

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Transmission Availability Data System 2008 Automatic Outage Metrics and Data Report

NERC

FINAL DRAFT

June 26, 2009

to ensure
the reliability of the
bulk power system

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1 Introduction

1.1 Contributors and Acknowledgements

The North American Electric Reliability Corporation (NERC) gratefully acknowledges the support of the Transmission Availability Data System Task Force (TADSTF), Open Access Technologies International (OATI,) and the 192 reporting Transmission Owners (TOs) in NERC. “Reporting TOs” are TOs that own any TADS facilities, as described in Section 1.3 below, on January 1, 2008.

- TADS Phase I participation is mandatory for all U.S. TOs on the NERC Compliance Registry, and all of the NERC TOs complied.¹
- Participation is voluntary for Mexican and Canadian TOs on the NERC Compliance Registry, and all non-U.S. TOs in NERC except one voluntarily provided data.

In addition to TOs, TADS Regional Entity coordinators (RECs) in NERC,² and NERC TADS administrators supported the effort.

1.2 TADS History

The TADS effort began with the establishment of the TADSTF under the NERC Planning Committee in October 2006. On October 27, 2007, the NERC Board of Trustees approved the collection of TADS Phase I data beginning in calendar year 2008. As described below, Phase I includes only Automatic Outage data, and the reader is referred to Appendix 1 for the definition of capitalized Phase I terms. On October 29, 2008, the board approved the collection of Non-Automatic Outage data beginning in calendar year 2010 (Phase II). Two reports describe all aspects of each phase, and these reports were the basis of the board’s approvals— one for Phase I and Phase II. They are available for download and review by the reader.³

1.3 Scope

This report is based upon Phase I data for the calendar year 2008. Phase I TADS includes Momentary and Sustained Automatic Outages of the following Elements (greater than or equal to 200 kV):

- AC Circuits ≥ 200 kV (Overhead and Underground Circuits). Radial circuits are included;
- DC Circuits with $\geq \pm 200$ kV DC voltage;
- Transformers with ≥ 200 kV low-side voltage; and
- AC/DC Back-to-Back (BTB) Converters with ≥ 200 kV AC voltage, both sides.

¹ For TADS, three U.S. companies in NERC that operate multiple NERC-registered TOs were allowed to submit one TADS set of data for their combined TOs. See *NERC ID Exceptions for TADS Data* posted at [NERC ID Exceptions](#).

² The *TADS Data Reporting Instruction Manual* dated November 21, 2008 has the names and contact information for all RECs in Appendix 9. The manual may be downloaded at [TADS Manual](#).

³ The Phase I report link is [Phase I report](#), and the Phase II report link is [Phase II report](#).

The following basic information is collected:

- Automatic Outage Data:
 - Event ID & Event Type
 - Outage ID code
 - Fault Type
 - Outage Initiation Code
 - Outage Start Time
 - Outage Duration
 - Outage Cause Codes
 - Initiating
 - Sustained
 - Outage Mode
- Element Inventory Summary:
 - Number of Elements
 - For AC and DC Circuits, Circuit Miles
 - For AC and DC Circuits, AC and DC Multi-Circuit Structure Miles.

1.4 TADS Reports – NERC, Regional, and Transmission Owner

This report is the second TADS reporting effort for 2008 data. A NERC-wide report for the first quarter of 2008 was produced and is dated October 30, 2008.⁴ It was the first TADS reporting effort, and it was required to exercise the data collection and analysis process prior to completing an entire year of data collection. The objective was to identify potential errors and settle on a report format. NERC staff and RECs did find several systematic data collection errors, and in the time between that report and the March 1, 2009 data submittal cut-off for TOs, NERC staff, working with OATI, improved the automatic data entry error checks in webTADS⁵ and asked TOs to correct previously submitted suspect data. That first report only contains NERC-wide metrics and data for the first quarter of 2008.

For calendar year 2008, one NERC-wide report and eight regional reports have been produced, using a common format, and these are posted on the TADSTF page on the NERC Web site. Appendix 1 (definitions) is common to each report and can be separately accessible on the TADSTF Web site page via links in this report.

In addition, each report has an associated Excel workbook that contains non-confidential data from webTADS as well as all of the tables and figures in the report that were developed from that data. Those workbooks are posted on the TADS Web site along with each report.

After NERC has posted the NERC-wide and regional reports for calendar year 2008, each TO which has a secure logon ID will be able to obtain its own metrics for the identical tables and figures contained in this report. NERC will be issuing instructions to all

⁴ The first quarter 2008 report is posted at [TADS 1Q 2008 Report](#).

⁵ All data was entered via a secure internet link into software called webTADS that was developed by OATI for NERC. It is used to collect and validate data (using basic logic checks). It also computes the data inputs used to produce the report.

reporting TOs on how this can be accomplished by early July, 2009. Each TO's confidential data and results are only available to that TO and not to the public.

This report contains an analysis of the NERC results and the metrics recommended by the TADSTF, taking into account comments the task force received on the first quarter 2008 report. The purpose of this report is to just state the facts of the first annual 2008 data collection. Moving forward the TADSTF⁶ and other NERC groups may separately provide observations, interpretations of the annual results, and suggest further areas for study. Readers of this report should not draw conclusions based on this initial first year data collection for 2008. It will take several years of data to provide interpretations with a high degree of confidence.

1.5 Confidential Data Not Publically Reported

Per the data confidentiality policy,⁷ the report does not display performance data associated with a TADS Element in a Voltage Class or for circuits of a particular construction type (Overhead or Underground) if all of the Elements in that Voltage Class and applicable construction type are reported by one TO.⁸ In this report, confidential performance data has *not* been displayed for the following Elements, Voltage Classes, and construction types that are reported by one TO in NERC:

1. AC Circuits – one TO reported all of the Underground 400-599 kV AC Circuit Performance Data in NERC. Therefore, no Underground 400-599 kV AC Circuit performance data is displayed in this report.
2. DC Circuits – one TO reported all the 200-299 kV DC Circuit performance data in NERC. In addition, one TO reported all of the Underground 400-499 kV DC Circuit performance data in NERC. Therefore, no 200-299 kV DC Circuit performance data or Underground 400-499 kV DC Circuit performance data is displayed in this report.

Where Underground circuit performance data has been excluded, the associated Overhead performance data has also been excluded to protect data confidentiality. The reason is that in certain tables, the combined total (Overhead plus Underground) performance data are displayed which could be used in conjunction with the Overhead component of the performance data to derive the Underground performance data.

1.6 Report Organization

Section 2 has summary NERC metrics and data for each of the reported Elements while Section 3 has more detailed data for these same Elements, with separate subsections devoted to each Element (e.g., Section 3.1 for AC Circuits, Section 3.3 for Transformers, etc.).

⁶ The TADSTF will become a working group on July 1, 2009. In NERC subgroup terminology, a “task force” is formed to address a specific issue, and after that issue is addressed, the task force is dissolved. A working group has on-going responsibility over a specific subject area.

⁷ See Section 1.5 of the *TADS Data Reporting and Instructions Manual* dated November 11, 2008.

⁸ NERC will ask the impacted TOs for permission beginning with the calendar year 2009 report.

1.6.1 Table and Figure Labeling

Table NERC 1-1 shows the assigned numbering scheme for the tables and figures in this report. The prefix “NERC” indicates the region covered by the report. The table and figure numbering scheme includes the major report section heading (e.g., Section 1, 2, 3.1, etc.) followed by a “dash” and then followed by a number (e.g., 1, 2, 3, etc.) that reflects the order that the table or figure appear in the report. Any tables or figures that are purposely omitted in this report are highlighted in the Table NERC 1-1. Tables or figures may be omitted because (i) they have no data because there are no Elements, or (ii) they contain confidential TO data, or (iii) there were no reported outages.

1.6.2 Tables and Figures Data Categories

The task force elected to use a common NERC-wide template for each of the tables and figures displaying performance data. The template only includes data categories (i.e., Voltage Class and construction type) for Elements that are found within NERC. The use of a common NERC-wide template allows for all reports (regional and NERC) to utilize a familiar format while making production easier. Table NERC 1-2 shows the categories included in the NERC template.

Performance data are not shown in Tables NERC 2-1 and NERC 2-2. These tables show, respectively, the Inventory of AC equipment and DC equipment within NERC. The task force felt that a complete snapshot of all TADS categories was needed, including categories with zero inventories in NERC.

1.6.3 Tables and Figures Data Display Conventions

Some regions do not have any Elements in a Voltage Class, but since those Elements exist elsewhere within NERC, the NERC template has a row or column for them. For example, only one region in NERC has DC Circuits in the 200-299 kV Voltage Class. That Voltage Class is contained in all DC Circuit tables in the NERC and all regional reports because the template is NERC-wide. However, the task force took these steps to assist the reader in viewing such tables:

1. Appendix 2 contains the metric definitions along with their acronyms. These acronyms are used frequently in tables and figures.
2. If there are no Elements of a particular Voltage Class and applicable construction type in a region, performance data in a table such as the number of Sustained Outages is shown as a “dash” and not a zero. Also, all calculations that would normally use that data are shown as a “dash.”
3. If there are Elements in a Voltage Class and applicable construction type, but the performance data displayed for that Element is equal to zero (for example, the number of Sustained Outages is equal to zero), a “0” is shown. In this case, if a computation using that data would result in a division by zero, a “tilde” (~) is shown for the results of that computation. This avoids the Excel “#DIV/0!” display.
4. If there are Elements in a Voltage Class and applicable construction type, but the performance data may not be displayed because it is confidential, all performance

- data for that Voltage Class and applicable construction type is removed and a “C” is displayed for that data. However, as explained in Section 2-3, Table NERC 2-3 (Event Types and Outages) generally includes all outage data because it does not reveal any confidential data; however, if it would reveal confidential performance data, that data would have a “C” displayed.
5. In each report subsection devoted to a specific Element (e.g., Section 3.1 for AC Circuits), separate tables display total (a) Element-Initiated Outages and (b) Other than Element-Initiated Outages for Sustained Outages by Voltage Class, and similar tables display the this data for Momentary Outages. These tables also compute metrics on a per Element basis, such as SOF. As described above, confidential performance data for a specific Voltage Class is displayed as a “C.” However, since these tables also compute per Element metrics for “All Voltages,” the “All Voltages” calculations would be incorrect if confidential performance data in a Voltage Class are excluded while non-confidential associated inventory data are included. Therefore, an “NC” has been displayed in the inventory data to ensure the correctness of the computations.⁹
 6. If a cell is not supposed to contain data, a grayed pattern is inserted in that cell. For example, Circuit Miles are not applicable to Transformers.

1.7 Feedback and Comments

Readers may submit comments and feedback to tadscomments@nerc.net at any time. At present, NERC is interested in report content suggestions, such as (i) the way the report is organized (ii) the way data are displayed and (iii) the type of data that should be reported. If changes are requested, please describe the benefits of each suggested change. NERC will use this feedback to develop and improve future reports.

⁹ The Excel “SUM” function treats text such as “C” or “NC” as a zero.

Table NERC 1-1
TADS Report Tables and Figure Guide – NERC Report

Tables omitted because they have no data, contain confidential TO data, or have no reported outages are shaded as follows:

Section No. and Name	Table Title	Table No.	Figure No.
1. Introduction	TADS Report Tables and Figures Guide	NERC 1-1	
	Categories Displayed in Report Tables and Figures with Performance Data	NERC 1-2	
2. Summary NERC Metrics and Data	Inventory of AC Transmission Equipment	NERC 2-1	
	Inventory of DC Transmission Equipment	NERC 2-2	
	AC Circuit Outage Frequency by Outage Initiation Code		NERC 2-1
	AC Circuit Outage Duration by Outage Initiation Code		NERC 2-2
	DC Circuit Outage Frequency by Outage Initiation Code		NERC 2-3
	DC Circuit Outage Duration by Outage Initiation Code		NERC 2-4
	Transformer Outage Frequency by Outage Initiation Code		NERC 2-5
	Transformer Outage Duration by Outage Initiation Code		NERC 2-6
	AC/DC BTB Converter Outage Frequency by Outage Initiation Code		NERC 2-7
	AC/DC BTB Converter Outage Duration by Outage Initiation Code		NERC 2-8
	Event Types and Outages	NERC 2-3	
	3.1 AC Circuit Metrics and Data	AC Circuit Sustained Outage – Element-Initiated Only	NERC 3.1-1
AC Circuit Sustained Outage Metrics – Other than “Element-Initiated”		NERC 3.1-2	
AC Circuit Sustained Outages by Cause Code		NERC 3.1-3	
AC Circuit Sustained Outages – Other Attributes		NERC 3.1-4	
AC Circuit Momentary Outage Metrics – Element-Initiated Only		NERC 3.1-5	
AC Circuit Momentary Outage Metrics – Other than “Element-Initiated”		NERC 3.1-6	
AC Circuit Momentary Outages by Cause Code		NERC 3.1-7	
AC Circuit Momentary Outages – Other Attributes		NERC 3.1-8	
AC Circuit Metrics 1-16 per Appendix 2		NERC 3.1-9	
3.2 DC Circuit Metrics and Data	DC Circuit Sustained Outage Metrics and Data – Element-Initiated Only	NERC 3.2-1	
	DC Circuit Sustained Outage Metrics – Other than “Element-Initiated”	NERC 3.2-2	
	DC Circuit Sustained Outages by Cause Code	NERC 3.2-3	
	DC Circuit Sustained Outages – Other Attributes	NERC 3.2-4	
	DC Circuit Momentary Outage Metrics – Element-Initiated Only	NERC 3.2-5	
	DC Circuit Momentary Outage Metrics – Other than “Element-Initiated”	NERC 3.2-6	
	DC Circuit Momentary Outages by Cause Code	NERC 3.2-7	
	DC Circuit Momentary Outages – Other Attributes	NERC 3.2-8	
	DC Circuit Metrics 1-16 per Appendix 2	NERC 3.2-9	

Table NERC 1-1 (cont'd)

3.3 Transformer Metrics and Data	Transformer Sustained Outage Metrics – Element-Initiated Only	NERC 3.3-1	
	Transformer Sustained Outage Metrics – Other than “Element-Initiated”	NERC 3.3-2	
	Transformer Sustained Outages by Cause Code	NERC 3.3-3	
	Transformer Sustained Outages – Other Attributes	NERC 3.3-4	
	Transformer Momentary Outage Metrics – Element-Initiated Only	NERC 3.3-5	
	Transformer Momentary Outage Metrics – Other than “Element-Initiated”	NERC 3.3-6	
	Transformer Momentary Outages by Cause Code	NERC 3.3-7	
	Transformer Momentary Outages – Other Attributes	NERC 3.3-8	
	Transformer Metrics 1-10 per Appendix 2	NERC 3.3-9	
3.4 AC/DC BTB Converter Metrics and Data	AC/DC BTB Converter Sustained Outage Metrics – Element-Initiated Only	NERC 3.4-1	
	AC/DC BTB Converter Sustained Outage Metrics – Other than “Element-Initiated”	NERC 3.4-2	
	AC/DC BTB Converter Sustained Outages by Cause Code	NERC 3.4-3	
	AC/DC BTB Converter Sustained Outages – Other Attributes	NERC 3.4-4	
	AC/DC BTB Converter Momentary Outage Metrics – Element-Initiated Only	NERC 3.4-5	
	AC/DC BTB Converter Momentary Outage Metrics – Other than “Element-Initiated”	NERC 3.4-6	
	AC/DC BTB Converter Momentary Outages by Cause Code	NERC 3.4-7	
	AC/DC BTB Converter Momentary Outages – Other Attributes	NERC 3.4-8	
	AC/DC BTB Converter Metrics 1-10 per Appendix 2	NERC 3.4-9	

Tables omitted because they have no data, contain confidential TO data, or have no reported outages are shaded as follows:

Table NERC 1-2
Categories Displayed in Report Tables and Figures with Performance Data
Based upon the NERC Inventory¹⁰

No categories of this type exist within NERC

Category	Voltage Class	Construction type (Overhead or Underground)	
		OH	UG
AC Circuit	200-299 kV	OH	UG
	300-399 kV	OH	UG
	400-599 kV	OH	UG
	600-799 kV	OH	UG
AC Multi-Circuit Structure Miles	200-299 kV		
	300-399 kV		
	400-599 kV		
	600-799 kV		
	Mixed Voltages		
DC Circuit	200-299 kV	OH	UG
	300-399 kV	OH	UG
	400-499 kV	OH	UG
	500-599 kV	OH	UG
	600-799 kV	OH	UG
DC Multi-Circuit Structure Miles	200-299 kV		
	300-399 kV		
	400-499 kV		
	500-599 kV		
	600-799 kV		
	Mixed Voltages		
Transformers	200-299 kV		
	300-399 kV		
	400-599 kV		
	600-799 kV		
AC/DC BTB Converters	200-299 kV		
	300-399 kV		
	400-599 kV		
	600-799 kV		

¹⁰ For performance tables and figures, only the categories above are shown. As noted in Section 1.6.2, Tables 2-1 and 2-2 have inventory data for all the Voltage Classes.

