

The logo for NERC (North American Electric Reliability Corporation) features the letters "NERC" in a bold, black, sans-serif font. A thick blue horizontal bar is positioned directly beneath the letters.

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Transmission Availability Data System 2008 Automatic Outage Metrics and Data Report

Region: TRE

June 30, 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), the Texas Regional Entity (TRE), and the 12 reporting Transmission Owners (TOs) in TRE. “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 TRE U.S. TOs complied. There are no non-U.S. TOs in TRE.

In addition to TOs, TADS Regional Entity coordinators (RECs) in TRE,¹ 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.²

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 $\geq +/-200$ 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 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](#).

² 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, 2008.³ 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 webTADS⁴ 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

³ The first quarter 2008 report is posted at [TADS 1Q 2008 Report](#).

⁴ 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 TRE 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 TADSTF⁵ 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,⁶ 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 owned or reported by one TO. Since none of the TRE performance data met any exclusion criterion, all TRE performance data is displayed in this report.

1.6 Report Organization

Section 2 has summary TRE 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.).

1.6.1 Table and Figure Labeling

Table TRE 1-1 shows the assigned numbering scheme for the tables and figures in this report. The prefix "TRE" 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 TRE 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 TRE 1-2 shows the categories included in the NERC template.

⁵ 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.

⁶ See Section 1.5 of the *TADS Data Reporting and Instructions Manual* dated November 11, 2008.

Performance data is not shown in Tables TRE 2-1 and TRE 2-2. These tables show, respectively, the Inventory of AC equipment and DC equipment within TRE. 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 TRE 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 TRE 2-3 (Event Types and Outages) includes all outage data and generally does not reveal any confidential data; however, if it would reveal confidential performance data, that data would have a “C” displayed.
5. In each Section 3 subsection devoted to a specific Element (e.g., 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.⁷

⁷ The Excel “SUM” function treats text such as “C” or “NC” as a zero.

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 is 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.

Table TRE 1-1
TADS Report Tables and Figure Guide – TRE 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	TRE 1-1	
	Categories Displayed in Report Tables and Figures with Performance Data	TRE 1-2	
2. Summary TRE Metrics and Data	Inventory of AC Transmission Equipment	TRE 2-1	
	Inventory of DC Transmission Equipment	TRE 2-2	
	AC Circuit Outage Frequency by Outage Initiation Code		TRE 2-1
	AC Circuit Outage Duration by Outage Initiation Code		TRE 2-2
	DC Circuit Outage Frequency by Outage Initiation Code		TRE 2-3
	DC Circuit Outage Duration by Outage Initiation Code		TRE 2-4
	Transformer Outage Frequency by Outage Initiation Code		TRE 2-5
	Transformer Outage Duration by Outage Initiation Code		TRE 2-6
	AC/DC BTB Converter Outage Frequency by Outage Initiation Code		TRE 2-7
	AC/DC BTB Converter Outage Duration by Outage Initiation Code		TRE 2-8
	Event Types and Outages	TRE 2-3	
	3.1 AC Circuit Metrics and Data	AC Circuit Sustained Outage Metrics – Element-Initiated Only	TRE 3.1-1
AC Circuit Sustained Outage Metrics – Other than “Element-Initiated”		TRE 3.1-2	
AC Circuit Sustained Outages by Cause Code		TRE 3.1-3	
AC Circuit Sustained Outages – Other Attributes		TRE 3.1-4	
AC Circuit Momentary Outage Metrics – Element-Initiated Only		TRE 3.1-5	
AC Circuit Momentary Outage Metrics – Other than “Element-Initiated”		TRE 3.1-6	
AC Circuit Momentary Outages by Cause Code		TRE 3.1-7	
AC Circuit Momentary Outages – Other Attributes		TRE 3.1-8	
AC Circuit Metrics 1-16 per Appendix 2		TRE 3.1-9	
3.2 DC Circuit Metrics and Data	DC Circuit Sustained Outage Metrics – Element-Initiated Only	TRE 3.2-1	
	DC Circuit Sustained Outage Metrics – Other than “Element-Initiated”	TRE 3.2-2	
	DC Circuit Sustained Outages by Cause Code	TRE 3.2-3	
	DC Circuit Sustained Outages – Other Attributes	TRE 3.2-4	
	DC Circuit Momentary Outage Metrics – Element-Initiated Only	TRE 3.2-5	
	DC Circuit Momentary Outage Metrics – Other than “Element-Initiated”	TRE 3.2-6	
	DC Circuit Momentary Outages by Cause Code	TRE 3.2-7	
	DC Circuit Momentary Outages – Other Attributes	TRE 3.2-8	
	DC Circuit Metrics 1-16 per Appendix 2	TRE 3.2-9	

