



SERC Protection and Controls Subcommittee Misoperation Composite Metric Score

Introduction

PRC-004-1 required Protection System Misoperations to be reported starting in August 2006 per a SERC Regional Criteria. In fourth quarter of 2012, NERC modified misoperations reporting to include reporting of both misoperations and operations (operations = correct operations + misoperations). Since that time, and until now, misoperation rate (misoperations/operations) was the default comparison used within SERC to measure Protection System performance.

The Protection and Control Subcommittee (PCS) Misoperation Composite Metric Score (MCMS) was created in response to the following two questions from the SERC Engineering Committee:

- 1) How can SERC interpret misoperation data to gauge risk?
- 2) How can SERC foster misoperation performance improvements within SERC's footprint?

The PCS's answer was to create the MCM as an alternative to looking at misoperation rates alone. The MCM uses submitted misoperations data to provide a risk based metric that can be assigned to entities and tracked over time.

What is the purpose of the PCS MCMS?

The purpose of the PCS MCMS is to use the misoperation data reported to NERC to determine entity misoperation performance based on the risk specific misoperations pose. The MCMS attempts to use all risk differentiators contained in the required NERC reportable data for Protection System misoperations.

The PCS MCMS is intended to be a tool that both entities and the reliability arm of SERC can use to compare entity performance over a long period of time. The PCS MCMS pertains only to transmission misoperations and operations data.

How should the PCS MCMS be used?

The SERC PCS intends for the MCMS to be used by entities to:

- 1) Trend their own performance and
- 2) Compare their own performance against that of similarly sized companies

It is also intended for SERC itself to use this metric to gauge relative performance and risks between entities.

The PCS will publish the SERC MCMS for all SERC members yearly (including trending); the PCS believes that comparisons between entities on shorter timeframes are not statistically relevant.



PCS Misoperation Composite Metric Score Defined

The following four categories are equally ranked to develop an entity's PCS MCMS:

- Misoperation Category, (25% weighting)
- Cause of Misoperation, (25% weighting)
- Corrective Action Plan Duration, (25% weighting)
- Misoperation Rate, (25% weighting)

The highest possible score a registered entity can obtain is 100; 25 points from each of the above categories. Within these four categories, points are removed based on risk. These categories are further defined below:

Misoperation Category - "Failure to Trip" (FTT) or "Slow Trip" (ST) misoperations lower an entity's MCMS more so than "Unnecessary Trip- No fault" (UTNF) or "Unnecessary Trip during Fault" (UTDF) since the former categories pose more risk to the BES than the latter.

The 25% weighting assigned to Misoperation Category is further broken down as:

Misoperation Category	Weighting
Failure to Trip or Slow Trip	15%
Unnecessary Trip- During Fault	7%
Unnecessary Trip - No Fault	3%

Table 1: Misoperation Category Weighting

Cause of Misoperation - the cause of a misoperation does not differentiate risk, however, a misoperation whose cause is not determined does pose a continued risk to the BES. For this reason, misoperation causes that are closed as "Unknown" lower an entity's MCMS more so than any other. Unknown cause is shown as Undetermined on the graphs in Figures 1 and 2 later in the document.

The 25% weighting assigned to Cause of Misoperation is further broken down as:

Cause of Misoperation	Weighting
Unknown	25%

Table 2: Cause of Misoperation Weighting

Corrective Action Plan Duration - slower resolution of misoperations reduces an entity's MCMS more so than quick resolution since slower resolution poses increased risk the BES. Duration is defined as the number of days between misoperation occurrence and completion of the CAP. CAP Duration is shown as CAP Completion on the graphs in Figures 1 and 2 later in the document.



Weightings for CAP duration will be assigned as follows:

CAP Duration	CAP Duration Weight
< 6 months	0.0
6 to 9 months	0.1
9 to 12 months	0.25
12 to 18 months	0.5
18 to 24 months	0.8
> 24 months	1.0

Table 3: CAP Duration Weighting

Misoperation Rate - a higher rate of misoperations reduces an entity’s MCMS more so than a lower rate of misoperations since the former poses an increased risk to the BES. Misoperation Rate is shown as Op Ratio on the graphs in Figures 1 and 2 later in the document.

