Misoperations Reduction Strategy

Purpose and Request

Protection systems are critical to the reliable operation of the electric grid. When a protection system fails to operate or operates incorrectly, the grid is operating in a less reliable state. In recent years, an increasing number of outages and events on the system have involved misoperations of protection systems, and these events tend to be more severe than events without misoperations. Addressing misoperations of protection systems is an important step in assuring the reliability of the bulk power system.

Reducing the number of protection system misoperations in the Western Interconnection requires coordination, communication and partnership across industry, regulators and vendors. To focus a coordinated effort, the WECC Misoperations Reduction Strategy Advisory Group, which included members from industry, WECC and its sister Regions, and NERC, created this draft Misoperations Reduction Strategy.

The advisory group requests and welcomes comments from all interested parties on all aspects of the draft Misoperations Reduction Strategy. The advisory group intends to use the comments to revise and refine the draft, with the hope of launching a coordinated, Interconnection-wide Misoperations Reduction Strategy in early 2018.

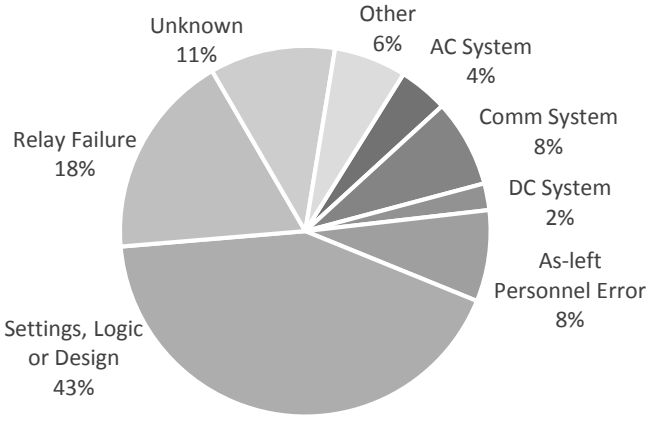
Misoperation Analysis

The draft Misoperations Reduction Strategy focuses on the top three causes of misoperations in the Western Interconnection. These cause categories make up 72 percent of all reported misoperations.

- Incorrect setting/logic/design errors
- Relay failures/malfunctions
- Unknown/unexplainable

By targeting these three causes, the West can take actions that will have the most impact in reducing the rate of misoperations.

2016 Misoperations by Cause



Navigating the Strategy:

The draft Misoperations Reduction Strategy is organized in eight issue-specific documents with four components:

1. Issue Summary – Provides a description of the issue.
2. Analysis – Provides additional insight into why the advisory group included the issue.
3. Action Plan – Outlines a set of proposed actions and actors to address the issue.
4. Time Estimate – Anticipated duration of each individual action, from creation to execution.

How to Comment:

1. Go to: https://www.wecc.biz/PerformanceAnalysis/Pages/Misoperations.aspx
2. Open the "Reduction Strategy" bar.
3. Review the issue documents.
4. Click "Submit Comments" button (You must be logged in to the WECC website. Anyone with an email address can create a WECC website login).
5. Complete and submit the comment form.

Misoperations Reduction Goal

Misoperations Reduction Goal

Reduce Misoperation Rate* by

Threshold 9%

Target 12%

Stretch 17%

The Goal

The Misoperations Reduction Goal allows for three levels of achievement.

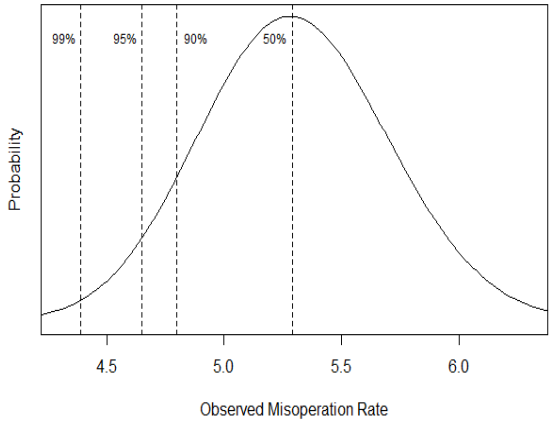
- Threshold: Reduction should be achievable with incremental improvements at individual entities, and should not require a coordinated effort among entities.
- Target: Reduction should require a coordinated effort among entities on key issues influencing misoperations.
- Stretch: Reduction should require fundamental changes to existing processes, practices, and/or relationships.