Table TRE 1-1 (cont'd)

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

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

Table TRE 1-2
Categories Displayed in Report Tables and Figures with Performance Data
Based upon the NERC Element Inventory⁸

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		

⁸ As noted in Section 1.6.2, Tables 2-1 and 2-2 have inventory data for all the Voltage Classes.

2 TRE 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, TRE 2-1 and TRE 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 TRE 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	0.0	0	263.6	10614	0	0	0	0			263.6	10614
Overhead	0.0	0	263.6	10614	0	0	0	0			263.6	10614
Underground	0.0	0	0	0	0	0	0	0			0	0
AC Multi-Circuit Structure Miles*		0		2054		0		0		0		2054
Transformer	0		0		0		0				0	

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

**Table TRE 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	0	0	0	0	0	0	0	0	0	0	0	0
Overhead	0	0	0	0	0	0	0	0	0	0	0	0
Underground	0	0	0	0	0	0	0	0	0	0	0	0
DC Multi-Circuit Structure Miles*		0		0		0		0		0		0
AC/DC BTB Converters**												
Name	200-299 kV		300-399 kV		400-599 kV				600-799 kV		All Voltages	
AC/DC BTB Converters**	0		0		0				0		0	

* 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 TRE 2-1
AC Circuit Outage Frequency by Outage Initiation Code