2 NERC Metrics and Data Summary

This section reports overall Element inventory data as well as two measures of Element performance - outage frequency for both Sustained and Momentary Outage Frequency (SOF and MOF) and Sustained Outage Duration Time (SODT) – on a per Element basis. The number of Elements shown in the inventory data was used to compute the “per Element” frequency and duration metrics. The figures showing frequency and duration metrics have a different scale for each Element. The scale was dictated by the Element’s data. Finally, the report provides the number and percentage of Events for each Event Type.

2.1 Element Inventory Data

The inventory data, summarized in two tables, NERC 2-1 and NERC 2-2 shows the average Element inventory for calendar year 2008 for AC transmission equipment and DC transmission equipment respectively. All Voltage Classes available for collection are included in these tables. Because TADS uses an equivalent (or average) inventory, the number of reported Elements will generally not be a whole number. As an example, an AC Circuit that is added in the middle of a reporting period will be shown as 0.5 of an AC Circuit in the inventory. This accurately reflects the exposure of Elements to outages.

2.2 Element Outage Frequency and Duration Metrics

Two figures for each TADS Element (AC Circuits, DC Circuits, Transformers, and AC/DC Back-to-Back Converters) are shown in this section.

- The first figure shows the Sustained Outage and Momentary Outage Frequency (SOF and MOF) by Outage Initiation Code.
- The second figure shows the Sustained Outage Duration Time per Element (SODT) by Outage Initiation Code.

**Table NERC 2-1
Inventory of AC Transmission Equipment**

Name	200-299 kV		300-399 kV		400-599 kV		600-799 kV		Mixed Voltages		All Voltages	
	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles
AC Circuit - All	4486.9	103942	1710.7	57228	610.5	33321	111	9451			6919.1	203942
Overhead	4380.2	103438	1645.3	56774	608.5	33236	111	9451			6745	202900
Underground	106.7	503	65.4	453	2	85	0	0			174.1	1042
AC Multi-Circuit Structure Miles*		14841		8807		3989		0		703		28340
Transformer	33.9		165		425.6		92				716.5	

* The data shown for AC Multi-Circuit Structure Miles is Multi-Circuit Structure Miles, not Circuit Miles.

**Table NERC 2-2
Inventory of DC Transmission Equipment**

Name	200-299 kV		300-399 kV		400-499 kV		500-599 kV		600-799 kV		All Voltages	
	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles	Equiv. No. Elements	Circuit Miles
DC Circuit - All	2	930	0	0	8	2920	10	5438	0	0	20	9289
Overhead	2	930	0	0	6	2917	10	5438	0	0	18	9285
Underground	0	0	0	0	2	3	0	0	0	0	2	3
DC Multi-Circuit Structure Miles*		465		0		1459		2719		0		4643
AC/DC BTB Converters**	10.3		6		0				0		16.3	

* The data shown for DC Multi-Circuit Structure Miles is Multi-Circuit Structure Miles, not Circuit Miles.

** AC/DC BTB Converter Voltage Classes are the highest AC Voltage Class of the two AC voltages on either side of the converter.

Figure NERC 2-1
AC Circuit Outage Frequency by Outage Initiation Code

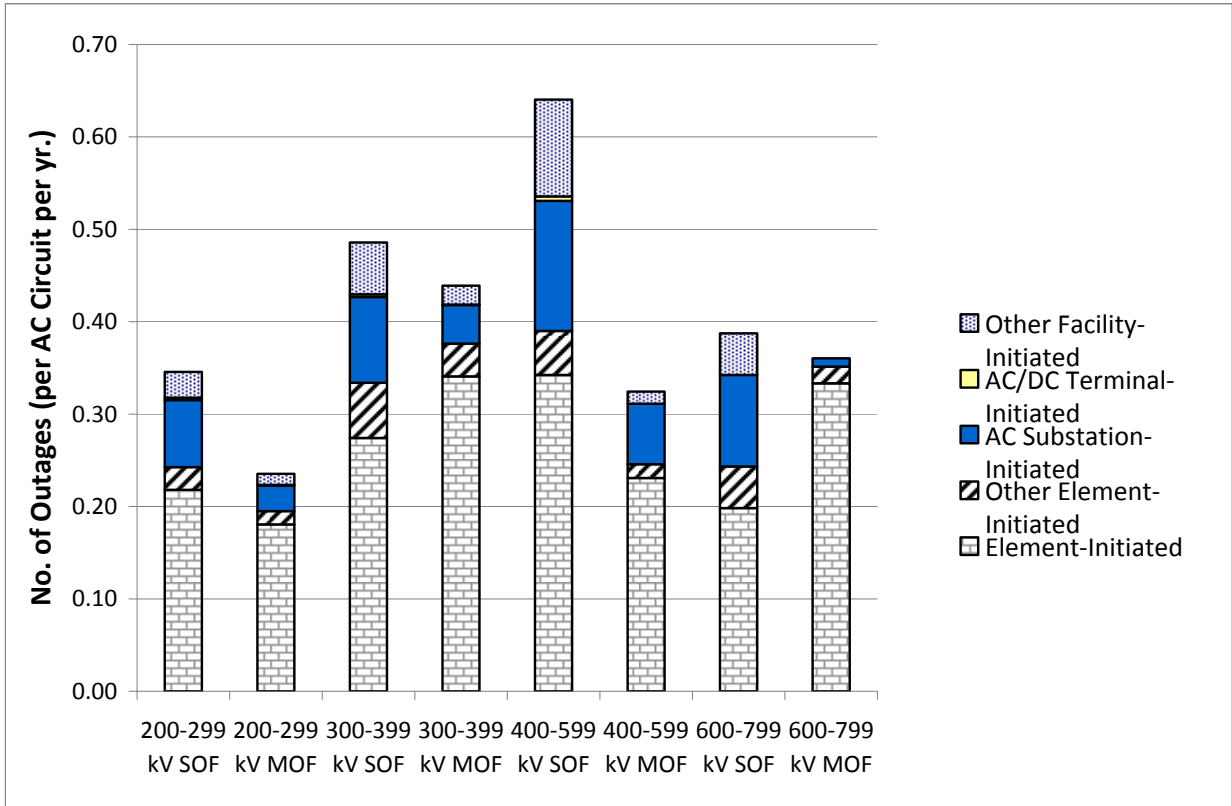


Figure NERC 2-2
AC Circuit Outage Duration by Outage Initiation Code

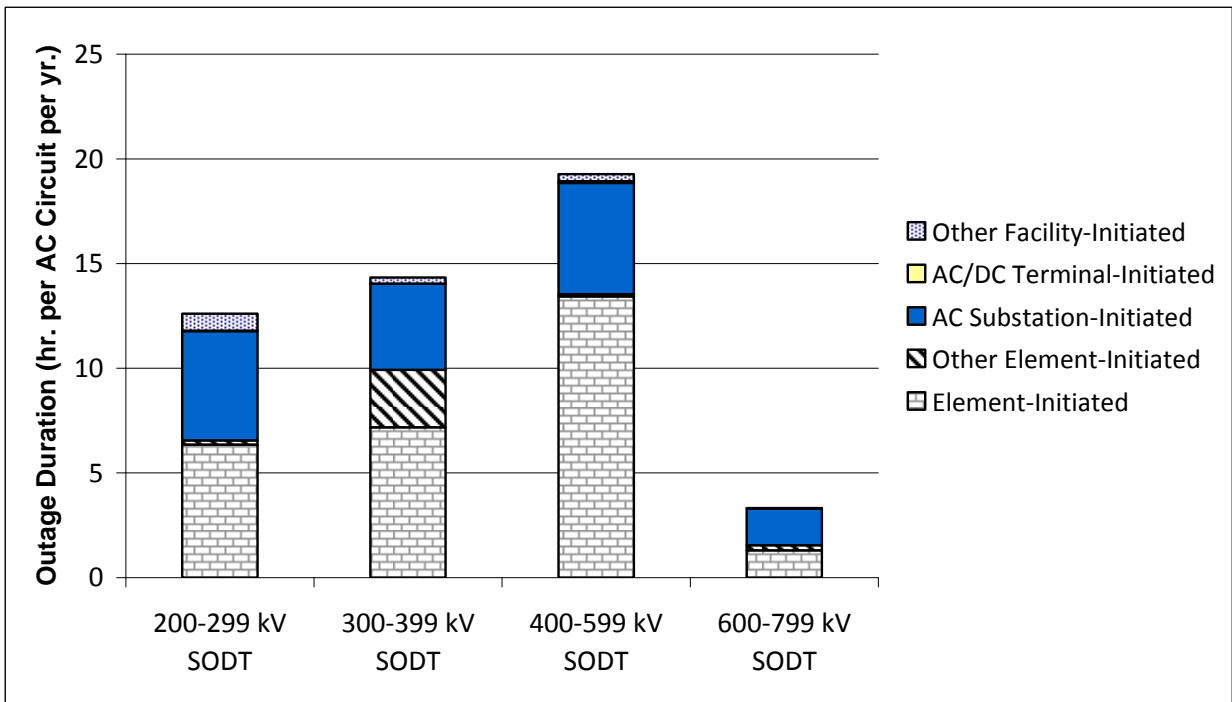


Figure NERC 2-3
DC Circuit Outage Frequency by Outage Initiation Code

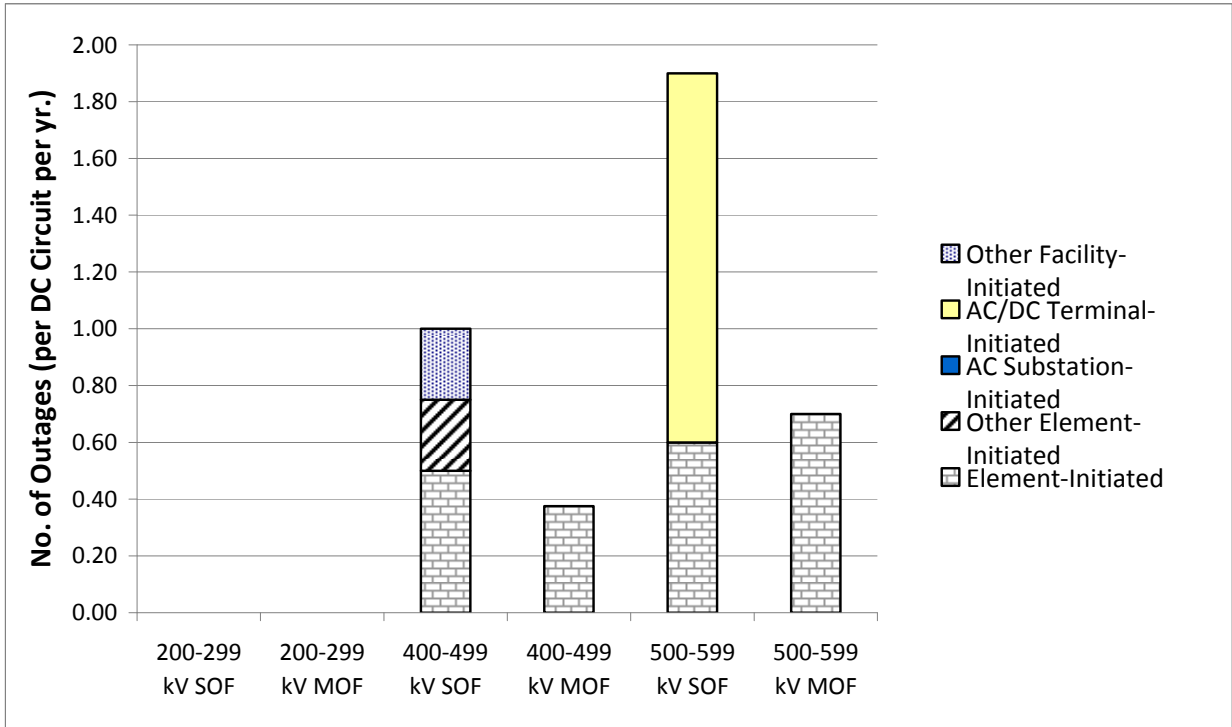
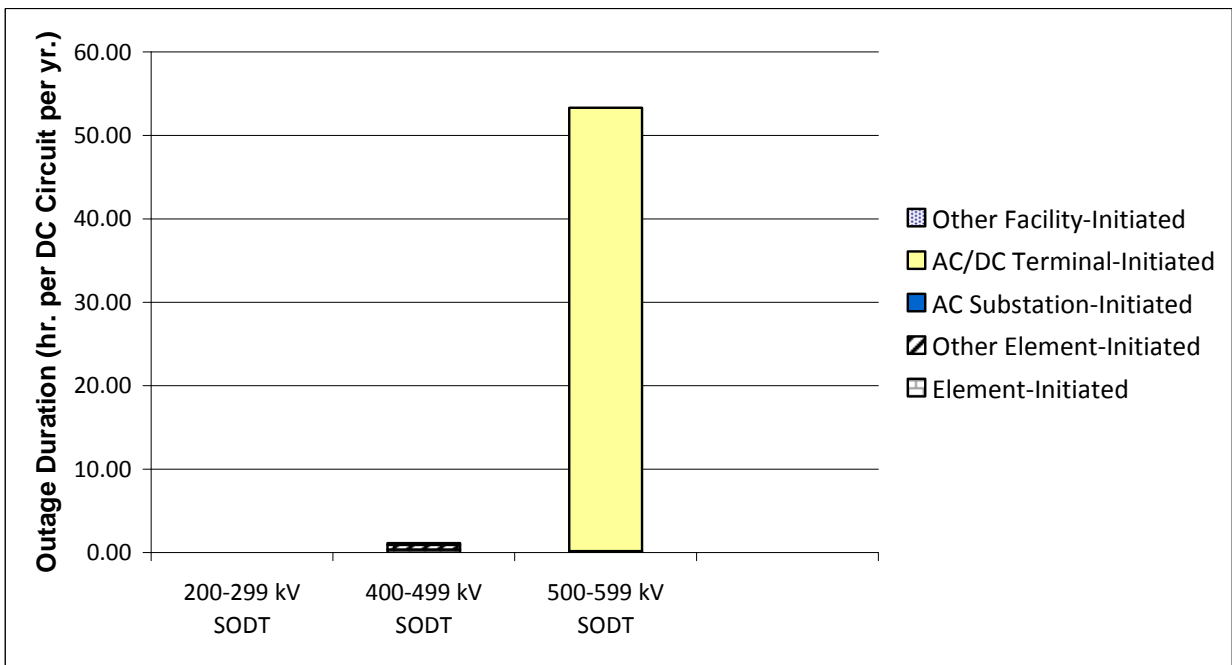
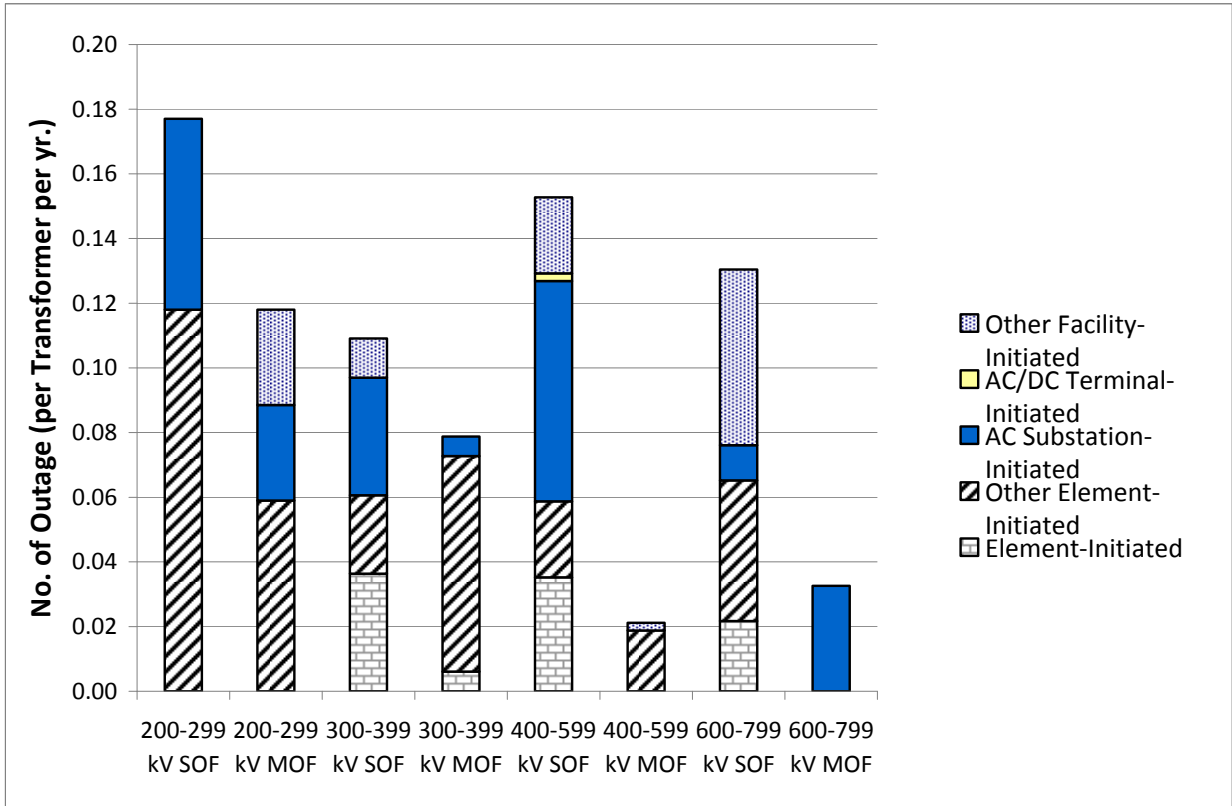