***This strategy is focused on achieving the target goal—a 12 percent reduction of the 2017 misoperation rate by 2021.**

Goal Justification

The Misoperations Reduction Goal was determined using a binomial model to evaluate whether the misoperation rate is decreasing over time. The probability of occurrence, p, for protection system misoperations is the misoperation rate—the percentage of all operations that are misoperations.

To determine if an actual change in misoperation rate occurs, the observed rate will be compared to an expected future misoperation rate. That expected future rate is based on a prediction of what we would expect to see going forward if the rate does not change. If our future observations differ significantly from our expectations, we will infer that the misoperation rate has changed. Due to sampling error, the misoperation rate we observe each year, p*, will vary somewhat without indicating a substantial change in the actual, systematic misoperation rate p. To account for this sampling error, we established a cut-off point below this normal variation.



Based on historical data from Q2 2016 through Q1 2017, the p value is 5.3 percent.** If the rate p remains 5.3 percent next year—and there is a similar number of operations total—we would expect to p* to be above 4.8 percent 90 percent of the time. In other words, accounting for normal variation in the data, 90 percent of the time after one year we'd expect our observed misoperation rate p* to be no more than 9 percent lower than the systematic rate p of 5.3 percent. So, if p* is more than 9 percent lower than the current rate, we would infer that p has decreased.

To determine target and stretch goals, we can increase the confidence of our inference. For the threshold, we use the 90 percent confidence interval. For the target and stretch, we use 95 percent and 99 percent, respectively.

**Once the data for 2017 (our baseline year) is complete, the value for p will be recalculated and the goal levels changed accordingly.

Questions to Consider:

1. Does reduction level seem reasonable?
2. Can this be accomplished by 2021?
3. Does the justification of the goal make sense? How can it be improved? Would you use a different method; if so, what would it be?

Application of Settings in the Field

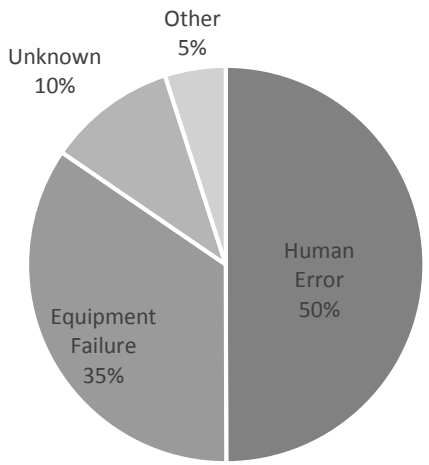
Issue Summary

Settings applied incorrectly in the field lead to misoperations. Modern protection devices contain hundreds of setting options depending on their intended use, which increases the complexity of the application process and introduces opportunities for human error. Training, personnel management, and quality controls can help ensure setting application processes are followed and reduce associated misoperations.

Analysis

Half of protection system misoperations have root or contributing causes related to human error. The Human Error category includes misoperations due to errors in relay scheme logic and design, application of designed settings to equipment, and as-left personnel errors.

2013-2016
Misoperations by Cause Category



Time Estimates & Action Plan

18 MO

WECC hosts a webinar or workshop with presentations from subject matter experts on challenges and techniques for application of settings in the field.

09 MO

Entities follow the checklist provided in the Process, Issues, Trends, and Quality Control of Relay Settings IEEE PSRC Working Group report to review processes involving application of settings in the field and commission testing.

18 MO

WECC, the RWG, and subject matter experts develop a best practice guide with examples of effective setting application and provide points of contact for entities interested in refining their process.