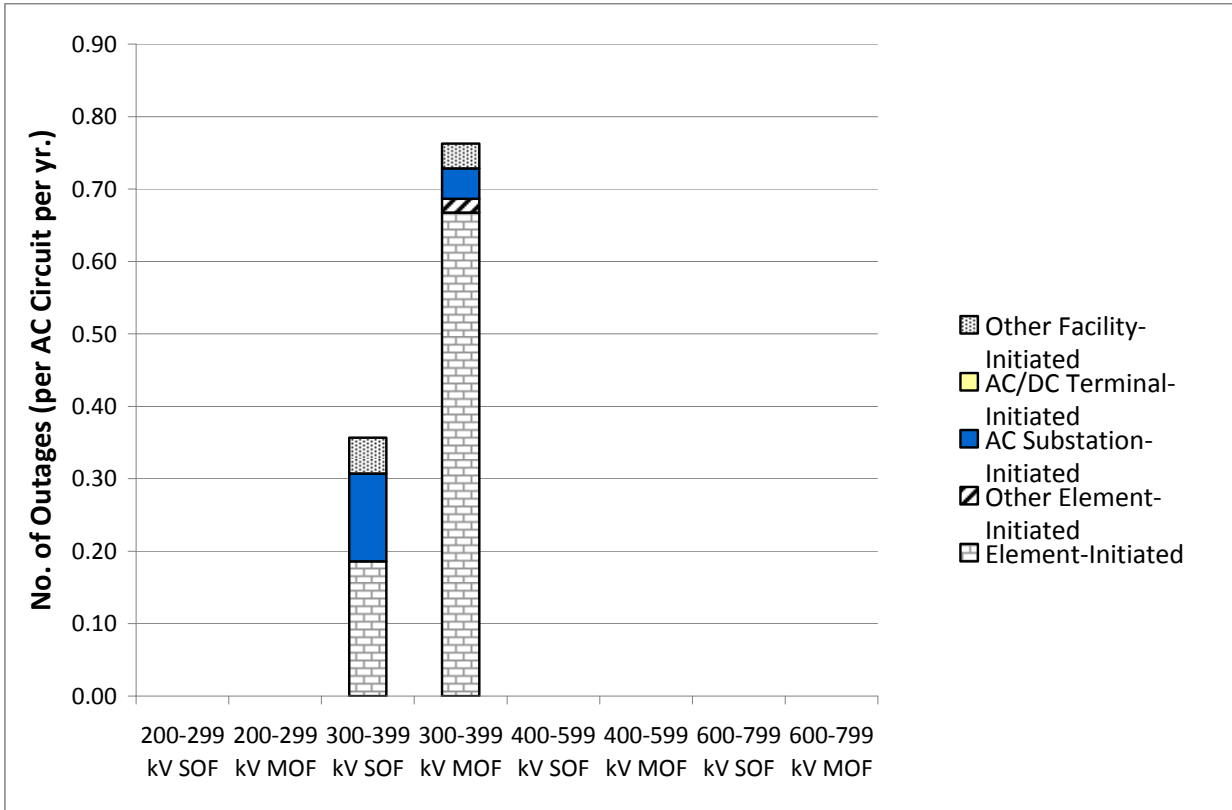


Figure TRE 2-2
AC Circuit Outage Duration by Outage Initiation Code

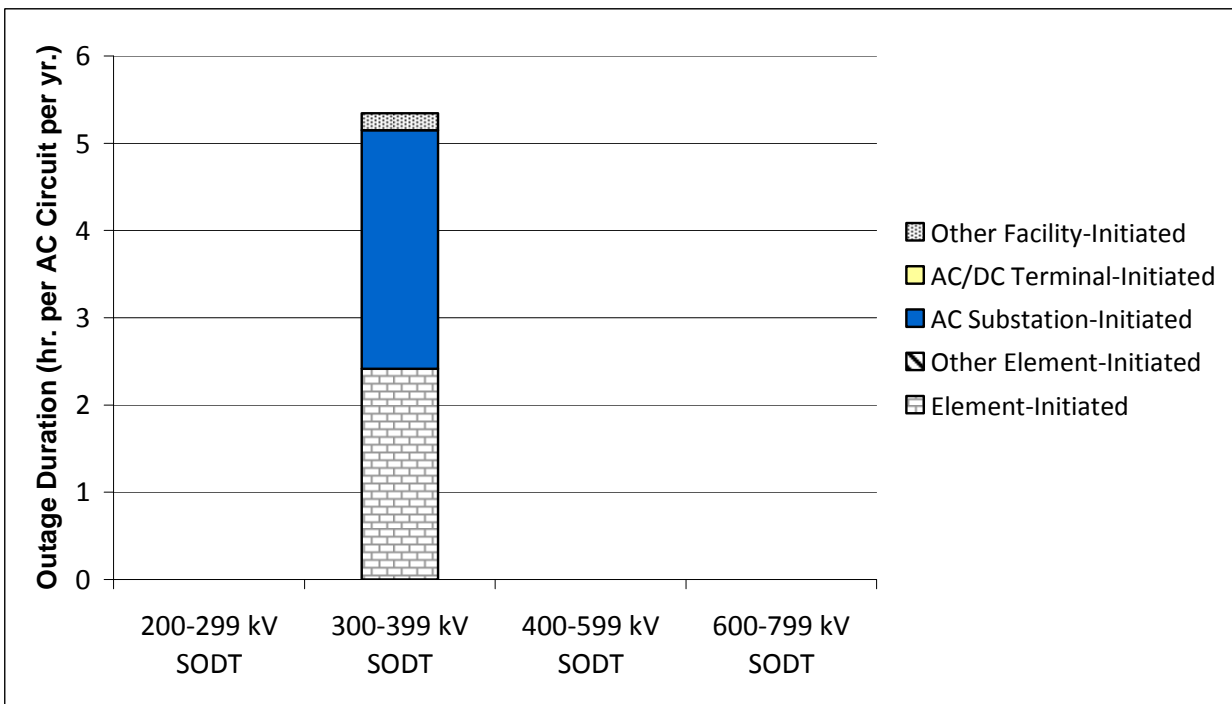


Figure TRE 2-3
DC Circuit Outage Frequency by Outage Initiation Code

This category of data is not displayed because there are no DC Circuits in TRE. See Table TRE 2-2 in this report.