Figure NERC 2-4
DC Circuit Outage Duration by Outage Initiation Code



**Figure NERC 2-5
Transformer Outage Frequency by Outage Initiation Code**



**Figure NERC 2-6
Transformer Outage Duration by Outage Initiation**

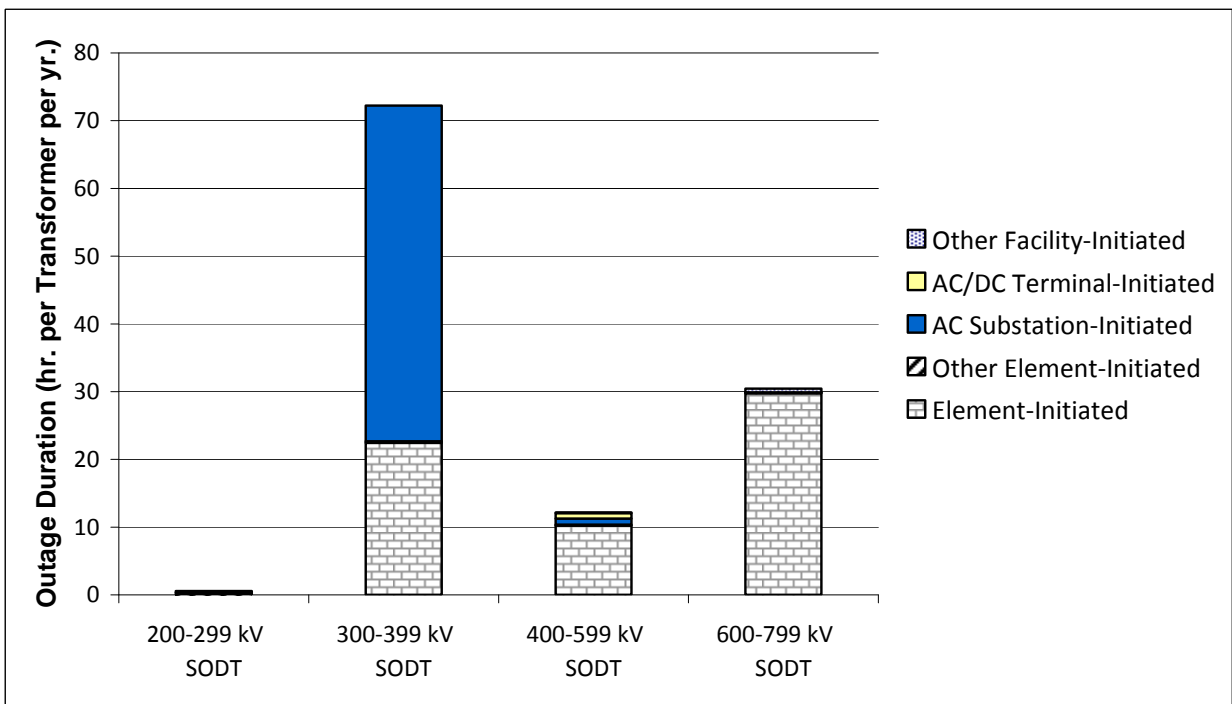


Figure NERC 2-7
AC/DC BTB Converter Outage Frequency by Outage Initiation Code

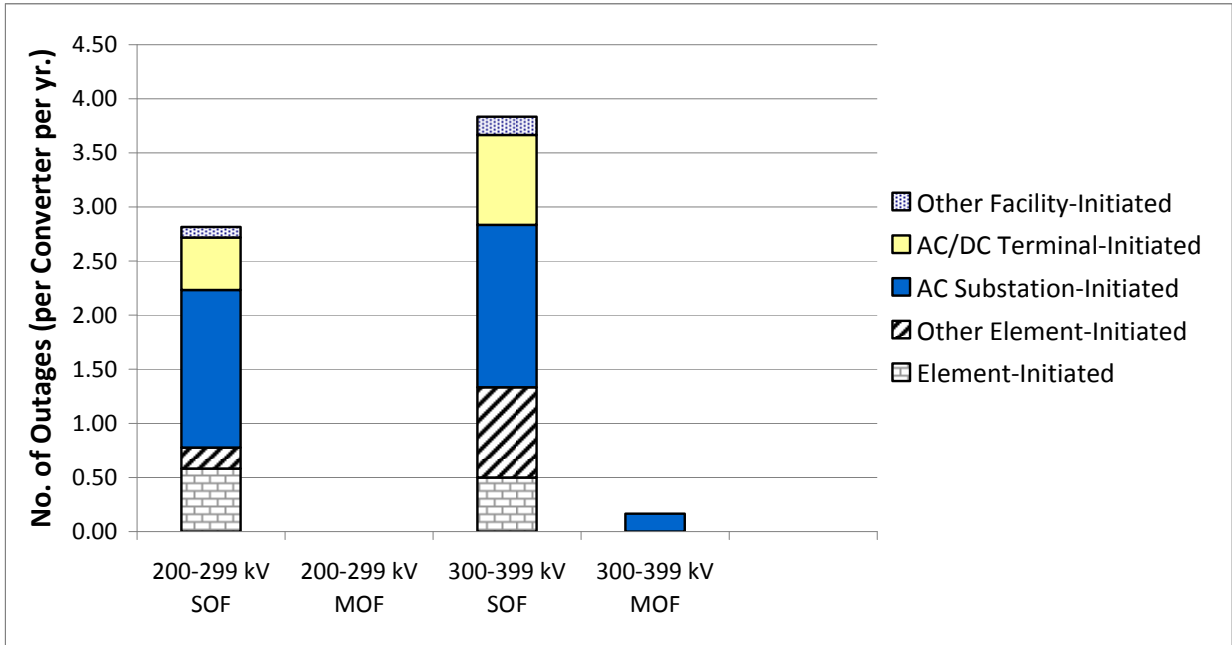
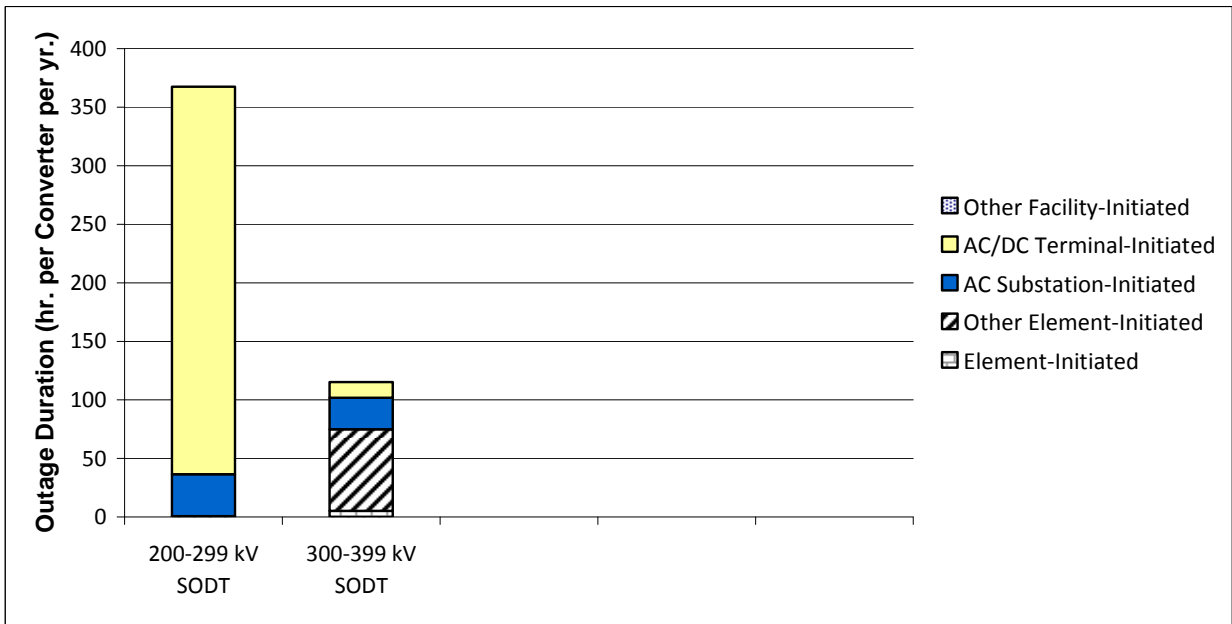


Figure NERC 2-8
AC/DC BTB Converter Outage Duration by Outage Initiation Code



2.3 Event Types

Event Type data, shown in Table NERC 2-3 below, provides the number and percentage of Events by Event Type as well as the number of outages associated with each Event. See the Event Type 10, 20, 30, 40, and 50 descriptions below.

Each Element outage, Sustained and Momentary, is assigned an Event Type. An Event may contain any number of Sustained and/or Momentary Outages and may include an outage from any type of Element; i.e. AC Circuit, DC Circuit, Transformer, or AC/DC BTB Converter. However, as defined, Event Types 10 and 20 involve only one Element outage, with Event Type 10 involving only an AC Circuit or a Transformer, and Event Type 20 involving a DC Circuit. Event Types 30 and 40 involve two AC Circuit and DC Circuit outages, respectively. Event Type 50 includes all other single or multiple outages not included elsewhere.

The Event Type data below has none of the confidential data exclusions described in Section 1.5. There are two reasons that the exclusions were not applied. First, no TO-specific performance data can be discerned. Second, because Event Types data are intended to include outages of more than one Element, it was not possible to delete confidential TO data without distorting the Event Type data.

**Table NERC 2-3
Event Types and Outages**

Event Type	Events		Outages	
	# Events	%	# Outages	%
10	3493	75.8%	3493	68.2%
20	67	1.5%	67	1.3%
30	101	2.2%	217	4.2%
40	2	0.0%	5	0.1%
50	943	20.5%	1342	26.2%
TOTAL	4606	100.0%	5124	100.0%

Event Type	Description
10	Automatic Outage of an AC Circuit or Transformer with Normal Clearing.
20	Automatic Outage of a DC Circuit with Normal Clearing.
30	Automatic Outage of two ADJACENT AC Circuits on common structures with Normal Clearing.
40	Automatic Outage of two ADJACENT DC Circuits on the common structures with Normal Clearing.
50	Other

3 NERC Metrics and Data Details

3.1 AC Circuit Metrics and Data

AC Circuit metrics are displayed in three sections: Section 3.1.1 addresses Sustained Outages and Section 3.1.2 addresses Momentary Outages. In all cases, the metrics displayed in these two sections include *all* AC Circuits (Overhead and Underground). Additionally, Section 3.1.3 has AC Circuit metrics that are differentiated into Overhead and Underground categories. Data and metrics are displayed for the four AC Voltage Classes in the NERC template plus the total of all Voltages Classes.

3.1.1 AC Circuit Sustained Outages

3.1.1.1 AC Circuit Sustained Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage was initiated.

- Table NERC 3.1-1 shows metrics for AC Circuit Sustained Outages that were “Element-Initiated,” which means the outages were initiated on or within the Element (AC Circuit in this case) being reported. Since these types of failures are directly linked to circuit exposure measured in Circuit Miles, this table provide a frequency calculation on a per 100 Circuit Miles (CM) basis.
- Table NERC 3.1-2 shows the metrics for AC Circuit Sustained Outages that were initiated by all other Outage Initiation Codes *except* those that were Element-Initiated. These included outages that were initiated on or within an AC Substation, an AC/DC Terminal, another TADS Element (Other-Element Initiated), or by Other Facilities.

**Table NERC 3.1-1
AC Circuit Sustained Outage Metrics - Element-Initiated Only**

Voltage Class	Circuit Miles	No. of Circuits	No. of Outages	Total Outage Time (hr)	Frequency (SCOF) (per 100 CM per yr)	Frequency (SOF) (per circuit per yr)	MTTR or Mean Outage Duration (hr)
200-299 kV	103942	4486.9	978	28523.1	0.9409	0.2180	29.2
300-399 kV	57228	1710.7	469	12289.9	0.8195	0.2742	26.2
400-599 kV	33321	610.5	209	8198.5	0.6272	0.3423	39.2
600-799 kV	9451	111.0	22	145.0	0.2328	0.1982	6.6
All Voltages	203942	6919.1	1678	49156.5	0.8228	0.2425	29.3

**Table NERC 3.1-2
AC Circuit Sustained Outage Metrics - Other than "Element-Initiated"**

Voltage Class	No. of Circuits	No. of Outages	Total Outage Time (hr)	Frequency (SOF) (per circuit per yr)	MTTR or Mean Outage Duration (hr)
200-299 kV	4486.9	573	28032.9	0.1277	48.9
300-399 kV	1710.7	362	12242.3	0.2116	33.8
400-599 kV	610.5	182	3568.1	0.2981	19.6
600-799 kV	111.0	21	224.4	0.1892	10.7
All Voltages	6919.1	1138	44067.7	0.1645	38.7

3.1.1.2 AC Circuit Sustained Outage Cause Code Data

For Sustained Outages, TADS requests two Cause Codes – an Initiating Cause Code that describes the initiating cause and a Sustained Cause Code that describes the cause that contributes to the longest duration. For 2008, TADS asked TOs to provide both if they are available, but if not, to supply one or the other. TADS has a Cause Code (Unavailable) that TOs can use if they do not have one of these two Cause Codes available. Table NERC 3.1-3 shows the two Outage Cause Codes (Initiating and Sustained) plus the number of outage hours associated with each Cause Code.