Questions to consider:

1. Is this an appropriate issue for the Misoperations Reduction Strategy?
2. How would you rank the priority of this issue (high, medium or low), and why?
3. Do you feel each action could be accomplished in the proposed time frame?
4. Does the Action Plan adequately address the issue?
5. What is the likelihood that your company would adopt the Action Plan (likely, possibly, unlikely), and why?

Ground Overcurrent Protection

Issue Summary

Many incorrect setting misoperations in the Western Interconnection are attributed to ground overcurrent settings. This indicates that most protection schemes lean toward dependability (relay will not fail to trip) over security (relay will not trip unnecessarily). Generally, this approach ensures relays trip when necessary to protect the system. However, when a ground overcurrent setting misoperation occurs, more facilities than necessary are removed from service, reducing system reliability. In some cases, this can impact load covered by removed facilities.

Time Estimates & Action Plan

12 MO — WECC and the RWG conduct analysis to determine the extent of condition in the Western Interconnection.

18 MO — WECC hosts educational webinars or workshops with industry subject matter experts addressing Ground Fault Protection challenges.

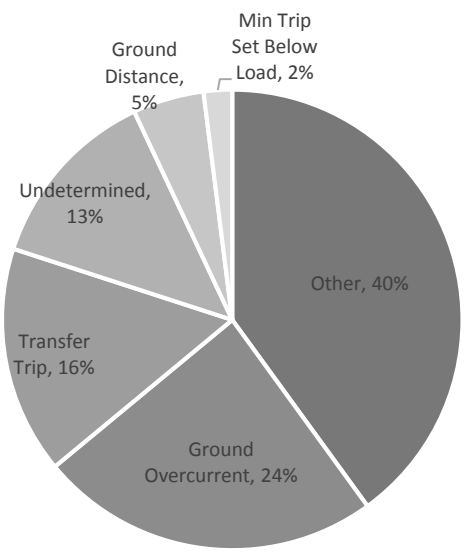
06 MO — Entities asess ground fault protection practices.

12 MO — WECC and the RWG develop a best practice guide with examples of effective coordination of ground overcurrent fault settings.

Analysis

In 2016, incorrect ground overcurrent settings accounted for 9 percent of total misoperations, and 24 percent of misoperations in the "Incorrect Settings, Logic or Design" cause code.

2016 Incorrect Setting and Design Misoperations by Subcategory



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2. How would you rank the priority of this issue (high, medium or low), and why?
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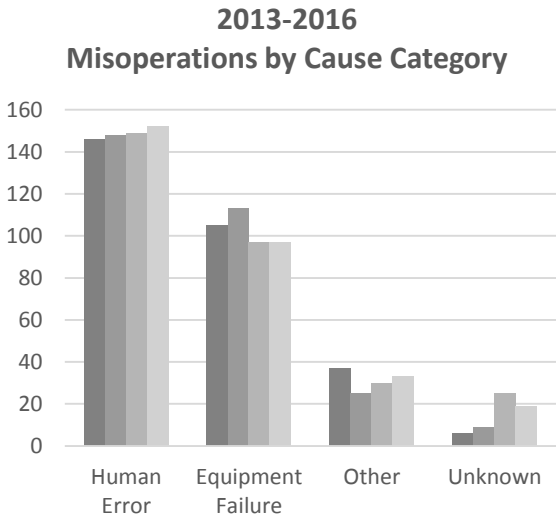
Human Performance During Commissioning

Issue Summary

The commissioning process is crucial to ensuring new equipment is installed correctly and will function as intended. Crossover and shared responsibilities between contractors and entity personnel increase the complexity of this process and introduce opportunities for error. Processes that account for potential complications can reduce the number of errors and resulting misoperations.

Analysis

Human error is the largest misoperation cause category, accounting for half of the misoperations reported in the Western Interconnection. This category includes misoperations due to errors in relay scheme logic and design, application of designed settings to equipment, and as-left personnel errors.