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

This category of data is not displayed because there are no DC Circuits in TRE. See Table TRE 2-2 in this report.

Figure TRE 2-5
Transformer Outage Frequency by Outage Initiation Code

This category of data is not displayed because there are no Transformers in TRE. See Table TRE 2-1 in this report.

Figure TRE 2-6
Transformer Outage Duration by Outage Initiation

This category of data is not displayed because there are no Transformers in TRE. See Table TRE 2-1 in this report.

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

This category of data is not displayed because there are no AC/DC BTB Converters in TRE. See Table TRE 2-2 in this report.

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

This category of data is not displayed because there are no AC/DC BTB Converters in TRE. See Table TRE 2-2 in this report.

2.3 Event Types

Event Type data, shown in Table TRE 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 is 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 TRE 2-3
Event Types and Outages**

Event Type	Events		Outages	
	# Events	%	# Outages	%
10	228	79.4%	228	77.3%
20	0	0.0%	0	0.0%
30	1	0.4%	2	0.7%
40	0	0.0%	0	0.0%
50	58	20.2%	65	22.0%
TOTAL	287	100.0%	295	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 TRE 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 TRE 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 tables provides a frequency calculation on a per 100 Circuit Miles (CM) basis.
- Table TRE 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 TRE 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	0	0.0	-	-	-	-	-
300-399 kV	10614	263.6	49	636.8	0.4617	0.1859	13.0
400-599 kV	0	0.0	-	-	-	-	-
600-799 kV	0	0.0	-	-	-	-	-
All Voltages	10614	263.6	49	636.8	0.4617	0.1859	13.0

**Table TRE 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	0.0	-	-	-	-
300-399 kV	263.6	45	771.8	0.1707	17.2
400-599 kV	0.0	-	-	-	-
600-799 kV	0.0	-	-	-	-
All Voltages	263.6	45	771.8	0.1707	17.2

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 TRE 3.1-3 shows the two Outage Cause Codes (Initiating and Sustained) plus the number of outage hours associated with each Cause Code.

Table TRE 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	-	-	-	-	-	-	13	13.8%	11	11.7%	181.0	12.9%
Lightning	-	-	-	-	-	-	12	12.8%	1	1.1%	0.1	0.0%
Environmental	-	-	-	-	-	-	0	0.0%	0	0.0%	0.0	0.0%
Contamination	-	-	-	-	-	-	4	4.3%	4	4.3%	3.3	0.2%
Foreign Interference	-	-	-	-	-	-	2	2.1%	3	3.2%	10.9	0.8%
Fire	-	-	-	-	-	-	5	5.3%	5	5.3%	4.7	0.3%
Vandalism, Terrorism, or Malicious Acts	-	-	-	-	-	-	1	1.1%	1	1.1%	2.8	0.2%
Failed AC Substation Equipment	-	-	-	-	-	-	20	21.3%	30	31.9%	724.6	51.4%
Failed AC/DC Terminal Equipment	-	-	-	-	-	-	0	0.0%	0	0.0%	0.0	0.0%
Failed Protection System Equipment	-	-	-	-	-	-	5	5.3%	5	5.3%	30.2	2.1%
Failed AC Circuit Equipment	-	-	-	-	-	-	6	6.4%	9	9.6%	273.0	19.4%
Failed DC Circuit Equipment	-	-	-	-	-	-	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	-	-	-	-	-	-	2	2.1%	2	2.1%	7.7	0.5%
Power System Condition	-	-	-	-	-	-	11	11.7%	10	10.6%	34.4	2.4%
Human Error	-	-	-	-	-	-	5	5.3%	6	6.4%	5.9	0.4%
Unknown	-	-	-	-	-	-	7	7.4%	6	6.4%	1.9	0.1%
Other	-	-	-	-	-	-	1	1.1%	0	0.0%	0.0	0.0%
Unavailable	-	-	-	-	-	-	0	0.0%	1	1.1%	128.0	9.1%
TOTAL	-	-	-	-	-	-	94	100.0%	94	100.0%	1408.6	100.0%