Table NERC 3.1-3 (p. 1 of 3)
AC Circuit Sustained Outages by Cause Code

Outage Cause Code	200-299 kV						300-399 kV					
	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	300	19.3%	189	12.2%	10648.2	18.8%	150	18.1%	99	11.9%	1997.5	8.1%
Lightning	147	9.5%	72	4.6%	145.8	0.3%	116	14.0%	67	8.1%	246.0	1.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Contamination	16	1.0%	5	0.3%	51.5	0.1%	14	1.7%	12	1.4%	28.1	0.1%
Foreign Interference	73	4.7%	58	3.7%	391.0	0.7%	15	1.8%	15	1.8%	145.8	0.6%
Fire	79	5.1%	69	4.4%	5977.9	10.6%	16	1.9%	10	1.2%	23.9	0.1%
Vandalism, Terrorism, or Malicious Acts	6	0.4%	3	0.2%	64.5	0.1%	2	0.2%	2	0.2%	12.0	0.0%
Failed AC Substation Equipment	151	9.7%	127	8.2%	13067.9	23.1%	72	8.7%	85	10.2%	2096.6	8.5%
Failed AC/DC Terminal Equipment	2	0.1%	2	0.1%	164.2	0.3%	2	0.2%	2	0.2%	2.8	0.0%
Failed Protection System Equipment	97	6.3%	89	5.7%	874.3	1.5%	56	6.7%	55	6.6%	333.1	1.4%
Failed AC Circuit Equipment	169	10.9%	194	12.5%	11233.0	19.9%	70	8.4%	111	13.4%	7747.2	31.6%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	39	2.5%	38	2.5%	1008.4	1.8%	5	0.6%	5	0.6%	140.1	0.6%
Power System Condition	52	3.4%	58	3.7%	181.4	0.3%	29	3.5%	33	4.0%	115.8	0.5%
Human Error	151	9.7%	107	6.9%	166.7	0.3%	75	9.0%	64	7.7%	1663.1	6.8%
Unknown	217	14.0%	238	15.3%	2142.8	3.8%	153	18.4%	149	17.9%	187.5	0.8%
Other	52	3.4%	127	8.2%	1050.6	1.9%	49	5.9%	95	11.4%	9543.8	38.9%
Unavailable	0	0.0%	175	11.3%	9387.9	16.6%	7	0.8%	27	3.2%	249.1	1.0%
TOTAL	1551	100.0%	1551	100.0%	56556.0	100.0%	831	100.0%	831	100.0%	24532.2	100.0%

Table NERC 3.1-3 (p. 2 of 3)
AC Circuit Sustained Outages by Cause Code

Outage Cause Code	400-599 kV						600-799 kV					
	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	68	17.4%	42	10.7%	3316.4	28.2%	9	20.9%	9	20.9%	90.1	24.4%
Lightning	27	6.9%	11	2.8%	6.7	0.1%	6	14.0%	6	14.0%	4.1	1.1%
Environmental	1	0.3%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Contamination	27	6.9%	18	4.6%	387.7	3.3%	0	0.0%	0	0.0%	0.0	0.0%
Foreign Interference	9	2.3%	6	1.5%	156.6	1.3%	0	0.0%	0	0.0%	0.0	0.0%
Fire	25	6.4%	16	4.1%	28.7	0.2%	0	0.0%	0	0.0%	0.0	0.0%
Vandalism, Terrorism, or Malicious Acts	4	1.0%	3	0.8%	66.5	0.6%	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	51	13.0%	29	7.4%	363.2	3.1%	11	25.6%	12	27.9%	219.1	59.3%
Failed AC/DC Terminal Equipment	1	0.3%	1	0.3%	30.7	0.3%	0	0.0%	0	0.0%	0.0	0.0%
Failed Protection System Equipment	26	6.6%	23	5.9%	37.2	0.3%	6	14.0%	6	14.0%	10.3	2.8%
Failed AC Circuit Equipment	14	3.6%	23	5.9%	3232.0	27.5%	1	2.3%	1	2.3%	37.3	10.1%
Failed DC Circuit Equipment	1	0.3%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	4	1.0%	3	0.8%	23.5	0.2%	0	0.0%	0	0.0%	0.0	0.0%
Power System Condition	23	5.9%	19	4.9%	35.4	0.3%	0	0.0%	0	0.0%	0.0	0.0%
Human Error	57	14.6%	43	11.0%	106.7	0.9%	4	9.3%	4	9.3%	4.8	1.3%
Unknown	49	12.5%	39	10.0%	69.7	0.6%	3	7.0%	2	4.7%	1.0	0.3%
Other	4	1.0%	2	0.5%	10.5	0.1%	3	7.0%	3	7.0%	2.8	0.7%
Unavailable	0	0.0%	113	28.9%	3895.1	33.1%	0	0.0%	0	0.0%	0.0	0.0%
TOTAL	391	100.0%	391	100.0%	11766.6	100.0%	43	100.0%	43	100.0%	369.4	100.0%

Table NERC 3.1-3 (p. 3 of 3)
AC Circuit Sustained Outages by Cause Code

Outage Cause Code	All Voltages					
	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	527	18.7%	339	12.0%	16052.2	17.2%
Lightning	296	10.5%	156	5.5%	402.6	0.4%
Environmental	1	0.0%	0	0.0%	0.0	0.0%
Contamination	57	2.0%	35	1.2%	467.3	0.5%
Foreign Interference	97	3.4%	79	2.8%	693.4	0.7%
Fire	120	4.3%	95	3.4%	6030.4	6.5%
Vandalism, Terrorism, or Malicious Acts	12	0.4%	8	0.3%	143.0	0.2%
Failed AC Substation Equipment	285	10.1%	253	9.0%	15746.7	16.9%
Failed AC/DC Terminal Equipment	5	0.2%	5	0.2%	197.7	0.2%
Failed Protection System Equipment	185	6.6%	173	6.1%	1254.9	1.3%
Failed AC Circuit Equipment	254	9.0%	329	11.7%	22249.5	23.9%
Failed DC Circuit Equipment	1	0.0%	0	0.0%	0.0	0.0%
Vegetation	48	1.7%	46	1.6%	1172.0	1.3%
Power System Condition	104	3.7%	110	3.9%	332.6	0.4%
Human Error	287	10.2%	218	7.7%	1941.3	2.1%
Unknown	422	15.0%	428	15.2%	2400.9	2.6%
Other	108	3.8%	227	8.1%	10607.6	11.4%
Unavailable	7	0.2%	315	11.2%	13532.1	14.5%
TOTAL	2816	100.0%	2816	100.0%	93224.2	100.0%

3.1.1.3 Other AC Circuit Sustained Outage Data

Table NERC 3.1-4 shows other AC Circuit Sustained Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type, and Outage Duration Interval.

Table NERC 3.1-4 (p. 1 of 3)
AC Circuit - Other Sustained Outage Attributes

Fault Type	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
No fault	382	24.6%	2856.4	5.1%	329	39.6%	13309.4	54.3%	138	35.3%	3309.7	28.1%	26	60.5%	302.1	81.8%
P-P fault	126	8.1%	2217.7	3.9%	41	4.9%	412.8	1.7%	29	7.4%	2391.3	20.3%	7	16.3%	1.9	0.5%
Single P-G fault	629	40.6%	37130.7	65.7%	277	33.3%	3537.2	14.4%	158	40.4%	2474.3	21.0%	9	20.9%	65.4	17.7%
P-P-G, 3 P, or 3P-G fault	137	8.8%	9460.3	16.7%	39	4.7%	6086.6	24.8%	21	5.4%	1350.4	11.5%	1	2.3%	0.1	0.0%
Unknown fault type	277	17.9%	4891.0	8.6%	145	17.4%	1186.1	4.8%	45	11.5%	2240.9	19.0%	0	0.0%	0.0	0.0%
TOTAL	1551	100.0%	56556.0	100.0%	831	100.0%	24532.2	100.0%	391	100.0%	11766.6	100.0%	43	100.0%	369.4	100.0%

Outage Initiation Code	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	978	63.1%	28523.1	50.4%	469	56.4%	12289.9	50.1%	209	53.5%	3309.7	28.1%	26	60.5%	302.1	81.8%
Other Element-Initiated	111	7.2%	889.1	1.6%	102	12.3%	4686.6	19.1%	29	7.4%	2391.3	20.3%	7	16.3%	1.9	0.5%
AC Substation-Initiated	325	21.0%	23408.3	41.4%	159	19.1%	7030.6	28.7%	86	22.0%	2474.3	21.0%	9	20.9%	65.4	17.7%
AC/DC Terminal-Initiated	12	0.8%	138.0	0.2%	5	0.6%	26.0	0.1%	3	0.8%	1350.4	11.5%	1	2.3%	0.1	0.0%
Other Facility-Initiated	125	8.1%	3597.6	6.4%	96	11.6%	499.1	2.0%	64	16.4%	2240.9	19.0%	0	0.0%	0.0	0.0%
TOTAL	1551	100.0%	56556.0	100.0%	831	100.0%	24532.2	100.0%	391	100.0%	11766.6	100.0%	43	100.0%	369.4	100.0%

Outage Mode Code	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Single Mode	1127	72.7%	46117.9	81.5%	568	68.4%	12289.9	50.1%	278	71.1%	7631.4	64.9%	22	51.2%	145.0	39.3%
Dependent Mode Initiating	58	3.7%	1426.5	2.5%	85	10.2%	4686.6	19.1%	21	5.4%	208.3	1.8%	5	11.6%	27.5	7.4%
Dependent Mode	157	10.1%	4837.7	8.6%	101	12.2%	7030.6	28.7%	43	11.0%	2853.2	24.2%	11	25.6%	193.1	52.3%
Common Mode	204	13.2%	3238.0	5.7%	72	8.7%	26.0	0.1%	46	11.8%	1067.9	9.1%	0	0.0%	0.0	0.0%
Common Mode Initiating	5	0.3%	936.0	1.7%	5	0.6%	499.1	2.0%	3	0.8%	5.8	0.0%	5	11.6%	3.9	1.0%
TOTAL	1551	100.0%	56556.0	100.0%	831	100.0%	24532.2	100.0%	391	100.0%	11766.6	100.0%	43	100.0%	369.4	100.0%

Table NERC 3.1-4 (p. 2 of 3)
AC Circuit – Other Sustained Outage Attributes

Event Type	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
10	974	62.8%	38001.5	67.2%	531	63.9%	5986.3	24.4%	242	61.9%	2548.2	21.7%	14	32.6%	104.2	28.2%
30	92	5.9%	1158.0	2.0%	49	5.9%	3697.3	15.1%	28	7.2%	108.8	0.9%	1	2.3%	0.1	0.0%
50	485	31.3%	17396.5	30.8%	251	30.2%	14848.6	60.5%	121	30.9%	9109.6	77.4%	28	65.1%	265.2	71.8%
TOTAL	1551	100.0%	56556.0	100.0%	831	100.0%	24532.2	100.0%	391	100.0%	11766.6	100.0%	43	100.0%	369.4	100.0%

Outage Duration Interval	200-299 kV		300-399 kV		400-599 kV		600-799 kV	
	No. Sust.	%	No. Sust.	%	No. Sust.	%	No. Sust.	%
1-5 Minutes	371	23.9%	210	25.3%	108	27.6%	7	16.3%
6-10 Minutes	126	8.1%	65	7.8%	43	11.0%	1	2.3%
11-30 Minutes	166	10.7%	90	10.8%	44	11.3%	7	16.3%
31-120 Minutes	210	13.5%	111	13.4%	58	14.8%	13	30.2%
> 120 Minutes	678	43.7%	355	42.7%	138	35.3%	15	34.9%
TOTAL	1551	100.0%	831	100.0%	391	100.0%	43	100.0%

Table NERC 3.1-4 (p. 3 of 3)
AC Circuit - Other Sustained Outage Attributes

Fault Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
No fault	875	31.1%	19777.6	21.2%
P-P fault	203	7.2%	5023.7	5.4%
Single P-G fault	1073	38.1%	43207.5	46.3%
P-P-G, 3 P, or 3P-G fault	198	7.0%	16897.4	18.1%
Unknown fault type	467	16.6%	8318.0	8.9%
TOTAL	2816	100.0%	93224.2	100.0%

Outage Initiation Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	1682	59.7%	44424.8	47.7%
Other Element-Initiated	249	8.8%	7968.9	8.5%
AC Substation-Initiated	579	20.6%	32978.5	35.4%
AC/DC Terminal-Initiated	21	0.7%	1514.5	1.6%
Other Facility-Initiated	285	10.1%	6337.6	6.8%
TOTAL	2816	100.0%	93224.2	100.0%

Outage Mode Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Single Mode	1995	70.8%	66184.2	71.0%
Dependent Mode Initiating	169	6.0%	6348.9	6.8%
Dependent Mode	312	11.1%	14914.5	16.0%
Common Mode	322	11.4%	4331.9	4.6%
Common Mode Initiating	18	0.6%	1444.7	1.5%
TOTAL	2816	100.0%	93224.2	100.0%

Event Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
10	1761	62.5%	46640.2	50.0%
30	170	6.0%	4964.1	5.3%
50	885	31.4%	41619.9	44.6%
TOTAL	2816	100.0%	93224.2	100.0%

Outage Duration Interval	All Voltages	
	No. Sust.	%
1-5 Minutes	696	24.7%
6-10 Minutes	235	8.3%
11-30 Minutes	307	10.9%
31-120 Minutes	392	13.9%
> 120 Minutes	1186	42.1%
TOTAL	2816	100.0%

3.1.2 AC Circuit Momentary Outages

3.1.2.1 AC Circuit Momentary Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage was initiated.

- Table NERC 3.1-5 shows metrics for AC Circuit Momentary Outages that were “Element-Initiated,” which means the outages were initiated on or within the Element (AC Circuit in this case) being reported. Since these types of failures are directly linked to circuit exposure measured in Circuit Miles, this table provides a frequency calculation on a per 100 Circuit Miles (CM) basis.
- Table NERC 3.1-6 shows the metrics for AC Circuit Momentary Outages that were initiated by all other Outage Initiation Codes *except* those that were Element-Initiated. These included outages that were initiated on or within an AC Substation, an AC/DC Terminal, another TADS Element (Other-Element Initiated), or by Other Facilities.

**Table NERC 3.1-5
AC Circuit Momentary Outage Metrics - Element-Initiated Only**

Voltage Class	Circuit Miles	No. of Circuits	No. of Outages	Frequency (MCOF) (per 100 CM per yr)	Frequency (MOF) (per circuit per yr)
200-299 kV	103942	4486.9	810	0.7793	0.1805
300-399 kV	57228	1710.7	583	1.0187	0.3408
400-599 kV	33321	610.5	141	0.4232	0.2310
600-799 kV	9451	111.0	37	0.3915	0.3333
All Voltages	203942	6919.1	1571	0.7703	0.2271

**Table NERC 3.1-6
AC Circuit Sustained Outage Metrics -
Other than "Element-Initiated"**

Voltage Class	No. of Circuits	No. of Outages	Frequency (MOF) (per circuit per yr)
200-299 kV	4486.9	246	0.0548
300-399 kV	1710.7	168	0.0982
400-599 kV	610.5	57	0.0934
600-799 kV	111.0	3	0.0270
All Voltages	6919.1	474	0.0685

3.1.2.2 AC Circuit Momentary Outage Cause Code Data

For Momentary Outages, TADS requests one Cause Code: an Initiating Cause Code. Table NERC 3.1-7 reports Cause Code data for AC Circuit Momentary Outages.

**Table NERC 3.1-7
AC Circuit Momentary Outages by Cause Code**

Outage Cause Code	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Weather, excluding lightning	93	8.8%	73	9.7%	7	3.5%	3	7.5%	176	8.6%
Lightning	381	36.1%	244	32.5%	60	30.3%	22	55.0%	707	34.6%
Environmental	1	0.1%	0	0.0%	0	0.0%	0	0.0%	1	0.0%
Contamination	17	1.6%	22	2.9%	7	3.5%	0	0.0%	46	2.2%
Foreign Interference	65	6.2%	25	3.3%	2	1.0%	0	0.0%	92	4.5%
Fire	15	1.4%	5	0.7%	11	5.6%	0	0.0%	31	1.5%
Vandalism, Terrorism, or Malicious Acts	4	0.4%	0	0.0%	0	0.0%	0	0.0%	4	0.2%
Failed AC Substation Equipment	35	3.3%	17	2.3%	3	1.5%	2	5.0%	57	2.8%
Failed AC/DC Terminal Equipment	0	0.0%	1	0.1%	0	0.0%	0	0.0%	1	0.0%
Failed Protection System Equipment	69	6.5%	56	7.5%	13	6.6%	5	12.5%	143	7.0%
Failed AC Circuit Equipment	47	4.5%	26	3.5%	1	0.5%	0	0.0%	74	3.6%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Vegetation	9	0.9%	4	0.5%	2	1.0%	0	0.0%	15	0.7%
Power System Condition	47	4.5%	2	0.3%	0	0.0%	0	0.0%	49	2.4%
Human Error	37	3.5%	33	4.4%	9	4.5%	0	0.0%	79	3.9%
Unknown	228	21.6%	222	29.6%	83	41.9%	7	17.5%	540	26.4%
Other	8	0.8%	21	2.8%	0	0.0%	1	2.5%	30	1.5%
Unavailable	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
TOTAL	1056	100.0%	751	100.0%	198	100.0%	40	100.0%	2045	100.0%

3.1.2.3 Other AC Circuit Momentary Outage Data

Table NERC 3.1-8 shows other AC Circuit Momentary Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type.