Time Estimates & Action Plan

12 MO

WECC shares data with each entity concerning misoperations associated with human performance issues during commissioning (e.g., as-left personnel errors, AC/DC systems).

18 MO

WECC, the RWG, and the HPWG develop a guide to address human performance in commission testing based on field experience and documents such as the IEEE commissioning document.

03 MO

Entities bring commission testing issues and questions to the RWG for discussion.

Questions to consider:

1. Is this an appropriate issue for the Misoperations Reduction Strategy?
2. How would you rank the priority of this issue (high, medium or low), and why?
3. Do you feel each action could be accomplished in the proposed time frame?
4. Does the Action Plan adequately address the issue?
5. What is the likelihood that your company would adopt the Action Plan (likely, possibly, unlikely), and why?

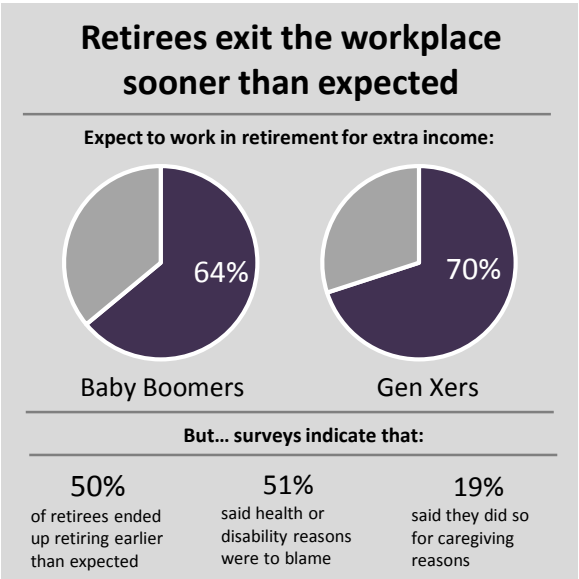
Knowledge Transfer

Issue Summary

Workforce turnover is an issue facing the entire industry. As an increasing number of skilled technicians and engineers become eligible for retirement, the loss of system-specific experience and expertise is imminent. Without sufficient practices in place to capture and transfer this knowledge, valuable information can be lost.

Analysis

By 2024, nearly 1 in 4 people in the labor force are projected to be age 55 or over. Additionally, 10,000 baby boomers retire each day.



Source: Insured Retirement Institute

Time Estimates & Action Plan

12 MO

The HPWG hosts educational webinars on knowledge transfer techniques, and address challenges specific to the electric industry.

18 MO

WECC, the HPWG and stakeholders develop a guide to help entities perform evaluations and identify strengths and weaknesses in their knowledge transfer practices.

12 MO

WECC, in partnership with stakeholders, drafts a best practices guide for knowledge transfer, including real-world examples and points of contact from across the industry.

Questions to consider:

1. Is this an appropriate issue for the Misoperations Reduction Strategy?
2. How would you rank the priority of this issue (high, medium or low), and why?
3. Do you feel each action could be accomplished in the proposed time frame?
4. Does the Action Plan adequately address the issue?
5. What is the likelihood that your company would adopt the Action Plan (likely, possibly, unlikely), and why?

Limited Information for Investigations

Issue Summary

Nearly 60 percent of misoperations with unknown causes are associated with electromechanical or solid state relays. Compared to microprocessor type relays, the data available from these two types of relays is limited, which increases the challenge of identifying the cause of a misoperation. Since a significant number of these relays are still in service, and replacement would be costly, resource intensive, and time consuming, developing investigation approaches specific to these relay types may reduce the tendency to assign unknown cause by default.

Time Estimates & Action Plan

12 MO

Entities evaluate the nature of this issue in their company using unknown misoperations data provided by WECC

24 MO

Entities determine the extent of condition by breaking down relay inventory by type, identifying the percentage of unknown misoperations by relay type, and performing internal evaluations of non-microprocessor systems to identify areas for improvement.