Table TRE 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	-	-	-	-	-	-	-	-	-	-	-	-
Lightning	-	-	-	-	-	-	-	-	-	-	-	-
Environmental	-	-	-	-	-	-	-	-	-	-	-	-
Contamination	-	-	-	-	-	-	-	-	-	-	-	-
Foreign Interference	-	-	-	-	-	-	-	-	-	-	-	-
Fire	-	-	-	-	-	-	-	-	-	-	-	-
Vandalism, Terrorism, or Malicious Acts	-	-	-	-	-	-	-	-	-	-	-	-
Failed AC Substation Equipment	-	-	-	-	-	-	-	-	-	-	-	-
Failed AC/DC Terminal Equipment	-	-	-	-	-	-	-	-	-	-	-	-
Failed Protection System Equipment	-	-	-	-	-	-	-	-	-	-	-	-
Failed AC Circuit Equipment	-	-	-	-	-	-	-	-	-	-	-	-
Failed DC Circuit Equipment	-	-	-	-	-	-	-	-	-	-	-	-
Vegetation	-	-	-	-	-	-	-	-	-	-	-	-
Power System Condition	-	-	-	-	-	-	-	-	-	-	-	-
Human Error	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-
Unavailable	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-

Table TRE 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	13	13.8%	11	11.7%	181.0	12.9%
Lightning	12	12.8%	1	1.1%	0.1	0.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%
Contamination	4	4.3%	4	4.3%	3.3	0.2%
Foreign Interference	2	2.1%	3	3.2%	10.9	0.8%
Fire	5	5.3%	5	5.3%	4.7	0.3%
Vandalism, Terrorism, or Malicious Acts	1	1.1%	1	1.1%	2.8	0.2%
Failed AC Substation Equipment	20	21.3%	30	31.9%	724.6	51.4%
Failed AC/DC Terminal Equipment	0	0.0%	0	0.0%	0.0	0.0%
Failed Protection System Equipment	5	5.3%	5	5.3%	30.2	2.1%
Failed AC Circuit Equipment	6	6.4%	9	9.6%	273.0	19.4%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	2	2.1%	2	2.1%	7.7	0.5%
Power System Condition	11	11.7%	10	10.6%	34.4	2.4%
Human Error	5	5.3%	6	6.4%	5.9	0.4%
Unknown	7	7.4%	6	6.4%	1.9	0.1%
Other	1	1.1%	0	0.0%	0.0	0.0%
Unavailable	0	0.0%	1	1.1%	128.0	9.1%
TOTAL	94	100.0%	94	100.0%	1408.6	100.0%

3.1.1.3 Other AC Circuit Sustained Outage Data

Table TRE 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 TRE 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	-	-	-	-	54	57.4%	423.0	30.0%	-	-	-	-	-	-	-	-
P-P fault	-	-	-	-	1	1.1%	1.1	0.1%	-	-	-	-	-	-	-	-
Single P-G fault	-	-	-	-	26	27.7%	711.6	50.5%	-	-	-	-	-	-	-	-
P-P-G, 3 P, or 3P-G fault	-	-	-	-	6	6.4%	223.1	15.8%	-	-	-	-	-	-	-	-
Unknown fault type	-	-	-	-	7	7.4%	49.8	3.5%	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	94	100.0%	1408.6	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	-	-	-	-	49	52.1%	636.8	45.2%	-	-	-	-	-	-	-	-
Other Element-Initiated	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-	-	-	-	-
AC Substation-Initiated	-	-	-	-	32	34.0%	720.9	51.2%	-	-	-	-	-	-	-	-
AC/DC Terminal-Initiated	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-	-	-	-	-
Other Facility-Initiated	-	-	-	-	13	13.8%	50.9	3.6%	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	94	100.0%	1408.6	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	-	-	-	-	55	58.5%	636.8	45.2%	-	-	-	-	-	-	-	-
Dependent Mode Initiating	-	-	-	-	15	16.0%	0.0	0.0%	-	-	-	-	-	-	-	-
Dependent Mode	-	-	-	-	6	6.4%	720.9	51.2%	-	-	-	-	-	-	-	-
Common Mode	-	-	-	-	17	18.1%	0.0	0.0%	-	-	-	-	-	-	-	-
Common Mode Initiating	-	-	-	-	1	1.1%	50.9	3.6%	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	94	100.0%	1408.6	100.0%	-	-	-	-	-	-	-	-

