Addendum for Events with Failed Station Equipment – Version 2

# Background

In December 2013, the NERC Planning and Operating Committees formed the AC Substation Equipment Task Force (ACSETF) to investigate substation equipment failures. The subsequent report from the ACSETF recommended that the NERC Event Analysis process collect information on station equipment failures going forward. The collection of this data will aid in future analysis of station equipment failures to identify trends that may be a threat to the reliability of the BES and potential ways to improve that reliability. As such, NERC Event Analysis is providing this addendum to aid in the gathering of that station equipment failure data.

This addendum is intended to be used as a form to collect failed station equipment information for submittal with the Brief Report for events. The format used in the addendum is designed to ease consistent data entry. Please use the Brief Report’s narrative section for any additional pertinent detail for each equipment failure. The form has space for only one failure for each equipment type listed. If the event involved more than one failure of the same type of equipment, fill out an additional copies of the addendum.

The form uses a failure modes and mechanisms (FMM) approach. Basically, a failure mode is what gets your attention – it tells you that the equipment has failed, while failure mechanisms are how the equipment gets going on the path to a failure. FMM information is intended to be provided in addition to the identified contributing causes and root cause determined through the entity’s root cause analysis of the event. A short video explaining the FMM approach is [located here](https://vimeopro.com/nerclearning/cause-coding/video/208745179).

FMM diagrams are being made available for each equipment type on the form. Obtain copies of substation equipment FMM diagrams from your regional entity’s event analysis group.

Only the top two tiers of FMM data – 1) the failure mode, and 2) the failure mechanism branch title are collected on the following form. The lower levels of Failure Mechanism detail shown on the diagrams are for entity use in determining which failure mechanism branch the failure traveled up, what symptoms might be measurable to give warning of developing failures, possible causes, and potential preventive actions.

Additional resources for entities to use in analysis of station equipment failures are IEEE C57.125 Guide for Failure Investigation, Documentation, Analysis and Reporting for Power Transformers and Shunt Reactors and IEEE C37.10 Guide for Diagnostics and Failure Investigation of Power Circuit Breakers.

# Instructions

1. Fill out the yellow Event Identification block.
2. Next, use the blue equipment type links to get to the failed equipment type.
3. Fill out the text fields for the equipment’s Manufacturer, Date of Manufacture, Model/Type, etc.
4. Then Locate the equipment’s Failure Mode in the left column.
5. In the cell to the right of the Failure Mode, pick the Failure Mechanism Branch Title from the dropdown.
6. Save the completed Failed Equipment Addendum with an appropriate file name.
7. Fill out additional Failed Equipment Addendums as necessary for the event.
8. Send the completed Failed Equipment Addendum(s) to your Regional Entity’s Event Analysis group.

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| --- | --- |
|  Event Identification (Identify the event associated with this addendum. Provide enough information to identify which event this form belongs with – region, entity name, date, time, location, *short* description) | Click here to enter text. |
| **Equipment Types** |
| [Oil-Filled Power Transformer](#Oil_Filled_Power_Transformer)[Instrument Transformer](#Instrument_Transformer) – PT / CT* [Electromagnetic Potential Transformer](#EMPT)
* [Coupling Capacitor Voltage Transformer](#CCVT)
* [Optical Voltage Transformer](#OVT)
* [Wound / Electromagnetic Current Transformer](#EMCT)
* [Optical Current Transformer](#OCT)

[Circuit Breaker](#Circuit_Breaker)* [SF6 Breaker](#SF6_Breaker)
* [Air Blast Breaker](#Air_Blast_Breaker)
* [Oil Breaker](#Oil_Breaker)

[Switch](#Switch)[Oil-Filled Reactor (Inductor)](#Oil_Filled_Reactor)[Capacitor Bank](#Capacitor_Bank)[Surge Arrester](#Surge_Arrester)[Relay](#Relay) |  |
| Oil-Filled Power Transformer |
| 1. Manufacturer
 | Click here to enter text. |
| 1. Date of manufacture
 | Click here to enter text. |
| 1. Transformer type
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| 1. Winding configuration
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| 1. Failure Modes
 | Failure Mechanisms |
| * 1. Winding failure
 | Choose an item. |
| * 1. Dielectric failure
 | Choose an item. |
| * 1. Tap changer failure
 | Choose an item. |
| * 1. Internal Lead Failure
 | Choose an item. |
| * 1. Cooling Failure
 | Choose an item. |
| * 1. Tank Failure
 | Choose an item. |
| * 1. Bushing failure
 | Choose an item. |
| * + 1. Bushing manufacturer
 | Click here to enter text. |
| * + 1. Date manufacture
 | Click here to enter text. |
| * + 1. Bushing type
 | Click here to enter text. |
| * 1. Other – please explain
 | Click here to enter text. |
| 1. Station Bus configuration
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| Instrument Transformer (Potential Transformer or Current Transformer) |
| 1. Manufacturer
 | Click here to enter text. |
| 1. Model
 | Click here to enter text. |
| 1. Date of manufacture
 | Click here to enter text. |
| 1. Type of instrument transformer
 | Choose an item. |
| 1. Location w/respect to bus and other devices / Mounting / Use
 | Click here to enter text. |
| 1. Failure Modes