**Table NERC 3.1-8
AC Circuit - Other Momentary Outage Attributes**

Fault Type	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
No fault	182	17.2%	265	35.3%	23	11.6%	28	70.0%	498	24.4%
P-P fault	47	4.5%	19	2.5%	5	2.5%	0	0.0%	71	3.5%
Single P-G fault	601	56.9%	352	46.9%	150	75.8%	12	30.0%	1115	54.5%
P-P-G, 3 P, or 3P-G fault	90	8.5%	12	1.6%	8	4.0%	0	0.0%	110	5.4%
Unknown fault type	136	12.9%	103	13.7%	12	6.1%	0	0.0%	251	12.3%
TOTAL	1056	100.0%	751	100.0%	198	100.0%	40	100.0%	2045	100.0%

Outage Initiation Code	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Element-Initiated	810	76.7%	583	77.6%	141	71.2%	37	92.5%	1571	76.8%
Other Element-Initiated	65	6.2%	61	8.1%	9	4.5%	2	5.0%	137	6.7%
AC Substation-Initiated	124	11.7%	71	9.5%	40	20.2%	1	2.5%	236	11.5%
AC/DC Terminal-Initiated	3	0.3%	1	0.1%	0	0.0%	0	0.0%	4	0.2%
Other Facility-Initiated	54	5.1%	35	4.7%	8	4.0%	0	0.0%	97	4.7%
TOTAL	1056	100.0%	751	100.0%	198	100.0%	40	100.0%	2045	100.0%

Outage Mode Code	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Single Mode	866	82.0%	471	62.7%	173	87.4%	11	27.5%	1521	74.4%
Dependent Mode Initiating	32	3.0%	178	23.7%	8	4.0%	26	65.0%	244	11.9%
Dependent Mode	98	9.3%	51	6.8%	12	6.1%	3	7.5%	164	8.0%
Common Mode	58	5.5%	49	6.5%	5	2.5%	0	0.0%	112	5.5%
Common Mode Initiating	2	0.2%	2	0.3%	0	0.0%	0	0.0%	4	0.2%
TOTAL	1056	100.0%	751	100.0%	198	100.0%	40	100.0%	2045	100.0%

Event Type	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	0	No. Mom.	0	No. Mom.	0	No. Mom.	%	No. Mom.	%
10	931	88.2%	568	75.6%	171	86.4%	26	65.0%	1696	82.9%
30	34	3.2%	9	1.2%	4	2.0%	0	0.0%	47	2.3%
50	91	8.6%	174	23.2%	23	11.6%	14	35.0%	302	14.8%
TOTAL	1056	100.0%	751	100.0%	198	100.0%	40	100.0%	2045	100.0%

3.1.3 Total AC Circuit Metrics

Table NERC 3.1-9 displays AC Circuit metrics that are defined in Appendix 2.

Table NERC 3.1-9
AC Circuit Metrics 1-16 per Appendix 2

Voltage Class	OH/UG	Element Outage Duration, Repair Time, and Update Time (4-7)									Element Availability (8-10)		
		Element Outage Frequency (1-3)			SODT	MTTR	MTTR	MTTR	MdTTR	MTBF	APC %	PCZO %	PCDR %
		TOF	SOF	MOF		P(5%) <	MTTR 50/50	P(5%) >					
200-299 kV	Overhead	0.59	0.35	0.24	11.72	33.56	33.56	33.57	1.18	25113.94	99.87	68.28	6.50
300-399 kV	Overhead	0.94	0.49	0.46	13.77	28.33	28.33	28.33	0.93	18037.1	99.84	59.32	1.35
400-599 kV	Overhead	C	C	C	C	C	C	C	C	C	C	C	C
600-799 kV	Overhead	0.75	0.39	0.36	3.33	8.56	8.59	8.62	1.37	22666.4	99.96	63.06	3.61
200-299 kV	Underground	0.20	0.20	0.00	48.75	244.48	247.70	250.92	2.18	44383.39	99.44	81.08	14.29
300-399 kV	Underground	0.47	0.47	0.00	28.57	59.85	60.27	60.68	2.48	18471.1	99.67	74.24	0.00
400-599 kV	Underground	C	C	C	C	C	C	C	C	C	C	C	C

Voltage Class	OH/UG	Circuit Outage Frequency (11-13)						Multiple Circuit Outage Frequency (14-16)			Outage Totals		
		TCOF		SCOF		MCOF		TMCOF	SMCOF	MMCOF	Momentary Outages	Sustained Outages	Sustained Outages Hours
		All	Elemt. Init.	All	Elemt. Init.	All	Elemt. Init.						
200-299 kV	Overhead	2.50	1.72	1.48	0.94	1.02	0.78	0.85	0.62	0.23	1056	1530	51354.4
300-399 kV	Overhead	2.73	1.85	1.41	0.82	1.32	1.03	0.66	0.56	0.10	751	800	22664.0
400-599 kV	Overhead	C	C	C	C	C	C	0.80	0.70	0.10	C	C	C
600-799 kV	Overhead	0.88	0.62	0.45	0.23	0.42	0.39	-	-	-	40	43	369.4
Mixed Voltages	Overhead							0.00	0.00	0.00			
200-299 kV	Underground	4.17	1.19	4.17	1.19	0.00	0.00				0	21	5201.6
300-399 kV	Underground	6.84	0.66	6.84	0.66	0.00	0.00				0	31	1868.2
400-599 kV	Underground	C	C	C	C	C	C				C	C	C
TOTAL											1847	2425	81457.6

3.2 DC Circuit Metrics and Data

DC Circuit metrics are displayed in three sections: Section 3.2.1 addresses Sustained Outages and Section 3.2.2 addresses Momentary Outages. In all cases, the metrics displayed in these two sections include *all* DC Circuits (Overhead and Underground). Additionally, Section 3.1.3 has DC Circuit metrics that are differentiated into Overhead and Underground categories. Data and metrics are displayed for the three DC Circuit Voltage Classes in the NERC template plus the total of all Voltage Classes.

3.2.1 DC Circuit Sustained Outages

3.2.1.1 DC Circuit Sustained Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

- Table NERC 3.2-1 shows metrics for DC Circuit Sustained Outages that were “Element-Initiated,” which means the outages were initiated on or within the Element (DC Circuit in this case) being reported. Since these types of failures are directly linked to circuit exposure measured in Circuit Miles, this table provide a frequency calculation on a per 100 Circuit Miles (CM) basis.
- Table NERC 3.2-2 shows the metrics for DC Circuit Sustained Outages that were initiated by all other Outage Initiation Codes *except* those that were Element-Initiated. These included outages that were initiated on or within an AC Substation, an AC/DC Terminal, another TADS Element (Other-Element Initiated), or by Other Facilities.

**Table NERC 3.2-1
DC Circuit Sustained Outage Metrics - Element-Initiated Only**

Voltage Class	Circuit Miles	No. of Circuits	No. of Outages	Total Outage Time (hr)	Frequency (SCOF) (per 100 CM per yr)	Frequency (SOF) (per circuit per yr)	MTTR or Mean Outage Duration (hr)
200-299 kV	NC	NC	C	C	C	C	C
400-499 kV	2920	8.0	4	3.03	0.1370	0.5000	0.8
500-599 kV	5438	10.0	6	1.88	0.1103	0.6000	0.3
All Voltages	2920	8.0	4	3.03	0.1370	0.5000	0.8

**Table NERC 3.2-2
DC Circuit Sustained Outage Metrics - Other than "Element-Initiated"**

Voltage Class	No. of Circuits	No. of Outages	Total Outage Time (hr)	Frequency (SOF) (per circuit per yr)	MTTR or Mean Outage Duration (hr)
200-299 kV	NC	C	C	C	C
400-499 kV	8.0	4	6.20	0.5000	1.6
500-599 kV	10.0	13	531.14	1.3000	40.9
All Voltages	8.0	4	6.20	0.5000	1.6

3.2.1.2 DC Circuit Sustained Outage Cause Code Data

For Sustained Outages, TADS requests two Cause Codes – an Initiating Cause Code that describes the initiating cause and a Sustained Cause Code that describes the cause that contributes to the longest duration. For 2008, TADS asked TOs to provide both if they are available, but if not, to supply one or the other. TADS has a Cause Code (Unavailable) that TOs can use if they do not have one of these two Cause Codes available. Table NERC 3.2-3 shows the two Outage Cause Codes (Initiating and Sustained) plus the number of outage hours associated with each Cause Code.

Table NERC 3.2-3 (p. 1 of 2)
DC Circuit Sustained Outages by Cause Code

Outage Cause Code	200-299 kV						400-499 kV					
	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Lightning	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Environmental	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Contamination	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Foreign Interference	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Fire	C	C	C	C	C	C	2	25.0%	2	25.0%	1.3	14.4%
Vandalism, Terrorism, or Malicious Acts	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Failed AC/DC Terminal Equipment	C	C	C	C	C	C	1	12.5%	1	12.5%	1.3	13.5%
Failed Protection System Equipment	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Circuit Equipment	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Failed DC Circuit Equipment	C	C	C	C	C	C	1	12.5%	1	12.5%	1.5	16.0%
Vegetation	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Power System Condition	C	C	C	C	C	C	2	25.0%	2	25.0%	4.4	48.0%
Human Error	C	C	C	C	C	C	1	12.5%	1	12.5%	0.3	3.0%
Unknown	C	C	C	C	C	C	1	12.5%	1	12.5%	0.5	4.9%
Other	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
Unavailable	C	C	C	C	C	C	0	0.0%	0	0.0%	0.0	0.0%
TOTAL	C	C	C	C	C	C	8	100.0%	8	100.0%	9.2	100.0%

Table NERC 3.2-3 (p. 2 of 2)
DC Circuit Sustained Outages by Cause Code

Outage Cause Code	500-599 kV						All Voltages					
	No. Int.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %	No. Int.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	2	10.5%	2	10.5%	0.4	0.1%	2	7.4%	2	7.4%	0.4	0.1%
Lightning	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Contamination	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Foreign Interference	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Fire	3	15.8%	3	15.8%	511.0	95.9%	5	18.5%	5	18.5%	512.3	94.5%
Vandalism, Terrorism, or Malicious Acts	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Failed AC/DC Terminal Equipment	8	42.1%	9	47.4%	16.7	3.1%	9	33.3%	10	37.0%	17.9	3.3%
Failed Protection System Equipment	1	5.3%	1	5.3%	2.8	0.5%	1	3.7%	1	3.7%	2.8	0.5%
Failed AC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Failed DC Circuit Equipment	2	10.5%	2	10.5%	0.6	0.1%	3	11.1%	3	11.1%	2.1	0.4%
Vegetation	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Power System Condition	0	0.0%	0	0.0%	0.0	0.0%	2	7.4%	2	7.4%	4.4	0.8%
Human Error	1	5.3%	1	5.3%	0.1	0.0%	2	7.4%	2	7.4%	0.4	0.1%
Unknown	2	10.5%	0	0.0%	0.0	0.0%	3	11.1%	1	3.7%	0.5	0.1%
Other	0	0.0%	1	5.3%	1.5	0.3%	0	0.0%	1	3.7%	1.5	0.3%
Unavailable	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
TOTAL	19	100.0%	19	100.0%	533.0	100.0%	27	100.0%	27	100.0%	542.3	100.0%

3.2.1.3 Other DC Circuit Sustained Outage Data

Table NERC 3.2-4 shows other DC Circuit Sustained Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type, and Outage Duration Interval.

Table NERC 3.2-4 (p. 1 of 2)
DC Circuit - Other Sustained Outage Attributes

Fault Type	200-299 kV				400-499 kV				500-599 kV				All Voltages			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
No fault	C	C	C	C	6	75.0%	7.9	85.6%	13	68.4%	531.1	99.6%	19	70.4%	539.0	99.4%
P-P fault	C	C	C	C	0	0.0%	0.0	0.0%	1	5.3%	0.4	0.1%	1	3.7%	0.4	0.1%
Single P-G fault	C	C	C	C	1	12.5%	0.8	8.5%	1	5.3%	0.8	0.2%	2	7.4%	1.6	0.3%
P-P-G, 3 P, or 3P-G fault	C	C	C	C	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
Unknown fault type	C	C	C	C	1	12.5%	0.6	6.0%	4	21.1%	0.6	0.1%	5	18.5%	1.2	0.2%
TOTAL	C	C	C	C	8	100.0%	9.2	100.0%	19	100.0%	533.0	100.0%	27	100.0%	542.3	100.0%

Outage Initiation Code	200-299 kV				400-499 kV				500-599 kV				All Voltages			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	C	C	C	C	4	50.0%	3.0	32.8%	6	31.6%	1.9	0.4%	10	37.0%	4.9	0.9%
Other Element-Initiated	C	C	C	C	2	25.0%	4.4	48.0%	0	0.0%	0.0	0.0%	2	7.4%	4.4	0.8%
AC Substation-Initiated	C	C	C	C	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
AC/DC Terminal-Initiated	C	C	C	C	0	0.0%	0.0	0.0%	13	68.4%	531.1	99.6%	13	48.1%	531.1	97.9%
Other Facility-Initiated	C	C	C	C	2	25.0%	1.8	19.2%	0	0.0%	0.0	0.0%	2	7.4%	1.8	0.3%
TOTAL	C	C	C	C	8	100.0%	9.2	100.0%	19	100.0%	533.0	100.0%	27	100.0%	542.3	100.0%

Outage Mode Code	200-299 kV				400-499 kV				500-599 kV				All Voltages			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Single Mode	C	C	C	C	6	75.0%	7.9	85.6%	15	78.9%	21.5	4.0%	21	77.8%	29.4	5.4%
Dependent Mode Initiating	C	C	C	C	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
Dependent Mode	C	C	C	C	0	0.0%	0.0	0.0%	1	5.3%	0.5	0.1%	1	3.7%	0.5	0.1%
Common Mode	C	C	C	C	2	25.0%	1.3	14.4%	3	15.8%	511.0	95.9%	5	18.5%	512.3	94.5%
Common Mode Initiating	C	C	C	C	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
TOTAL	C	C	C	C	8	100.0%	9.2	100.0%	19	100.0%	533.0	100.0%	27	100.0%	542.3	100.0%

Table NERC 3.2-4 (p. 2 of 2)
DC Circuit – Other Sustained Outage Attributes

Event Type	200-299 kV				400-499 kV				500-599 kV				All Voltages			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
20	C	C	C	C	5	62.5%	6.4	69.6%	14	73.7%	18.6	3.5%	19	70.4%	25.1	4.6%
40	C	C	C	C	2	25.0%	1.3	14.4%	3	15.8%	511.0	95.9%	5	18.5%	512.3	94.5%
50	C	C	C	C	1	12.5%	1.5	16.0%	2	10.5%	3.4	0.6%	3	11.1%	4.9	0.9%
TOTAL	C	C	C	C	8	100.0%	9.2	100.0%	19	100.0%	533.0	100.0%	27	100.0%	542.3	100.0%

Outage Duration Interval	200-299 kV		400-499 kV		500-599 kV		All Voltages	
	No. Sust.	%	No. Sust.	%	No. Sust.	%	No. Sust.	%
1-5 Minutes	C	C	0	0.0%	2	10.5%	2	7.4%
6-10 Minutes	C	C	0	0.0%	4	21.1%	4	14.8%
11-30 Minutes	C	C	3	37.5%	2	10.5%	5	18.5%
31-120 Minutes	C	C	4	50.0%	4	21.1%	8	29.6%
> 120 Minutes	C	C	1	12.5%	7	36.8%	8	29.6%
TOTAL	C	C	8	100.0%	19	100.0%	27	100.0%

3.2.2 DC Circuit Momentary Outages

3.2.2.1 DC Circuit Momentary Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

- Table NERC 3.2-5 shows metrics for DC Circuit Momentary Outages that were “Element-Initiated,” which means the outages were initiated on or within the Element (DC Circuit in this case) being reported. Since these types of failures are directly linked to circuit exposure measured in Circuit Miles, this table provides a frequency calculation on a per 100 Circuit Miles (CM) basis.
- Table NERC 3.2-6 shows the metrics for DC Circuit Momentary Outages that were initiated by all other Outage Initiation Codes *except* those that were Element-Initiated. These included outages that were initiated on or within an AC Substation, an AC/DC Terminal, another TADS Element (Other-Element Initiated), or by Other Facilities.