Table TRE 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	-	-	-	-	59	62.8%	1034.9	73.5%	-	-	-	-	-	-	-	-
30	-	-	-	-	1	1.1%	0.0	0.0%	-	-	-	-	-	-	-	-
50	-	-	-	-	34	36.2%	373.7	26.5%	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	94	100.0%	1408.6	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	-	-	9	9.6%	-	-	-	-
6-10 Minutes	-	-	6	6.4%	-	-	-	-
11-30 Minutes	-	-	10	10.6%	-	-	-	-
31-120 Minutes	-	-	18	19.1%	-	-	-	-
> 120 Minutes	-	-	51	54.3%	-	-	-	-
TOTAL	-	-	94	100.0%	-	-	-	-

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

Fault Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
No fault	54	57.4%	423.0	30.0%
P-P fault	1	1.1%	1.1	0.1%
Single P-G fault	26	27.7%	711.6	50.5%
P-P-G, 3 P, or 3P-G fault	6	6.4%	223.1	15.8%
Unknown fault type	7	7.4%	49.8	3.5%
TOTAL	94	100.0%	1408.6	100.0%

Outage Initiation Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	49	52.1%	636.8	45.2%
Other Element-Initiated	0	0.0%	0.0	0.0%
AC Substation-Initiated	32	34.0%	720.9	51.2%
AC/DC Terminal-Initiated	0	0.0%	0.0	0.0%
Other Facility-Initiated	13	13.8%	50.9	3.6%
TOTAL	94	100.0%	1408.6	100.0%

Outage Mode Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Single Mode	55	58.5%	636.8	45.2%
Dependent Mode Initiating	15	16.0%	0.0	0.0%
Dependent Mode	6	6.4%	720.9	51.2%
Common Mode	17	18.1%	0.0	0.0%
Common Mode Initiating	1	1.1%	50.9	3.6%
TOTAL	94	100.0%	1408.6	100.0%

Event Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
10	59	62.8%	1034.9	73.5%
30	1	1.1%	0.0	0.0%
50	34	36.2%	373.7	26.5%
TOTAL	94	100.0%	1408.6	100.0%

Outage Duration Interval	All Voltages	
	No. Sust.	%
1-5 Minutes	9	9.6%
6-10 Minutes	6	6.4%
11-30 Minutes	10	10.6%
31-120 Minutes	18	19.1%
> 120 Minutes	51	54.3%
TOTAL	94	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 TRE 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 tables provides a frequency calculation on a per 100 Circuit Miles (CM) basis.
- Table TRE 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 TRE 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	0	0.0	-	-	-
300-399 kV	10614	263.6	176	1.6582	0.6677
400-599 kV	0	0.0	-	-	-
600-799 kV	0	0.0	-	-	-
All Voltages	10614	263.6	176	1.6582	0.6677

**Table TRE 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	0.0	-	-
300-399 kV	263.6	25	0.0948
400-599 kV	0.0	-	-
600-799 kV	0.0	-	-
All Voltages	263.6	25	0.0948

3.1.2.2 AC Circuit Momentary Outage Cause Code Data

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

**Table TRE 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	-	-	21	10.4%	-	-	-	-	21	10.4%
Lightning	-	-	48	23.9%	-	-	-	-	48	23.9%
Environmental	-	-	0	0.0%	-	-	-	-	0	0.0%
Contamination	-	-	17	8.5%	-	-	-	-	17	8.5%
Foreign Interference	-	-	19	9.5%	-	-	-	-	19	9.5%
Fire	-	-	2	1.0%	-	-	-	-	2	1.0%
Vandalism, Terrorism, or Malicious Acts	-	-	0	0.0%	-	-	-	-	0	0.0%
Failed AC Substation Equipment	-	-	4	2.0%	-	-	-	-	4	2.0%
Failed AC/DC Terminal Equipment	-	-	0	0.0%	-	-	-	-	0	0.0%
Failed Protection System Equipment	-	-	8	4.0%	-	-	-	-	8	4.0%
Failed AC Circuit Equipment	-	-	8	4.0%	-	-	-	-	8	4.0%
Failed DC Circuit Equipment	-	-	0	0.0%	-	-	-	-	0	0.0%
Vegetation	-	-	0	0.0%	-	-	-	-	0	0.0%
Power System Condition	-	-	0	0.0%	-	-	-	-	0	0.0%
Human Error	-	-	3	1.5%	-	-	-	-	3	1.5%
Unknown	-	-	69	34.3%	-	-	-	-	69	34.3%
Other	-	-	2	1.0%	-	-	-	-	2	1.0%
Unavailable	-	-	0	0.0%	-	-	-	-	0	0.0%
TOTAL	-	-	201	100.0%	-	-	-	-	201	100.0%