(use the section below matching the CT/PT Type) |  |
| * 1. Coupling Capacitor Voltage Transformer Failure Modes
 | Failure Mechanisms |
| * + 1. External Fault
 | Choose an item. |
| * + 1. Internal Fault
 | Choose an item. |
| * + 1. Mechanical Failure
 | Choose an item. |
| * + 1. Open / High Impedance
 | Choose an item. |
| * + 1. Electromagnetic Unit (EMU) Failure
 | Choose an item. |
| * 1. Electromagnetic Potential Transformer Failure Modes
 | Failure Mechanisms |
| * + 1. External Fault
 | Choose an item. |
| * + 1. Internal Fault
 | Choose an item. |
| * + 1. Mechanical Failure
 | Choose an item. |
| * + 1. Open / High Impedance
 | Choose an item. |
| * + 1. Winding Failure
 | Choose an item. |
| * 1. Optical Voltage Transformer Failure Modes
 | Failure Mechanisms |
| * + 1. External Fault
 | Choose an item. |
| * + 1. Internal Fault
 | Choose an item. |
| * + 1. Mechanical Failure
 | Choose an item. |
| * + 1. Signal Loss
 | Choose an item. |
| * 1. Electromagnetic Current Transformer Failure Modes
 | Failure Mechanisms |
| * + 1. External Fault
 | Choose an item. |
| * + 1. Internal Fault
 | Choose an item. |
| * + 1. Mechanical Failure
 | Choose an item. |
| * + 1. Open / High Impedance
 | Choose an item. |
| * + 1. Winding Failure
 | Choose an item. |
| * 1. Optical Current Transformer Failure Modes
 | Failure Mechanisms |
| * + 1. External Fault
 | Choose an item. |
| * + 1. Internal Fault
 | Choose an item. |
| * + 1. Mechanical Failure
 | Choose an item. |
| * + 1. Signal Loss
 | Choose an item. |
| Circuit Breaker |
| 1. Manufacturer
 | Click here to enter text. |
| 1. Model
 | Click here to enter text. |
| 1. Date of manufacture
 | Click here to enter text. |
| 1. Type of Circuit Breaker
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| 1. Failure Modes