**Table NERC 3.2-5
DC Circuit Momentary Outage Metrics - Element-Initiated Only**

Voltage Class	Circuit Miles	No. of Circuits	No. of Outages	Frequency (MCOF) (per 100 CM per yr)	Frequency (MOF) (per circuit per yr)
200-299 kV	NC	NC	C	C	C
400-499 kV	2920	8.0	3	0.1027	0.3750
500-599 kV	5438	10.0	7	0.1287	0.7000
All Voltages	8359	18	10	0.1196	0.5556

**Table NERC 3.2-6
DC Circuit Momentary Outage Metrics -
Other than "Element-Initiated"**

Voltage Class	No. of Circuits	No. of Outages	Frequency (MOF) (per circuit per yr)
200-299 kV	NC	C	C
400-499 kV	8.0	0	0.0000
500-599 kV	10.0	0	0.0000
All Voltages	18.0	0	0.0000

3.2.2.2 DC Circuit Momentary Outage Cause Code Data

For Momentary Outages, TADS requests one Cause Code: an Initiating Cause Code. Table NERC 3.2-7 reports Cause Code data for DC Circuit Momentary Outages.

**Table NERC 3.2-7
DC Circuit Momentary Outages by Cause Code**

Outage Cause Code	200-299 kV		400-499 kV		500-599 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Weather, excluding lightning	C	C	0	0.0%	0	0.0%	0	0.0%
Lightning	C	C	1	33.3%	0	0.0%	1	10.0%
Environmental	C	C	0	0.0%	0	0.0%	0	0.0%
Contamination	C	C	0	0.0%	0	0.0%	0	0.0%
Foreign Interference	C	C	0	0.0%	0	0.0%	0	0.0%
Fire	C	C	0	0.0%	0	0.0%	0	0.0%
Vandalism, Terrorism, or Malicious Acts	C	C	0	0.0%	0	0.0%	0	0.0%
Failed AC Substation Equipment	C	C	0	0.0%	0	0.0%	0	0.0%
Failed AC/DC Terminal Equipment	C	C	0	0.0%	0	0.0%	0	0.0%
Failed Protection System Equipment	C	C	0	0.0%	0	0.0%	0	0.0%
Failed AC Circuit Equipment	C	C	0	0.0%	0	0.0%	0	0.0%
Failed DC Circuit Equipment	C	C	0	0.0%	0	0.0%	0	0.0%
Vegetation	C	C	0	0.0%	0	0.0%	0	0.0%
Power System Condition	C	C	0	0.0%	0	0.0%	0	0.0%
Human Error	C	C	0	0.0%	0	0.0%	0	0.0%
Unknown	C	C	2	66.7%	7	100.0%	9	90.0%
Other	C	C	0	0.0%	0	0.0%	0	0.0%
Unavailable	C	C	0	0.0%	0	0.0%	0	0.0%
TOTAL	C	C	3	100.0%	7	100.0%	10	100.0%

3.2.2.3 Other DC Circuit Momentary Outage Data

Table NERC 3.2-8 shows other DC Circuit Momentary Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type.

**Table NERC 3.2-8
DC Circuit - Other Momentary Outage Attributes**

Fault Type	200-299 kV		400-499 kV		500-599 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
No fault	C	C	0	0.0%	0	0.0%	0	0.0%
P-P fault	C	C	0	0.0%	0	0.0%	0	0.0%
Single P-G fault	C	C	0	0.0%	0	0.0%	0	0.0%
P-P-G, 3 P, or 3P-G fault	C	C	0	0.0%	0	0.0%	0	0.0%
Unknown fault type	C	C	3	100.0%	7	100.0%	10	100.0%
TOTAL	C	C	3	100.0%	7	100.0%	10	100.0%

Outage Initiation Code	200-299 kV		400-499 kV		500-599 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Element-Initiated	C	C	3	100.0%	7	100.0%	10	100.0%
Other Element-Initiated	C	C	0	0.0%	0	0.0%	0	0.0%
AC Substation-Initiated	C	C	0	0.0%	0	0.0%	0	0.0%
AC/DC Terminal-Initiated	C	C	0	0.0%	0	0.0%	0	0.0%
Other Facility-Initiated	C	C	0	0.0%	0	0.0%	0	0.0%
TOTAL	C	C	3	100.0%	7	100.0%	10	100.0%

Outage Mode Code	200-299 kV		400-499 kV		500-599 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Single Mode	C	C	3	100.0%	7	100.0%	10	100.0%
Dependent Mode Initiating	C	C	0	0.0%	0	0.0%	0	0.0%
Dependent Mode	C	C	0	0.0%	0	0.0%	0	0.0%
Common Mode	C	C	0	0.0%	0	0.0%	0	0.0%
Common Mode Initiating	C	C	0	0.0%	0	0.0%	0	0.0%
TOTAL	C	C	3	100.0%	7	100.0%	10	100.0%

Event Type	200-299 kV		400-499 kV		500-599 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
20	C	C	0	0.0%	7	100.0%	7	70.0%
40	C	C	0	0.0%	0	0.0%	0	0.0%
50	C	C	3	100.0%	0	0.0%	3	30.0%
TOTAL	C	C	3	100.0%	7	100.0%	10	100.0%

3.2.3 Total DC Circuit Metrics

Table NERC 3.2-9 displays DC Circuit metrics that are defined in Appendix 2.

**Table NERC 3.2-9
DC Circuit Metrics 1-16 per Appendix 2**

Voltage Class	OH/UG	Element Outage Duration, Repair Time, and Update Time (4-7)									Element Availability (8-10)		
		Element Outage Frequency (1-3)			SODT	MTTR	MTTR	MTTR	MdTTR	MTBF	APC %	PCZO %	PCDR %
		TOF	SOF	MOF		P(5%) <	MTTR 50/50	P(5%) >					
200-299 kV	Overhead	C	C	C	C	C	C	C	C	C	C	C	C
400-499 kV	Overhead	C	C	C	C	C	C	C	C	C	C	C	C
400-499 kV	Underground	C	C	C	C	C	C	C	C	C	C	C	C
500-599 kV	Overhead	2.60	1.90	0.70	53.30	27.63	28.05	28.48	0.57	4595.10	99.39	10.00	34.62

Voltage Class	OH/UG	Circuit Outage Frequency (11-13)						Multiple Circuit Outage Frequency (14-16)			Outage Totals		
		TCOF		SCOF		MCOF		TMCOF	SMCOF	MMCOF	Momentary Outages	Sustained Outages	Sustained Outages Hours
		All	Elemt. Init.	All	Elemt. Init.	All	Elemt. Init.						
200-299 kV	Overhead	C	C	C	C	C	C	C	C	C	C	C	C
400-499 kV	Overhead	C	C	C	C	C	C	0.14	0.14	0.00	C	C	C
400-499 kV	Underground	C	C	C	C	C	C				C	C	C
500-599 kV	Overhead	0.48	0.24	0.35	0.11	0.13	0.13	0.11	0.11	0.00	7	19	533.0
TOTAL											7	19	533.0

3.3 Transformer Metrics and Data

Transformer metrics are displayed in three sections: Section 3.3.1 addresses Sustained Outages, Section 3.3.2 addresses Momentary Outages, and Section 3.3.3 has Transformer metrics per the formulas in Appendix 2. Data and metrics are displayed for all four Transformer Voltages Classes in the NERC template plus the total of all Voltage Classes.

3.3.1 Transformer Sustained Outages

3.3.1.1 Transformer Sustained Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

- Table NERC 3.3-1 shows metrics for Transformer Sustained Outages that were “Element-Initiated,” which means the outages were initiated on or within the Element (Transformer in this case) being reported.
- Table NERC 3.3-2 shows the metrics for Transformer Sustained Outages that were initiated by all other Outage Initiation Codes *except* those that were Element-Initiated. These included outages that were initiated on or within an AC Substation, an AC/DC Terminal, another TADS Element (Other-Element Initiated), or by Other Facilities.

**Table NERC 3.3-1
Transformer Sustained Outage Metrics - Element-Initiated Only**

Voltage Class	No. of Transformers	No. of Outages	Total Outage Time (hr)	Frequency (SOF) (per transformer per yr)	MTTR or Mean Outage Duration (hr)
200-299 kV	33.9	0	0.0	0.0000	~
300-399 kV	165.0	6	3701.8	0.0364	617.0
400-599 kV	425.6	15	4351.8	0.0352	290.1
600-799 kV	92.0	2	2737.7	0.0217	1368.8
All Voltages	716.5	23	10791.3	0.0321	469.2

**Table NERC 3.3-2
Transformer Sustained Outage Metrics - Other than "Element-Initiated"**

Voltage Class	No. of Transformers	No. Outages	Total Outage Time (hr)	Frequency (SOF) (per transformer per yr)	MTTR or Mean Outage Duration (hr)
200-299 kV	33.9	6	18.7	0.1770	3.1
300-399 kV	165.0	12	8216.8	0.0727	684.7
400-599 kV	425.6	50	813.3	0.1175	16.3
600-799 kV	92.0	10	63.0	0.1087	6.3
All Voltages	716.5	78	9112.0	0.1089	116.8

3.3.1.2 Transformer Sustained Outage Cause Code Data

For Sustained Outages, TADS requests two Cause Codes – an Initiating Cause Code that describes the initiating cause and a Sustained Cause Code that describes the cause that contributes to the longest duration. For 2008, TADS asked TOs to provide both if they are available, but if not, to supply one or the other. TADS has a Cause Code (Unavailable) that TOs can use if they do not have one of these two Cause Codes available. Table NERC 3.3-3 shows the two Outage Cause Codes (Initiating and Sustained) plus the number of outage hours associated with each Cause Code.

Table NERC 3.3-3 (p. 1 of 3)
Transformer Sustained Outages by Cause Code

Outage Cause Code	200-299kV						300-399kV					
	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	1	5.6%	8027.8	67.4%
Lightning	2	33.3%	0	0.0%	0.0	0.0%	1	5.6%	1	5.6%	0.2	0.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Contamination	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Foreign Interference	0	0.0%	0	0.0%	0.0	0.0%	1	5.6%	1	5.6%	0.0	0.0%
Fire	0	0.0%	0	0.0%	0.0	0.0%	2	11.1%	0	0.0%	0.0	0.0%
Vandalism, Terrorism, or Malicious Acts	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	2	33.3%	2	33.3%	7.7	41.2%	6	33.3%	5	27.8%	3843.7	32.2%
Failed AC/DC Terminal Equipment	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Failed Protection System Equipment	0	0.0%	0	0.0%	0.0	0.0%	2	11.1%	1	5.6%	0.3	0.0%
Failed AC Circuit Equipment	1	16.7%	0	0.0%	0.0	0.0%	0	0.0%	1	5.6%	2.8	0.0%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Power System Condition	0	0.0%	0	0.0%	0.0	0.0%	1	5.6%	1	5.6%	0.0	0.0%
Human Error	0	0.0%	0	0.0%	0.0	0.0%	4	22.2%	4	22.2%	4.5	0.0%
Unknown	1	16.7%	2	33.3%	10.5	56.2%	1	5.6%	1	5.6%	1.0	0.0%
Other	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Unavailable	0	0.0%	2	33.3%	0.5	2.7%	0	0.0%	2	11.1%	38.2	0.3%
TOTAL	6	100.0%	6	100.0%	18.7	100.0%	18	100.0%	18	100.0%	11918.6	100.0%

Table NERC 3.3-3 (p. 2 of 3)
Transformer Sustained Outages by Cause Code

Outage Cause Code	400-599kV						600-799kV					
	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	1	1.5%	1	1.5%	0.1	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Lightning	1	1.5%	0	0.0%	0.0	0.0%	1	8.3%	0	0.0%	0.0	0.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Contamination	2	3.1%	1	1.5%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Foreign Interference	2	3.1%	1	1.5%	0.1	0.0%	1	8.3%	1	8.3%	1.8	0.1%
Fire	3	4.6%	3	4.6%	762.9	14.8%	0	0.0%	0	0.0%	0.0	0.0%
Vandalism, Terrorism, or Malicious Acts	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	22	33.8%	16	24.6%	844.0	16.3%	2	16.7%	3	25.0%	2744.2	98.0%
Failed AC/DC Terminal Equipment	1	1.5%	1	1.5%	10.4	0.2%	0	0.0%	0	0.0%	0.0	0.0%
Failed Protection System Equipment	5	7.7%	4	6.2%	171.7	3.3%	3	25.0%	3	25.0%	48.3	1.7%
Failed AC Circuit Equipment	4	6.2%	2	3.1%	8.1	0.2%	0	0.0%	0	0.0%	0.0	0.0%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	1	1.5%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Power System Condition	4	6.2%	5	7.7%	35.1	0.7%	0	0.0%	1	8.3%	0.1	0.0%
Human Error	15	23.1%	11	16.9%	514.7	10.0%	3	25.0%	2	16.7%	0.5	0.0%
Unknown	3	4.6%	4	6.2%	10.9	0.2%	0	0.0%	0	0.0%	0.0	0.0%
Other	1	1.5%	4	6.2%	6.6	0.1%	2	16.7%	2	16.7%	5.9	0.2%
Unavailable	0	0.0%	12	18.5%	2800.7	54.2%	0	0.0%	0	0.0%	0.0	0.0%
TOTAL	65	100.0%	65	100.0%	5165.2	100.0%	12	100.0%	12	100.0%	2800.7	100.0%

Table NERC 3.3-3 (p. 3 of 3)
Transformer Sustained Outages by Cause Code

Outage Cause Code	All Voltages					
	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	1	1.0%	2	2.0%	8027.9	40.3%
Lightning	5	5.0%	1	1.0%	0.2	0.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%
Contamination	2	2.0%	1	1.0%	0.0	0.0%
Foreign Interference	4	4.0%	3	3.0%	1.9	0.0%
Fire	5	5.0%	3	3.0%	762.9	3.8%
Vandalism, Terrorism, or Malicious Acts	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	32	31.7%	26	25.7%	7439.6	37.4%
Failed AC/DC Terminal Equipment	1	1.0%	1	1.0%	10.4	0.1%
Failed Protection System Equipment	10	9.9%	8	7.9%	220.3	1.1%
Failed AC Circuit Equipment	5	5.0%	3	3.0%	10.9	0.1%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	1	1.0%	0	0.0%	0.0	0.0%
Power System Condition	5	5.0%	7	6.9%	35.2	0.2%
Human Error	22	21.8%	17	16.8%	519.7	2.6%
Unknown	5	5.0%	7	6.9%	22.4	0.1%
Other	3	3.0%	6	5.9%	12.4	0.1%
Unavailable	0	0.0%	16	15.8%	2839.4	14.3%
TOTAL	101	100.0%	101	100.0%	19903.2	100.0%

3.3.1.3 Other Transformer Sustained Outage Data

Table NERC 3.3-4 shows other Transformer Sustained Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type, and Outage Duration Interval.