3.1.2.3 Other AC Circuit Momentary Outage Data

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

**Table TRE 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	-	-	42	20.9%	-	-	-	-	42	20.9%
P-P fault	-	-	2	1.0%	-	-	-	-	2	1.0%
Single P-G fault	-	-	150	74.6%	-	-	-	-	150	74.6%
P-P-G, 3 P, or 3P-G fault	-	-	6	3.0%	-	-	-	-	6	3.0%
Unknown fault type	-	-	1	0.5%	-	-	-	-	1	0.5%
TOTAL	-	-	201	100.0%	-	-	-	-	201	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	-	-	176	87.6%	-	-	-	-	176	87.6%
Other Element-Initiated	-	-	5	2.5%	-	-	-	-	5	2.5%
AC Substation-Initiated	-	-	11	5.5%	-	-	-	-	11	5.5%
AC/DC Terminal-Initiated	-	-	0	0.0%	-	-	-	-	0	0.0%
Other Facility-Initiated	-	-	9	4.5%	-	-	-	-	9	4.5%
TOTAL	-	-	201	100.0%	-	-	-	-	201	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	-	-	152	75.6%	-	-	-	-	152	75.6%
Dependent Mode Initiating	-	-	25	12.4%	-	-	-	-	25	12.4%
Dependent Mode	-	-	9	4.5%	-	-	-	-	9	4.5%
Common Mode	-	-	15	7.5%	-	-	-	-	15	7.5%
Common Mode Initiating	-	-	0	0.0%	-	-	-	-	0	0.0%
TOTAL	-	-	201	100.0%	-	-	-	-	201	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	-	-	169	84.1%	-	-	-	-	169	84.1%
30	-	-	1	0.5%	-	-	-	-	1	0.5%
50	-	-	31	15.4%	-	-	-	-	31	15.4%
TOTAL	-	-	201	100.0%	-	-	-	-	201	100.0%

3.1.3 Total AC Circuit Metrics

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

Table TRE 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	-	-	-	-	-	-	-	-	-	-	-	-
300-399 kV	Overhead	1.12	0.36	0.76	5.34	14.98	14.98	14.99	2.47	24617.6	99.94	52.08	0.34
400-599 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
600-799 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
200-299 kV	Underground	-	-	-	-	-	-	-	-	-	-	-	-
300-399 kV	Underground	-	-	-	-	-	-	-	-	-	-	-	-
400-599 kV	Underground	-	-	-	-	-	-	-	-	-	-	-	-

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	Elem. Init.	All	Elem. Init.	All	Elem. Init.						
200-299 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
300-399 kV	Overhead	2.78	2.12	0.89	0.46	1.89	1.66	0.10	0.05	0.05	201	94	1408.6
400-599 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
600-799 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
Mixed Voltages	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
200-299 kV	Underground	-	-	-	-	-	-	-	-	-	-	-	-
300-399 kV	Underground	-	-	-	-	-	-	-	-	-	-	-	-
400-599 kV	Underground	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL											201	94	1408.6

3.2 DC Circuit Metrics and Data

This category of data is not displayed because there are no DC Circuits in TRE. See Table TRE 2-2 in this report.

3.3 Transformer Metrics and Data

This category of data is not displayed because there are no Transformers in TRE. See Table TRE 2-1 in this report.

3.4 AC/DC BTB Converter Metrics and Data

This category of data is not displayed because there are no AC/DC BTB Converters in TRE. See Table TRE 2-2 in this report.

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 Table TRE 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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