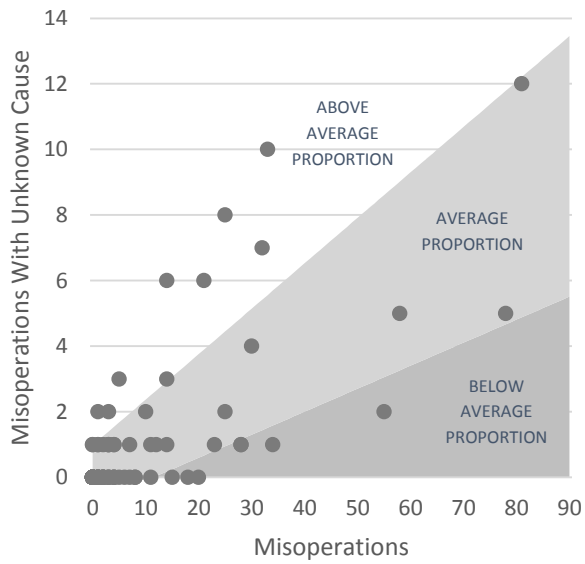
18 MO

Entities create replacement plans for non-microprocessor systems with performance issues and implement reinforcement strategies to identify areas where monitoring equipment may capture useful information.

Analysis

"Unknown" remains one of the top causes of misoperations in the Western Interconnection. When cause cannot be determined, there is an increased likelihood that the same misoperation will occur multiple times. Preliminary analysis suggests that at least one-fifth of misoperations are repeat misoperations.

Unknown Misoperations by Entity



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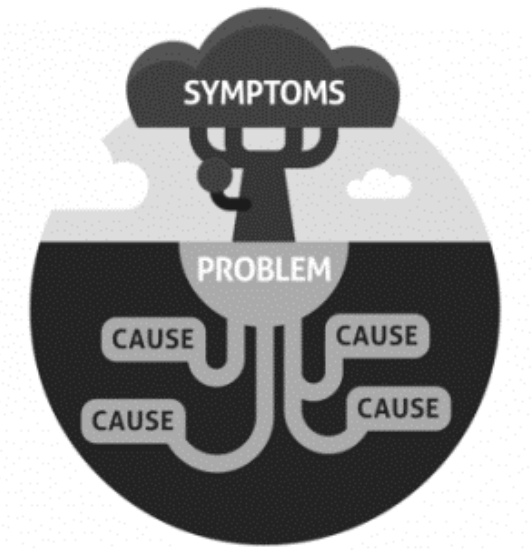
Root Cause Analysis

Issue Summary

Some misoperation investigations end once the initiating cause is determined. Ending an investigation at this stage may provide enough information to resolve a single instance of the issue, but can miss the extent of condition on the system. Thorough root cause analyses can identify latent errors and may prevent additional misoperations stemming from the same issue.

Analysis

Misoperation reports do not always provide enough detail to identify common and trending causes. This may be an indication that misoperation investigations focus solely on initiating causes.



Time Estimates & Action Plan

06 MO	NERC and the ERO Enterprise develop root cause analysis training and guideline specific to misoperations.
12 MO	WECC shares information with entities regarding their incorrect setting misoperations relative to other entities and the WECC average.
12 MO	WECC and subject matter experts draft a best practice guide with examples of effective misoperations root cause analyses.
06 MO	NERC and ERO Enterprise conduct webinar or in-person training to address root cause analysis in misoperation investigation.
12 MO	WECC and subject matter experts create an evaluation guide to facilitate entity self-assessment of misoperation root cause analysis practices.

Questions to consider:

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2. How would you rank the priority of this issue (high, medium or low), and why?
3. Do you feel each action could be accomplished in the proposed time frame?
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Testing Application of Settings

Issue Summary

Entities can prevent misoperations by testing the application of settings. Common approaches include comprehensive quality control reviews and power system simulator testing. Proactively validating settings prior to applying and testing them in the field creates opportunities to catch errors and prevent misoperations before they occur. Simulating anticipated scenarios can ensure settings will operate as intended, and timely identify potential adjustments.