Two additional risk differentiators are used in three of the above four categories: voltage (kV) of the BES element that misoperated and whether the misoperation opened a BES element or not.

Misoperations on higher voltage BES elements are weighted higher since they pose a higher risk to BES reliability. Each misoperation is weighting by its voltage class as defined below:

Voltage of circuit Erroneously Removed	kV Weighting
0 - 99 kV (BES)	0.8
100 - 199 kV	1.0
200 - 299 kV	1.3
300 - 499 kV	1.5
500 - 765 kV	2.0

Table 4: Voltage Class Weighting

Misoperations that do not interrupt BES elements, but instead only open a BES breaker (like a ring breaker) pose less risk to the BES. Each misoperation is weighting by its equipment weighting factor which is defined below:

Equipment Removed from Service	Equipment Weighing
BES element	1.0
BES breaker only	0.1

Table 5: Equipment Weighting

How the MCMS is calculated

An entity’s scoring for each of the above four categories (Misoperation Category, Cause of Misoperation, Corrective Action Plan Duration, and Misoperation Rate) are assigned using the following formulas:



Misoperation Category points = MC1 =

$$15 * \left[1 - \frac{\sum_1^a ((kV \text{ Weighting}_a) * (\text{Equipment Weighting}_a))}{(\text{total misoperation count})} \right] +$$

$$7 * \left[1 - \frac{\sum_1^b ((kV \text{ Weighting}_b) * (\text{Equipment Weighting}_b))}{(\text{total misoperation count})} \right] +$$

$$3 * \left[1 - \frac{\sum_1^c ((kV \text{ Weighting}_c) * (\text{Equipment Weighting}_c))}{(\text{total misoperation count})} \right]$$

Where a = each FTT and ST misoperation (up to a total), b = each UTDF misoperation (up to b total), and c = each UTNF misoperation (up to c total).

Misoperation Cause points = MC2 =

$$25 * \left[1 - \frac{\sum_1^d ((kV \text{ Weighting}_d) * (\text{Equipment Weighting}_d))}{(\text{total misoperation count})} \right]$$

Where d = each "Unknown" misoperation, up to d total.

Corrective Action Plan Duration points = CAPD =

$$25 * \left[1 - \frac{\sum_1^e ((kV \text{ Weighting}_e) * (\text{Equipment Weighting}_e) * (\text{CAP Duration Weight}_e))}{(\text{total misoperation count})} \right]$$

Where e = each misoperation investigation closed, up to e total.

Misoperation Rate points = MR =

$$25 * \left[1 - \frac{(\text{total misoperation count})}{(\text{total correct operation count}) + (\text{total misoperation count})} \right]$$

Entity Misoperation Composite Metric Score = MC1 + MC2 + CAPD + MR

Note: The lowest score possible in each of the four categories (MC1, MC2, CAPD, & MR) is zero.



MCMS Scoring Example

For a given year, fictitious ACME Transmission reported 22 correct operations and the following Misoperation data:

Misop. #	Category	BES Element Removed	Cause	kV of circuit	CAP Duration (months)
1	Failure to Trip	Line	Unknown/unexplainable	161	2.5
2	Failure to Trip	Line	As Left Personnel Error	161	9
3	Slow Trip	Bus	Unknown/unexplainable	161	17
4	Unnecessary Trip During Fault	Line	Communications	230	1
5	Unnecessary Trip During Fault	Breaker	Unknown/unexplainable	161	3
6	Unnecessary Trip During Fault	Line	Relay Failure/Malfunction	500	5
7	Unnecessary Trip No Fault	Line	Unknown/unexplainable	500	10
8	Failure to Trip	Line	Unknown/unexplainable	230	11