Table NERC 3.3-4 (p. 1 of 3)
Transformer - Other Sustained Outage Attributes

Fault Type	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
No fault	4	66.7%	8.2	43.9%	10	55.6%	87.0	0.7%	42	64.6%	1283.3	24.8%	10	83.3%	63.1	2.3%
P-P fault	0	0.0%	0.0	0.0%	2	11.1%	104.4	0.9%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
Single P-G fault	1	16.7%	10.1	53.7%	4	22.2%	1.1	0.0%	11	16.9%	3021.8	58.5%	2	16.7%	2737.7	97.7%
P-P-G, 3 P, or 3P-G fault	0	0.0%	0.0	0.0%	2	11.1%	11726.2	98.4%	2	3.1%	331.4	6.4%	0	0.0%	0.0	0.0%
Unknown fault type	1	16.7%	0.5	2.5%	0	0.0%	0.0	0.0%	10	15.4%	528.6	10.2%	0	0.0%	0.0	0.0%
TOTAL	6	100.0%	18.7	100.0%	18	100.0%	11918.6	100.0%	65	100.0%	5165.2	100.0%	12	100.0%	2800.7	100.0%

Outage Initiation Code	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	0	0.0%	0.0	0.0%	6	33.3%	3701.8	31.1%	15	23.1%	4351.8	84.3%	2	16.7%	2737.7	97.7%
Other Element-Initiated	4	66.7%	11.0	58.8%	4	22.2%	40.2	0.3%	10	15.4%	53.0	1.0%	4	33.3%	7.8	0.3%
AC Substation-Initiated	2	33.3%	7.7	41.2%	6	33.3%	8175.5	68.6%	29	44.6%	394.6	7.6%	1	8.3%	6.5	0.2%
AC/DC Terminal-Initiated	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	1	1.5%	331.3	6.4%	0	0.0%	0.0	0.0%
Other Facility-Initiated	0	0.0%	0.0	0.0%	2	11.1%	1.1	0.0%	10	15.4%	34.4	0.7%	5	41.7%	48.7	1.7%
TOTAL	6	100.0%	18.7	100.0%	18	100.0%	11918.6	100.0%	65	100.0%	5165.2	100.0%	12	100.0%	2800.7	100.0%

Outage Mode Code	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Single Mode	2	33.3%	7.7	41.2%	9	50.0%	3705.9	31.1%	25	38.5%	1217.7	23.6%	6	50.0%	2704.8	96.6%
Dependent Mode Initiating	0	0.0%	0.0	0.0%	2	11.1%	2.0	0.0%	7	10.8%	3739.1	72.4%	3	25.0%	88.2	3.1%
Dependent Mode	4	66.7%	11.0	58.8%	2	11.1%	8027.9	67.4%	27	41.5%	188.6	3.7%	3	25.0%	7.8	0.3%
Common Mode	0	0.0%	0.0	0.0%	5	27.8%	182.8	1.5%	4	6.2%	16.3	0.3%	0	0.0%	0.0	0.0%
Common Mode Initiating	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	2	3.1%	3.4	0.1%	0	0.0%	0.0	0.0%
TOTAL	6	100.0%	18.7	100.0%	18	100.0%	11918.6	100.0%	65	100.0%	5165.2	100.0%	12	100.0%	2800.7	100.0%

Table NERC 3.3-4 (p. 2 of 3)
Transformer – Other Sustained Outage Attributes

Event Type	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
10	4	66.7%	18.2	97.3%	6	33.3%	11733.1	98.4%	21	32.3%	869.1	16.8%	1	8.3%	2650.0	94.6%
50	2	33.3%	0.5	2.7%	12	66.7%	185.5	1.6%	44	67.7%	4296.0	83.2%	11	91.7%	150.7	5.4%

Outage Duration Interval	200-299 kV		300-399 kV		400-599 kV		600-799 kV	
	No. Sust.	%	No. Sust.	%	No. Sust.	%	No. Sust.	%
1-5 Minutes	1	16.7%	4	22.2%	7	10.8%	1	8.3%
6-10 Minutes	0	0.0%	0	0.0%	2	3.1%	1	8.3%
11-30 Minutes	2	33.3%	2	11.1%	3	4.6%	2	16.7%
31-120 Minutes	1	16.7%	3	16.7%	15	23.1%	2	16.7%
> 120 Minutes	2	33.3%	9	50.0%	38	58.5%	6	50.0%
TOTAL	6	100.0%	18	100.0%	65	100.0%	12	100.0%

Table NERC 3.3-4 (p. 3 of 3)
Transformer - Other Sustained Outage Attributes

Fault Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
No fault	66	65.3%	1441.6	7.2%
P-P fault	2	2.0%	104.4	0.5%
Single P-G fault	18	17.8%	5770.6	29.0%
P-P-G, 3 P, or 3P-G fault	4	4.0%	12057.6	60.6%
Unknown fault type	11	10.9%	529.1	2.7%
TOTAL	101	100.0%	19903.2	100.0%

Outage Initiation Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	23	22.8%	10791.3	54.2%
Other Element-Initiated	22	21.8%	112.1	0.6%
AC Substation-Initiated	38	37.6%	8584.4	43.1%
AC/DC Terminal-Initiated	1	1.0%	331.3	1.7%
Other Facility-Initiated	17	16.8%	84.2	0.4%
TOTAL	101	100.0%	19903.2	100.0%

Outage Mode Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Single Mode	42	41.6%	7636.2	38.4%
Dependent Mode Initiating	12	11.9%	3829.3	19.2%
Dependent Mode	36	35.6%	8235.3	41.4%
Common Mode	9	8.9%	199.1	1.0%
Common Mode Initiating	2	2.0%	3.4	0.0%
TOTAL	101	100.0%	19903.2	100.0%

Event Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
10	32	31.7%	15270.5	76.7%
50	69	68.3%	4632.7	23.3%
TOTAL	101	100.0%	19903.2	100.0%

Outage Duration Interval	All Voltages	
	No. Sust.	%
1-5 Minutes	13	12.9%
6-10 Minutes	3	3.0%
11-30 Minutes	9	8.9%
31-120 Minutes	21	20.8%
> 120 Minutes	55	54.5%
TOTAL	101	100.0%

3.3.2 Transformer Momentary Outages

3.3.2.1 Transformer Momentary Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

- Table NERC 3.3-5 shows metrics for Transformer Momentary Outages that were “Element-Initiated,” which means the outages were initiated on or within the Element (Transformer in this case) being reported.
- Table NERC 3.3-6 shows the metrics for Transformer Momentary Outages that were initiated by all other Outage Initiation Codes *except* those that were Element-Initiated. These included outages that were initiated on or within an AC Substation, an AC/DC Terminal, another TADS Element (Other-Element Initiated), or by Other Facilities.

**Table NERC 3.3-5
Transformer Momentary Outage Metrics - Element-Initiated Only**

Voltage Class	No. of Transformers	No. of Outages	Frequency (MOF) (per transformer per yr)
200-299 kV	33.9	0	0.0000
300-399 kV	165.0	1	0.0061
400-599 kV	425.6	0	0.0000
600-799 kV	92.0	0	0.0000
All Voltages	716.5	1	0.0014

**Table NERC 3.3-6
Transformer Momentary Outage Metrics - Other than "Element-Initiated"**

Voltage Class	No. of Transformers	No. of Outages	Frequency (MOF) (per transformer per yr)
200-299 kV	33.9	4	0.1180
300-399 kV	165.0	12	0.0727
400-599 kV	425.6	9	0.0211
600-799 kV	92.0	3	0.0326
All Voltages	716.5	28	0.0391

3.3.2.2 Transformer Momentary Outage Cause Code Data

For Momentary Outages, TADS requests one Cause Code: an Initiating Cause Code. Table NERC 3.3-7 reports Cause Code data for Transformer Momentary Outages.

**Table NERC 3.3-7
Transformer Momentary Outages by Cause Code**

Outage Cause Code	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Weather, excluding lightning	0	0.0%	0	0.0%	2	22.2%	0	0.0%	2	6.9%
Lightning	2	50.0%	6	46.2%	0	0.0%	0	0.0%	8	27.6%
Environmental	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Contamination	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Foreign Interference	0	0.0%	0	0.0%	2	22.2%	0	0.0%	2	6.9%
Fire	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Vandalism, Terrorism, or Malicious Acts	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Failed AC Substation Equipment	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Failed AC/DC Terminal Equipment	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Failed Protection System Equipment	1	25.0%	0	0.0%	0	0.0%	3	100.0%	4	13.8%
Failed AC Circuit Equipment	0	0.0%	1	7.7%	0	0.0%	0	0.0%	1	3.4%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Vegetation	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Power System Condition	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Human Error	1	25.0%	1	7.7%	2	22.2%	0	0.0%	4	13.8%
Unknown	0	0.0%	5	38.5%	2	22.2%	0	0.0%	7	24.1%
Other	0	0.0%	0	0.0%	1	11.1%	0	0.0%	1	3.4%
Unavailable	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
TOTAL	4	100.0%	13	100.0%	9	100.0%	3	100.0%	29	100.0%

3.3.2.3 Other Transformer Momentary Outage Data

Table NERC 3.2-8 shows other Transformer Momentary Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type.

3.3.3 Total Transformer Metrics

Table NERC 3.3-9 displays Transformer metrics that are defined in Appendix 2.

**Table NERC 3.3-8
Transformer - Other Momentary Outage Attributes**

Fault Type	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
No fault	3	75.0%	13	100.0%	9	100.0%	3	100.0%	28	96.6%
P-P fault	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Single P-G fault	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
P-P-G, 3 P, or 3P-G fault	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Unknown fault type	1	25.0%	0	0.0%	0	0.0%	0	0.0%	1	3.4%
TOTAL	4	100.0%	13	100.0%	9	100.0%	3	100.0%	29	100.0%

Outage Initiation Code	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Element-Initiated	0	0.0%	1	7.7%	0	0.0%	0	0.0%	1	3.4%
Other Element-Initiated	2	50.0%	11	84.6%	8	88.9%	0	0.0%	21	72.4%
AC Substation-Initiated	1	25.0%	1	7.7%	0	0.0%	3	100.0%	5	17.2%
AC/DC Terminal-Initiated	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Other Facility-Initiated	1	25.0%	0	0.0%	1	11.1%	0	0.0%	2	6.9%
TOTAL	4	100.0%	13	100.0%	9	100.0%	3	100.0%	29	100.0%

Outage Mode Code	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Single Mode	0	0.0%	1	7.7%	1	11.1%	0	0.0%	2	6.9%
Dependent Mode Initiating	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Dependent Mode	2	50.0%	11	84.6%	7	77.8%	3	100.0%	23	79.3%
Common Mode	2	50.0%	1	7.7%	1	11.1%	0	0.0%	4	13.8%
Common Mode Initiating	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
TOTAL	4	100.0%	13	100.0%	9	100.0%	3	100.0%	29	100.0%

Event Type	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
10	1	25.0%	1	7.7%	0	0.0%	0	0.0%	2	6.9%
50	3	75.0%	12	92.3%	9	100.0%	3	100.0%	27	93.1%
TOTAL	4	100.0%	13	100.0%	9	100.0%	3	100.0%	29	100.0%

**Table NERC 3.3-9
Transformer Metrics 1-10 per Appendix 2***

Voltage Class	Element Outage Frequency (1-3)			Element Outage Duration, Repair Time, and Update Time (4-7)						Element Availability (8-10)		
	TOF	SOF	MOF	SODT	MTTR	MTTR	MTTR	MdTTR	MTBF	APC %	PCZO %	PCDR %
					P(5%) <	MTTR 50/50	P(5%) >					
200-299 kV	0.29	0.18	0.12	0.55	2.79	3.12	3.45	0.93	49626.48	99.99	84.85	0.00
300-399 kV	0.19	0.11	0.08	72.23	649.91	662.15	674.38	2.18	79857.85	99.17	68.07	0.00
400-599 kV	0.17	0.15	0.02	12.14	79.33	79.46	79.59	3.25	57435.47	99.86	82.98	6.76
600-799 kV	0.16	0.13	0.03	30.44	222.09	233.39	244.69	2.18	67110.61	99.65	95.65	0.00

*Note: Metrics 11-16 only apply to AC Circuits or DC Circuits

Voltage Class	Outage Totals		
	Momentary Outages	Sustained Outages	Sustained Outages Hours
200-299 kV	4	6	18.7
300-399 kV	13	18	11918.6
400-599 kV	9	65	5165.2
600-799 kV	3	12	2800.7
TOTAL	29	101	19903.2

3.4 AC/DC BTB Converter Metrics and Data

AC/DC BTB Converter metrics are displayed in three sections: Section 3.4.1 addresses Sustained Outages, Section 3.4.2 addresses Momentary Outages, and Section 3.4.3 has AC/DC BTB Converter metrics per the formulas in Appendix 2. Data and metrics are displayed for the two AC/DC BTB Converter Voltages Classes in the NERC template plus the total of all Voltage Classes.

3.4.1 AC/DC BTB Converter Sustained Outages

3.4.1.1 AC/DC BTB Converter Sustained Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

- Table NERC 3.4-1 shows metrics for AC/DC BTB Converter Sustained Outages that were “Element-Initiated,” which means the outages were initiated on or within the Element (AC/DC BTB Converter in this case) being reported.
- Table NERC 3.4-2 shows the metrics for AC/DC BTB Converter Sustained Outages that were initiated by all other Outage Initiation Codes *except* those that were Element-Initiated. These included outages that were initiated on or within an AC Substation, an AC/DC Terminal, another TADS Element (Other-Element Initiated), or by Other Facilities.

Table NERC 3.4-1

AC/DC BTB Converter Sustained Outage Metrics - Element-Initiated Only

Voltage Class	No. of Converters	No. of Outages	Total Outage Time (hr)	Frequency (SOF) (per converter per yr)	MTTR or Mean Outage Duration (hr)
200-299 kV	10.3	6	5.1	0.5825	0.9
300-399 kV	6.0	3	30.8	0.5000	10.3
All Voltages	16.3	9	35.9	0.5521	4.0

Table NERC 3.4-2

AC/DC BTB Converter Sustained Outage Metrics - Other than "Element-Initiated"

Voltage Class	No. of Converters	No. Outages	Total Outage Time (hr)	Frequency (SOF) (per converter per yr)	MTTR or Mean Outage Duration (hr)
200-299 kV	10.3	23	3779.2	2.2330	164.3
300-399 kV	6.0	20	660.3	3.3333	33.0
All Voltages	16.3	43	4439.5	2.6380	103.2

3.4.1.2 AC/DC BTB Converter Sustained Outage Cause Code Data

For Sustained Outages, TADS requests two Cause Codes – an Initiating Cause Code that describes the initiating cause and a Sustained Cause Code that describes the cause that contributes to the longest duration. For 2008, TADS asked TOs to provide both if they are available, but if not, to supply one or the other. TADS has a Cause Code (Unavailable) that TOs can use if they do not have one of these two Cause Codes available. Table NERC 3.4-3 shows the two Outage Cause Codes (Initiating and Sustained) plus the number of outage hours associated with each Cause Code.

Table NERC 3.4-3 (p 1 of 2)
AC/DC BTB Converter Sustained Outages by Cause Code

Outage Cause Code	200-299kV						300-399kV					
	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	2	6.9%	1	3.4%	0.4	0.0%	2	8.7%	2	8.7%	5.4	0.8%
Lightning	1	3.4%	0	0.0%	0.0	0.0%	3	13.0%	1	4.3%	1.6	0.2%
Environmental	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Contamination	0	0.0%	0	0.0%	0.0	0.0%	1	4.3%	1	4.3%	7.4	1.1%
Foreign Interference	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Fire	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Vandalism, Terrorism, or Malicious Acts	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	8	27.6%	8	27.6%	58.6	1.5%	3	13.0%	3	13.0%	145.1	21.0%
Failed AC/DC Terminal Equipment	1	3.4%	1	3.4%	3382.9	89.4%	8	34.8%	9	39.1%	503.3	72.8%
Failed Protection System Equipment	3	10.3%	3	10.3%	297.9	7.9%	0	0.0%	1	4.3%	0.2	0.0%
Failed AC Circuit Equipment	3	10.3%	3	10.3%	36.8	1.0%	2	8.7%	1	4.3%	16.1	2.3%
Failed DC Circuit Equipment	4	13.8%	4	13.8%	3.8	0.1%	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Power System Condition	2	6.9%	0	0.0%	0.0	0.0%	0	0.0%	2	8.7%	1.6	0.2%
Human Error	2	6.9%	2	6.9%	0.3	0.0%	3	13.0%	3	13.0%	10.6	1.5%
Unknown	1	3.4%	3	10.3%	1.8	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Other	2	6.9%	4	13.8%	2.0	0.1%	1	4.3%	0	0.0%	0.0	0.0%
Unavailable	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
TOTAL	29	100.0%	29	100.0%	3784.3	100.0%	23	100.0%	23	100.0%	691.1	100.0%

Table NERC 3.4-3 (p 2 of 2)
AC/DC BTB Converter Sustained Outages
by Cause Code

Outage Cause Code	All Voltages					
	No. Init.	Init. %	No. Sust.	Sust. %	No. Hrs.	Hours %
Weather, excluding lightning	4	7.7%	3	5.8%	5.8	0.1%
Lightning	4	7.7%	1	1.9%	1.6	0.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%
Contamination	1	1.9%	1	1.9%	7.4	0.2%
Foreign Interference	0	0.0%	0	0.0%	0.0	0.0%
Fire	0	0.0%	0	0.0%	0.0	0.0%
Vandalism, Terrorism, or Malicious Acts	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	11	21.2%	11	21.2%	203.7	4.6%
Failed AC/DC Terminal Equipment	9	17.3%	10	19.2%	3886.1	86.8%
Failed Protection System Equipment	3	5.8%	4	7.7%	298.0	6.7%
Failed AC Circuit Equipment	5	9.6%	4	7.7%	52.9	1.2%
Failed DC Circuit Equipment	4	7.7%	4	7.7%	3.8	0.1%
Vegetation	0	0.0%	0	0.0%	0.0	0.0%
Power System Condition	2	3.8%	2	3.8%	1.6	0.0%
Human Error	5	9.6%	5	9.6%	10.8	0.2%
Unknown	1	1.9%	3	5.8%	1.8	0.0%
Other	3	5.8%	4	7.7%	2.0	0.0%
Unavailable	0	0.0%	0	0.0%	0.0	0.0%
TOTAL	52	100.0%	52	100.0%	4475.4	100.0%

3.4.1.3 Other AC/DC BTB Converter Sustained Outage Data

Table NERC 3.4-4 shows other AC/DC BTB Converter Sustained Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type, and Outage Duration Interval.

