new RAS definitions)

WECC RS White Paper

- P4 and P5 are multiple contingencies, but RAS single component failure is not the next contingency, per PRC-012, R1.3 and RAS definition
- P4 failure of a breaker associated with a RAS to operate seldom (never?) results in removing any of the listed elements from service
- P5 applies for specified non-redundant relay failures (note 13), a but RAS-associated breaker (function 52) isn't on the list
- TPL-001-4 Table 1, P4 and P5 do not address failure of a breaker associated with a RAS

RAS Breaker Failure Mitigation

What is Possible?

- Initiate traditional Breaker Failure, but be careful about resulting BES performance
- Over-operate RAS action when possible, similar to mitigation for a single RAS component failure, with a somewhat different motivation
- The redundancy afforded by actions taken by other independent schemes or devices

What about WECC RAS Design Guide?

Failure of a circuit breaker to trip when called upon to trip by the RAS, even when equipped with dual trip coils, is considered a credible failure. . . . However, it should be shown that failure of a breaker to trip (or close) will still result in acceptable system performance.

- Written before the FAC or TPL standards were enforceable
- Does it impose any additional requirements beyond (perhaps soon-to-be-retired) FAC?
- Is it enforceable?

What about WECC RAS Design Guide?

- WECC Guides, on their own, are in the nature of Good Utility Practice (good engineering at reasonable cost consistent with good business practice), but that does not make them enforceable on a WECC-wide basis
- Any expectation beyond FAC is probably mitigation following multi-phase faults (see slide 16), and even that looks to be be short-term
- Does your company specify that it complies with WECC Guides for IPPs, TSAs, internal projects et al . . . ?

Your Company Policy on WECC Guides

Does your Company have a specific internal policy or include language in IPP interconnection or TSA studies something like . . .

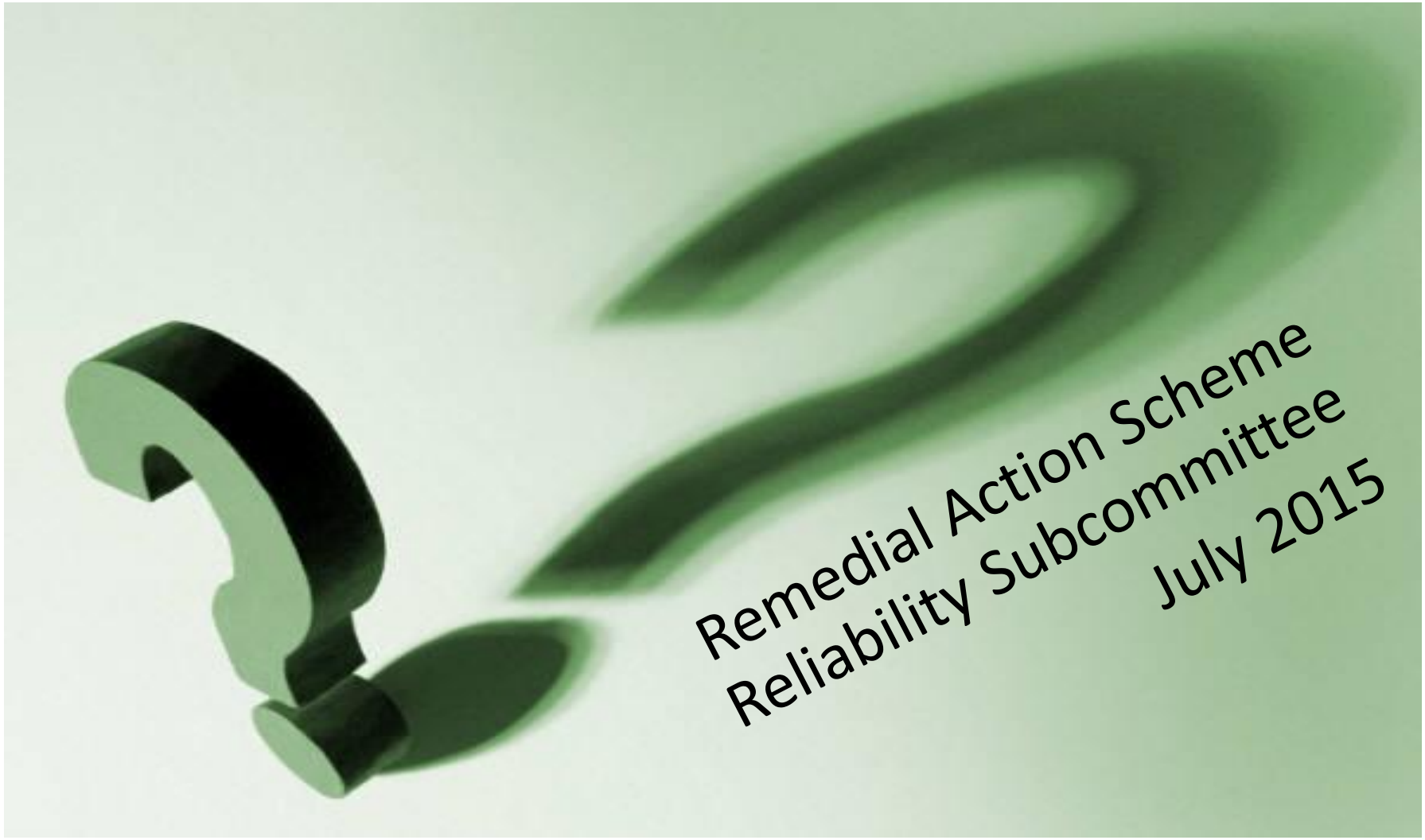
> The interconnection must satisfy Good Utility Practice and meet all applicable industry, NERC, and WECC planning and operating standards, guidelines, and criteria . . . ?

FERC standards of conduct say you must apply the same rules to your internal projects as to external customers – no favoritism (does something similar apply in Canada?)

What Does the Future Look Like?

- It is probably hard to stop retirement of the E1.1.4 variance, or include it at some other appropriate location (TPL-001-4 variance??)
- Standards still wouldn't address failure of a RAS-associated breaker or require related studies
- Good Utility Practice would still say to do the studies and mitigation
- If your company has adopted WECC Guides as part of its standard practice for IPPs or other customers, both study and mitigation probably are still be required due to FERC standards of conduct rules
- Revise the WECC RAS Design Guide?

Questions?


Remedial Action Scheme
Reliability Subcommittee
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