Table 6: Reported Misoperation data for ACME Transmission example

Given this reporting, ACME's Misoperation Composite Metric Score = MC1 + MC2 + CAPD + MR.

$$MC1 = 15 * \left[1 - \frac{(1*1)+(1*1)+(1*1)+(1.3*1)}{8} \right] + 7 * \left[1 - \frac{(1.3*1)+(1*0.1)+(2*1)}{8} \right] + 3 * \left[1 - \frac{(2*1)}{8} \right] = 13.2$$

$$MC2 = 25 * \left[1 - \frac{(1*1)+(1*1)+(1*0.1)+(2*1)+(1.3*1)}{8} \right] = 8.1$$

$$CAPD = 25 * \left[1 - \frac{(0+(1*1*0.1)+(1*1*0.5)+0+0+0+(2*1*0.25)+(1.3*1*0.25))}{8} \right] = 20.5$$

$$MR = 25 * \left(1 - \frac{8}{22+8} \right) = 18.3$$

Acme Transmission's MCMS = MC1 + MC2 + CAPD + MR = 13.2 + 8.1 + 20.5 + 18.3 = 60.1.

MCMS Reports

The MCMS can produce two report cards. One identifies the scores of SERC registered entities in relation to the best score of 100. An individual registered entity performance report is the second report. Examples of the reports are shown in Figures 1 and 2 below.

SERC Misoperations Score Companies greater than 350 circuits

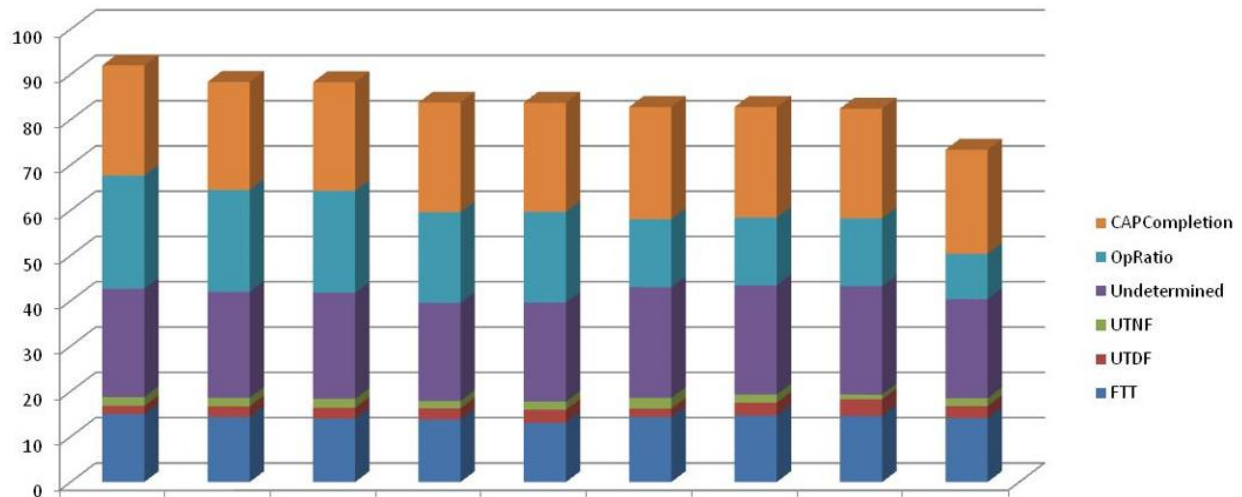


Figure 1: SERC Entity Comparison Report

Many of the entities with 100% score typically have very few operations, thus do not face the challenges of larger entities with numerous facilities. Entities will be grouped based on the number of BES transmission circuits they operate per TADS circuit count data. There are three groupings:

1. Companies with greater than 350 circuits
2. Companies with between 76 and 349 circuits
3. Companies with less than 76 circuits