**Table NERC 3.4-4
AC/DC BTB Converter - Other Sustained Outage Attributes**

Fault Type	200-299 kV				300-399 kV				All Voltages			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
No fault	21	72.4%	3757.0	99.3%	19	82.6%	684.6	99.1%	40	76.9%	4441.7	99.2%
P-P fault	1	3.4%	0.8	0.0%	2	8.7%	4.9	0.7%	3	5.8%	5.7	0.1%
Single P-G fault	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
P-P-G, 3 P, or 3P-G fault	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
Unknown fault type	7	24.1%	26.5	0.7%	2	8.7%	1.6	0.2%	9	17.3%	28.1	0.6%
TOTAL	29	100.0%	3784.3	100.0%	23	100.0%	691.1	100.0%	52	100.0%	4475.4	100.0%

Outage Initiation Code	200-299 kV				300-399 kV				All Voltages			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	6	20.7%	5.1	0.1%	3	13.0%	30.8	4.5%	9	17.3%	35.9	0.8%
Other Element-Initiated	2	6.9%	1.1	0.0%	5	21.7%	418.0	60.5%	7	13.5%	419.1	9.4%
AC Substation-Initiated	15	51.7%	370.0	9.8%	9	39.1%	162.6	23.5%	24	46.2%	532.6	11.9%
AC/DC Terminal-Initiated	5	17.2%	3408.1	90.1%	5	21.7%	79.5	11.5%	10	19.2%	3487.6	77.9%
Other Facility-Initiated	1	3.4%	0.0	0.0%	1	4.3%	0.2	0.0%	2	3.8%	0.2	0.0%
TOTAL	29	100.0%	3784.3	100.0%	23	100.0%	691.1	100.0%	52	100.0%	4475.4	100.0%

Outage Mode Code	200-299 kV				300-399 kV				All Voltages			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Single Mode	23	79.3%	3747.0	99.0%	10	43.5%	232.4	33.6%	33	63.5%	3979.4	88.9%
Dependent Mode Initiating	1	3.4%	0.4	0.0%	2	8.7%	23.5	3.4%	3	5.8%	23.9	0.5%
Dependent Mode	5	17.2%	36.9	1.0%	11	47.8%	435.2	63.0%	16	30.8%	472.2	10.6%
Common Mode	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
Common Mode Initiating	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
TOTAL	29	100.0%	3784.3	100.0%	23	100.0%	691.1	100.0%	52	100.0%	4475.4	100.0%

Event Type	200-299 kV				300-399 kV				All Voltages			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
50	29	100.0%	3784.3	100.0%	23	100.0%	691.1	100.0%	52	100.0%	4475.4	100.0%
TOTAL	29	100.0%	3784.3	100.0%	23	100.0%	691.1	100.0%	52	100.0%	4475.4	100.0%

Outage Duration Interval	200-299 kV		300-399 kV		All Voltages	
	No. Sust.	%	No. Sust.	%	No. Sust.	%
1-5 Minutes	2	6.9%	1	4.3%	3	5.8%
6-10 Minutes	2	6.9%	1	4.3%	3	5.8%
11-30 Minutes	6	20.7%	0	0.0%	6	11.5%
31-120 Minutes	10	34.5%	6	26.1%	16	30.8%
> 120 Minutes	9	31.0%	15	65.2%	24	46.2%
TOTAL	29	100.0%	23	100.0%	52	100.0%

3.4.2 AC/DC BTB Converter Momentary Outages

3.4.2.1 AC/DC BTB Converter Momentary Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

- Table NERC 3.4-5 shows metrics for AC/DC BTB Converter Momentary Outages that were “Element-Initiated,” which means the outages were initiated on or within the Element (AC/DC BTB Converter in this case) being reported.
- Table NERC 3.4-6 shows the metrics for AC/DC BTB Converter Momentary Outages that were initiated by all other Outage Initiation Codes *except* those that were Element-Initiated. These included outages that were initiated on or within an AC Substation, an AC/DC Terminal, another TADS Element (Other-Element Initiated), or by Other Facilities.

**Table NERC 3.4-5
AC/DC BTB Converter Momentary Outage Metrics
- Element-Initiated Only**

Voltage Class	No. of Converters	No. of Outages	Frequency (MOF) (per converter per yr)
200-299 kV	10.3	0	0.0000
300-399 kV	6.0	0	0.0000
All Voltages	16.3	0	0.0000

**Table NERC 3.4-6
AC/DC BTB Converter Momentary Outage Metrics -
Other than "Element-Initiated"**

Voltage Class	No. of Converters	No. of Outages	Frequency (MOF) (per converter per yr)
200-299 kV	10.3	0	0.0000
300-399 kV	6.0	1	0.1667
All Voltages	16.3	1	0.0613

3.4.2.2 AC/DC BTB Converter Momentary Outage Cause Code Data

For Momentary Outages, TADS requests one Cause Code: an Initiating Cause Code. Table NERC 3.4-7 reports Cause Code data for AC/DC BTB Converter Momentary Outages.

3.4.2.3 Other AC/DC BTB Converter Momentary Outage Data

Table NERC 3.4-8 shows other AC/DC BTB Converter Momentary Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type.

3.4.3 Total AC/DC BTB Converter Metrics

Table NERC 3.4-9 displays AC/DC BTB Converter metrics which are defined in Appendix 2.

**Table NERC 3.4-7
AC/DC BTB Converter Momentary Outages
by Cause Code**

Outage Cause Code	200-299 kV		300-399 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%
Weather, excluding lightning	0	~	0	0.0%	0	0.0%
Lightning	0	~	0	0.0%	0	0.0%
Environmental	0	~	0	0.0%	0	0.0%
Contamination	0	~	0	0.0%	0	0.0%
Foreign Interference	0	~	0	0.0%	0	0.0%
Fire	0	~	0	0.0%	0	0.0%
Vandalism, Terrorism, or Malicious Acts	0	~	0	0.0%	0	0.0%
Failed AC Substation Equipment	0	~	1	100.0%	1	100.0%
Failed AC/DC Terminal Equipment	0	~	0	0.0%	0	0.0%
Failed Protection System Equipment	0	~	0	0.0%	0	0.0%
Failed AC Circuit Equipment	0	~	0	0.0%	0	0.0%
Failed DC Circuit Equipment	0	~	0	0.0%	0	0.0%
Vegetation	0	~	0	0.0%	0	0.0%
Power System Condition	0	~	0	0.0%	0	0.0%
Human Error	0	~	0	0.0%	0	0.0%
Unknown	0	~	0	0.0%	0	0.0%
Other	0	~	0	0.0%	0	0.0%
Unavailable	0	~	0	0.0%	0	0.0%
TOTAL	0	~	1	100.0%	1	100.0%

**Table NERC 3.4-8
AC/DC BTB Converter
Other Momentary Outage Attributes**

Fault Type	200-299 kV		300-399 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%
No fault	0	~	1	100.0%	1	100.0%
P-P fault	0	~	0	0.0%	0	0.0%
Single P-G fault	0	~	0	0.0%	0	0.0%
P-P-G, 3 P, or 3P-G fault	0	~	0	0.0%	0	0.0%
Unknown fault type	0	~	0	0.0%	0	0.0%
TOTAL	0	~	1	100.0%	1	100.0%

Outage Initiation Code	200-299 kV		300-399 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%
Element-Initiated	0	~	0	0.0%	0	0.0%
Other Element-Initiated	0	~	0	0.0%	0	0.0%
AC Substation-Initiated	0	~	1	100.0%	1	100.0%
AC/DC Terminal-Initiated	0	~	0	0.0%	0	0.0%
Other Facility-Initiated	0	~	0	0.0%	0	0.0%
TOTAL	0	~	1	100.0%	1	100.0%

Outage Mode Code	200-299 kV		300-399 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%
Single Mode	0	~	0	0.0%	0	0.0%
Dependent Mode Initiating	0	~	0	0.0%	0	0.0%
Dependent Mode	0	~	1	100.0%	1	100.0%
Common Mode	0	~	0	0.0%	0	0.0%
Common Mode Initiating	0	~	0	0.0%	0	0.0%
TOTAL	0	~	1	100.0%	1	100.0%

Event Type	200-299 kV		300-399 kV		All Voltages	
	No. Mom.	0	No. Mom.	0	No. Mom.	%
50	0	~	1	100.0%	1	100.0%
TOTAL	0	~	1	100.0%	1	100.0%

**Table NERC 3.4-9
AC/DC BTB Converter Metrics 1-10 per Appendix 2***

Voltage Class	Element Outage Frequency (1-3)			Element Outage Duration, Repair Time, and Update Time (4-7)						Element Availability (8-10)		
	TOF	SOF	MOF	SODT	MTTR	MTTR	MTTR	MdTTR	MTBF	APC %	PCZO %	PCDR %
					P(5%) <	MTTR 50/50	P(5%) >					
200-299 kV	2.82	2.82	0.00	367.41	129.13	130.49	131.86	0.92	2989.34	95.64	28.85	0.00
300-399 kV	4.00	3.83	0.17	115.18	29.82	30.05	30.28	3.02	2261.43	98.67	0.00	0.00

*Note: Metrics 11-16 only apply to AC Circuits or DC Circuits

Voltage Class	Outage Totals		
	Momentary Outages	Sustained Outages	Sustained Outages Hours
200-299 kV	0	29	3784.3
300-399 kV	1	23	691.1
TOTAL	1	52	4475.4

Appendix 1 TADS Definitions

The definitions are a separate document that may be downloaded at
[http://www.nerc.com/docs/pc/tadstf/Appendix_1_TADS_2008_Reports_\(All\).pdf](http://www.nerc.com/docs/pc/tadstf/Appendix_1_TADS_2008_Reports_(All).pdf).

Appendix 2 Metric Definitions

The metrics definitions are contained on the table below, which is divided into two sections: the first page has metrics 1-10 that apply to *all* Elements. The second page has metrics 11-16 that only apply to AC Circuits or DC Circuits.

- Metric 5: Mean-time-to-repair (MTTR) has the same meaning as mean outage duration. Since this calculation is based upon a limited number of outages, the computed value is an *estimate* of the “true” MTTR for the Element. Using statistical methods, one can estimate the uncertainty in the mean calculation. The tables in the main report provide a range of MTTR values:
 - The value that is calculated straight from the data is labeled “MTTR 50/50.”
 - The MTTR labeled “P(5%) >” means the true MTTR has a 5 % chance of being greater than this value, and the MTTR labeled “P(5%)<” means the true MTTR has a 5% chance of being lower than this value

When a fairly large number of outages are used to calculate the MTTR 50/50 value, the range of uncertainty is fairly low. See the Overhead AC Circuit MTTR values on NERC 3.1-9. When only a few outages are used, the range is very large, indicating a high degree of uncertainty between the calculated MTTR and the “true” MTTR.

- Metrics 11, 12, and 13: Circuit outage frequency on a per 100 Circuit Mile basis - total circuit outage frequency (TCOF), Sustained (circuit) Outage frequency (SCOF), and Momentary (circuit) Outage frequency (MCOF), are calculated twice – one calculation includes *all* outages while a second calculation only includes Element-Initiated outages. The second calculation more correctly relates outages initiated on the circuit (the Element in this case) to total circuit exposure measured by mileage.

No.	Metric	Formula	Units	Acronym
<i>Element Outage Frequency</i>				
1	Element Total Automatic Outage Frequency	Total Automatic Outages / Total Elements	No. Automatic Outages per Element per year	TOF
2	Element Sustained Outage Frequency	Total Sustained Outages / Total Elements	No. Sustained Outages per Element per year	SOF
3	Element Momentary Outage Frequency	Total Momentary Outages / Total Elements	No. Momentary Outages per Element per year	MOF
<i>Element Outage Duration, Repair Time, and Up Time</i>				
4	Element Sustained Outage Duration Time	Total Sustained Outage Hours / Total Elements	No. Sustained Outages hours per Element per year	SODT
5	Element Sustained Outage Mean Time to Repair. Also referred to as Mean Outage Duration	Total Sustained Outage Hours / Total Sustained Element Outages	Average no. of Sustained Outage Hours per outaged Element	MTTR
6	Median Time to Repair Sustained Element Outage Failures	The time when 50% of the Mean Time to Repair minutes are greater than this figure	Median no. of Sustained Outage Hours per outaged Element	MdTTR
7	Mean Time Between Sustained Element Outages (Mean "Up Time"). Also referred to as Mean Time Between Failures.	(Total Element Hours - Total Sustained Outage Hours) / Total Sustained Element Outages	Mean (average) no. of hours of operation of an Element before it fails	MTBF ¹
<i>Element Availability</i>				
8	Element Availability Percentage	1- (Total Sustained Outage Hours / Total Element Hours) * 100	Percentage	APC ¹
9	Percentage of Elements with Zero Automatic Outages	Total Elements with Zero Automatic Outages / Total Elements	Percentage	PCZO
10	Percent of Element Automatic Outages associated with a Disturbance Report (EOP-004)	Total Automatic Outages associated with a Disturbance Report / Total Automatic Outages	Percentage	PCDR

1 Since Non-Automatic Outage data are not collected, these metrics will be overstated from industry definitions.

	Metric	Formula	Units	Acronym
<i>Circuit Outage Frequency, per 100 Circuit Miles (Applies to AC and DC Circuits Only)</i>				
11	Circuit Total Outage Frequency, Mileage Adjusted	$(\text{Total Circuit Automatic Outages} * 100) / \text{Total Circuit Miles}$	No. Automatic Outages per 100 Circuit Miles per year	TCOF _{100CM}
12	Circuit Sustained Outage Frequency, Mileage Adjusted	$(\text{Total Circuit Sustained Outages} * 100) / \text{Total Circuit Miles}$	No. Sustained Outages per 100 Circuit Miles per year	SCOF _{100CM}
13	Circuit Momentary Outage Frequency, Mileage Adjusted	$(\text{Total Circuit Momentary Outages} * 100) / \text{Total Circuit Miles}$	No. Momentary Outages per 100 Circuit Miles per year	MCOF _{100CM}
<i>Multiple Circuit Outage Frequency per 100 Multi-Circuit Structure Miles (For AC Circuits, multi circuit outages are Event Type 30 outages; for DC Circuits, they are Event Type 40 outages.)</i>				
14	Multi Circuit Total Outage Frequency, Mileage Adjusted	$(\text{Total Multi-Circuit Automatic Outages} * 100) / \text{Total Multi-Circuit Structure Miles}$	No. Automatic Outages per 100 Multi-Circuit Structures Miles per year	TMCOF _{100SM}
15	Multi-Circuit Sustained Outage Frequency, Mileage Adjusted	$(\text{Total Multi-Circuit Sustained Outages} * 100) / \text{Total Multi-Circuit Structure Miles}$	No. Sustained Outages per 100 Multi-Circuit Structure Miles per year	SMCOF _{100SM}
16	Multi-Circuit Momentary Outage Frequency, Mileage Adjusted	$(\text{Total Multi-Circuit Momentary Outages} * 100) / \text{Total Multi-Circuit Structure Miles}$	No. Momentary Outages per 100 Multi-Circuit Structure Miles per year	MMCOF _{100SM}

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