Time Estimates & Action Plan

12 MO — WECC and the RWG create a guideline for testing application of settings, and include an evaluation checklist.

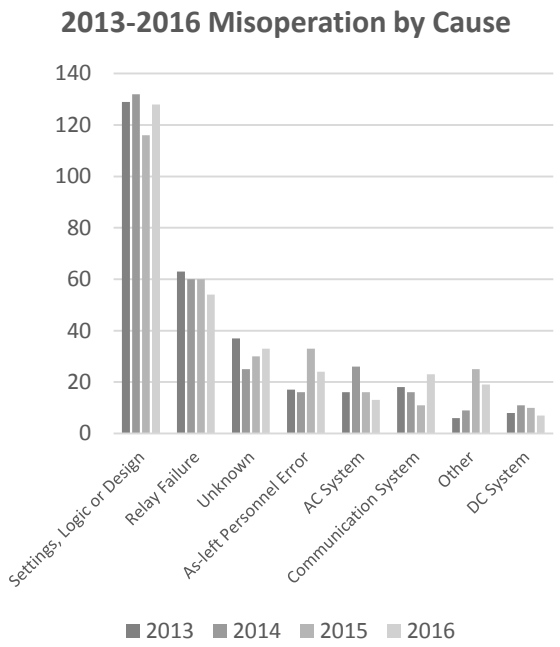
12 MO — WECC and subject matter experts develop a best practice guide for testing application of settings, including real-world examples and points of contact from across the industry.

03 MO — The RWG remains a point of contact for entities interested in refining their processes.

09 MO — Entities perform internal evaluations of practices regarding application testing prior to field implementation, and identify areas for improvement.

Analysis

Preventing misoperations caused by "Incorrect settings, logic or design" can reduce the number of misoperations in the Western Interconnection significantly. This cause code accounts for 43 percent of all misoperations in the Western Interconnection, and is the leasing cause of misoperations nationally.



Questions to consider:

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Short-Circuit Model Quality

Issue Summary

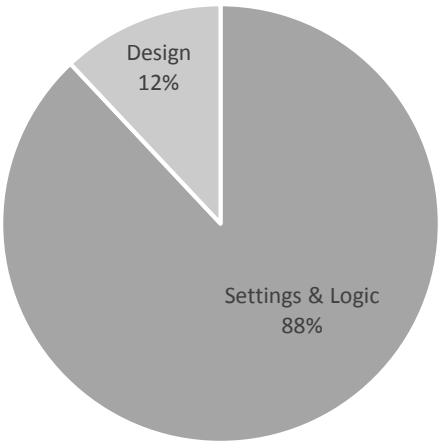
Short-circuit models are critical to developing settings and studying impacts of elements on the system. Flawed or outdated short-circuit models can result in creation and/or application of inaccurate settings. Established processes for updating and sharing short-circuit model information can improve setting consistency and accuracy by ensuring that settings are based on timely, accurate models.

Analysis

Forty percent of misoperations reported in the Western Interconnection are caused by "Incorrect settings, logic, or design errors"—the largest subcategory of "Human Error".

The majority of these misoperations concern protection system setting errors, which can be reduced by improving short-circuit model quality.

2016 Incorrect Settings, Logic or Design Misoperations



Time Estimates & Action Plan

12 MO

WECC and the RWG host a webinar to discuss top issues and inconsistencies in short-circuit models with the WECC Short-Circuit Modeling Work Group (SCMWG).

12 MO

WECC and RWG create an evaluation checklist for short-circuit models and related practices, including communication and information sharing practices.

03 MO

Entities actively participate in regional model initiatives or share short-circuit information with neighboring entities.

03 MO

Entities participate in the newly formed WECC SCMWG.

Questions to consider:

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2. How would you rank the priority of this issue (high, medium or low), and why?
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