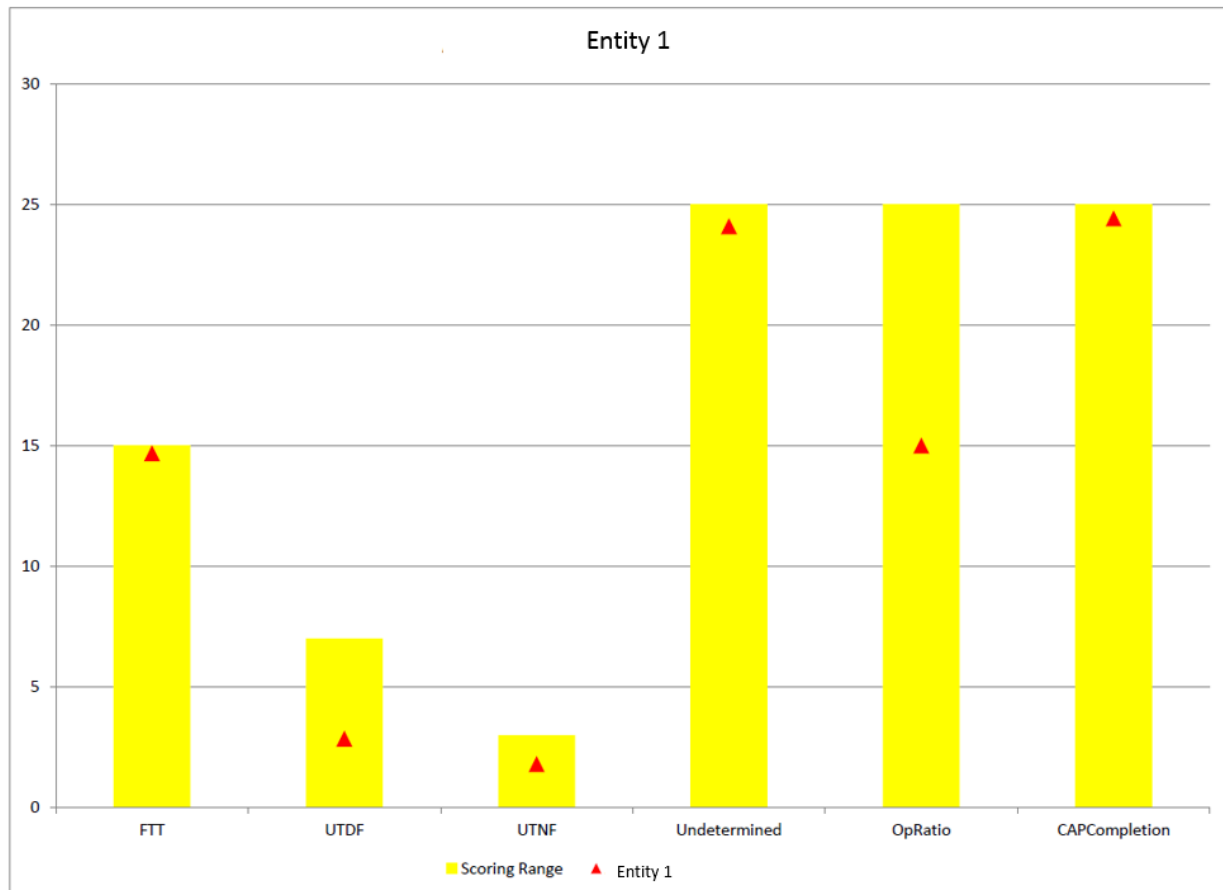


Figure 2: Individual Entity Report

The yellow bars in the individual entity report indicate the maximum points an entity can score in an area. The red diamonds show where the entity actually scored. This view provides insight into areas of improvement for the entity.

Conclusion

The MCM produces a SERC entity report and an individual entity report that entities can use as a tool to gauge their misoperations performance and possibly identify areas for improvement.

References

- 1 *Glossary of Terms Used in NERC Reliability Standards*. (2016, August). Retrieved from http://www.nerc.com/files/glossary_of_terms.pdf