(use the section below matching the Breaker Type) |  |
| * 1. SF6 Breaker Failure Modes
 | Failure Mechanisms |
| * + 1. Actuation Failure
 | Choose an item. |
| * + 1. Contact Failure
 | Choose an item. |
| * + 1. Dielectric Failure
 | Choose an item. |
| * + 1. Tank Failure
 | Choose an item. |
| * + 1. Bushing failure
 | Choose an item. |
| * + - 1. Bushing manufacturer
 | Click here to enter text. |
| * + - 1. Date manufacture
 | Click here to enter text. |
| * + - 1. Bushing type
 | Click here to enter text. |
| * + 1. Other – please explain
 | Click here to enter text. |
| * 1. Air Blast Breaker Failure Modes
 | Failure Mechanisms |
| * + 1. Actuation Failure
 | Choose an item. |
| * + 1. Contact Failure
 | Choose an item. |
| * + 1. Air Supply Failure
 | Choose an item. |
| * + 1. Pressure Boundary Failure
 | Choose an item. |
| * + 1. Bushing failure
 | Choose an item. |
| * + - 1. Bushing manufacturer
 | Click here to enter text. |
| * + - 1. Date manufacture
 | Click here to enter text. |
| * + - 1. Bushing type
 | Click here to enter text. |
| * + 1. Other – please explain
 | Click here to enter text. |
| * 1. Oil Breaker Failure Modes
 | Failure Mechanisms |
| * + 1. Actuation Failure
 | Choose an item. |
| * + 1. Contact Failure
 | Choose an item. |
| * + 1. Dielectric Failure
 | Choose an item. |
| * + 1. Tank Failure
 | Choose an item. |
| * + 1. Bushing failure
 | Choose an item. |
| * + - 1. Bushing manufacturer
 | Click here to enter text. |
| * + - 1. Date manufacture
 | Click here to enter text. |
| * + - 1. Bushing type
 | Click here to enter text. |
| * + 1. Other – please explain
 | Click here to enter text. |
| Switch |
| 1. Manufacturer
 | Click here to enter text. |
| 1. Model
 | Click here to enter text. |
| 1. Date of manufacture
 | Click here to enter text. |
| 1. Switch type
 | Click here to enter text. |
| * 1. If ‘Other’ – please explain
 | Click here to enter text. |
| 1. Switch Failure Modes
 | Failure Mechanisms |
| * 1. Actuation Failure
 | Choose an item. |
| * 1. Contact Failure
 | Choose an item. |
| * 1. Bushing failure
 | Choose an item. |
| * + 1. Bushing manufacturer
 | Click here to enter text. |
| * + 1. Date manufacture
 | Click here to enter text. |
| * + 1. Bushing type
 | Click here to enter text. |
| * 1. Other – please explain
 | Click here to enter text. |
| 1. Station Bus configuration
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| Oil-Filled Reactor (Inductor) |
| 1. Manufacturer
 | Click here to enter text. |
| 1. Date of manufacture
 | Click here to enter text. |
| 1. Transformer type
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| 1. Winding configuration
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| 1. Failure Modes
 | Failure Mechanisms |
| * 1. Winding failure
 | Choose an item. |
| * 1. Dielectric failure
 | Choose an item. |
| * 1. Internal Lead Failure
 | Choose an item. |
| * 1. VSR Air Gap / Tap changer failure
 | Choose an item. |
| * 1. Cooling Failure
 | Choose an item. |
| * 1. Tank Failure
 | Choose an item. |
| * 1. Bushing failure
 | Choose an item. |
| * + 1. Bushing manufacturer
 | Click here to enter text. |
| * + 1. Date manufacture
 | Click here to enter text. |
| * + 1. Bushing type
 | Click here to enter text. |
| * 1. Other – please explain
 | Click here to enter text. |
| 1. Station Bus configuration
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| Capacitor Bank |
| 1. Manufacturer
 | Click here to enter text. |
| 1. Failed Item Date of manufacture
 | Click here to enter text. |
| 1. Capacitor type
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| 1. Failure Mode
 | Failure Mechanisms |
| * 1. External Fault
 | Choose an item. |
| * 1. Internal Fault/Tracking
 | Choose an item. |
| * 1. Tank Failure
 | Choose an item. |
| * 1. Open/High Impedance
 | Choose an item. |
| * 1. Other – please explain
 | Click here to enter text. |
| 1. Cap Bank configuration
 | Choose an item. |
| If ‘Other’ please explain: | Click here to enter text. |
| Surge Arrester |
| 1. Manufacturer
 | Click here to enter text. |
| 1. Model
 | Click here to enter text. |
| 1. Date of manufacture
 | Click here to enter text. |
| 1. Surge Arrester type
 | Choose an item. |
| * 1. If ‘Other’ – please explain
 | Click here to enter text. |
| 1. Surge Arrester Failure Modes
 | Failure Mechanisms |
| * 1. External Fault
 | Choose an item. |
| * 1. Internal Fault/Tracking
 | Choose an item. |
| * 1. Mechanical Failure
 | Choose an item. |
| * 1. Open/High Resistance Loss of Function
 | Choose an item. |
| * 1. Other-please explain
 | Click here to enter text. |
| 1. Surge Arrester Location/Mounting/Use
 | Click here to enter text. |
| **Relay** |
| 1. Manufacturer
 | Click here to enter text. |
| 1. Model
 | Click here to enter text. |
| 1. Date of manufacture
 | Click here to enter text. |
| 1. Relay type
 | Choose an item. |
| 1. Type of failure
 | Click here to enter text. |
| * 1. Power supply
 | Click here to enter text. |
| * 1. A/D
 | Click here to enter text. |
| * 1. Failed contact
 | Click here to enter text. |
| * 1. Failed directional element
 | Click here to enter text. |
| * 1. High resistance contact
 | Click here to enter text. |
| * 1. Other-please explain
 | Click here to enter text. |
| 1. Cause of failure
 | Click here to enter text. |
| * 1. Heat
 | Click here to enter text. |
| * 1. Age
 | Click here to enter text. |
| * 1. Duty cycle
 | Click here to enter text. |
| * 1. Mechanical binding
 | Click here to enter text. |
| * 1. Other-please explain
 | Click here to enter text. |

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| **Revision History** |
| **Version** | **Date** | **Revisions** |
| Initial | 5/24/2016 | Initial posting of Addendum for Events with Failed Station Equipment |
| 1 | 12/11/2018 | Added FMM methodology, expanded equipment handled to 14 types. |
| 2 | 8/19/2019 | Updated format, corrected the Switch Type entry to text field. |