

# NERC

NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

## Transmission Availability Data System 2008 Automatic Outage Metrics and Data Report

Region: WECC

June 30, 2009

to ensure  
the reliability of the  
bulk power system

116-390 Village Blvd., Princeton, NJ 08540  
609.452.8060 | 609.452.9550 fax  
[www.nerc.com](http://www.nerc.com)

# Table of Contents

1	Introduction.....	1
1.1	Contributors and Acknowledgements.....	1
1.2	TADS History .....	1
1.3	Scope.....	1
1.4	TADS Reports – NERC, Regional, and Transmission Owner .....	2
1.5	Confidential Data Not Publically Reported.....	3
1.6	Report Organization.....	3
1.6.1	Table and Figure Labeling.....	4
1.6.2	Tables and Figures Data Categories .....	4
1.6.3	Tables and Figures Data Display Conventions.....	4
1.7	Feedback and Comments .....	5
2	WECC Metrics and Data Summary .....	9
2.1	Element Inventory Data .....	9
2.2	Element Outage Frequency and Duration Metrics.....	9
2.3	Event Types .....	15
3	WECC Metrics and Data Details.....	16
3.1	AC Circuit Metrics and Data.....	16
3.1.1	AC Circuit Sustained Outages .....	16
3.1.1.1	AC Circuit Sustained Outage Initiation Code Metrics .....	16
3.1.1.2	AC Circuit Sustained Outage Cause Code Data .....	18
3.1.1.3	Other AC Circuit Sustained Outage Data .....	20
3.1.2	AC Circuit Momentary Outages .....	24
3.1.2.1	AC Circuit Momentary Outage Initiation Code Metrics .....	24
3.1.2.2	AC Circuit Momentary Outage Cause Code Data.....	24
3.1.2.3	Other AC Circuit Momentary Outage Data.....	25
3.1.3	Total AC Circuit Metrics .....	26
3.2	DC Circuit Metrics and Data.....	28
3.3	Transformer Metrics and Data.....	29
3.3.1	Transformer Sustained Outages.....	29
3.3.1.1	Transformer Sustained Outage Initiation Code Metrics .....	29
3.3.1.2	Transformer Sustained Outage Cause Code Data.....	30
3.3.1.3	Other Transformer Sustained Outage Data.....	32
3.3.2	Transformer Momentary Outages.....	36
3.3.2.1	Transformer Momentary Outage Initiation Code Metrics.....	36
3.3.2.2	Transformer Momentary Outage Cause Code Data.....	36
3.3.2.3	Other Transformer Momentary Outage Data.....	37
3.3.3	Total Transformer Metrics.....	37
3.4	AC/DC BTB Converter Metrics and Data.....	40
3.4.1	AC/DC BTB Converter Sustained Outages.....	40
3.4.1.1	AC/DC BTB Converter Sustained Outage Initiation Code Metrics .....	40

3.4.1.2	AC/DC BTB Converter Sustained Outage Cause Code Data.....	41
3.4.1.3	Other AC/DC BTB Converter Sustained Outage Data.....	42
3.4.2	AC/DC BTB Converter Momentary Outages.....	44
3.4.3	Total AC/DC BTB Converter Metrics.....	44
Appendix 1	TADS Definitions.....	1-1
Appendix 2	Metric Definitions.....	2-1
Appendix 3	TADS Task Force Members.....	3-1

# 1 Introduction

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## 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 63 reporting Transmission Owners (TOs) in the Western Electricity Coordinating Council (WECC). “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 WECC TOs complied.
- Participation is voluntary for Mexican and Canadian TOs on the NERC Compliance Registry, and all non-U.S. TOs in WECC voluntarily provided data.<sup>1</sup>

In addition to TOs, TADS Regional Entity coordinators (RECs) in WECC,<sup>2</sup> 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.<sup>3</sup>

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

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<sup>1</sup> For TADS, two Canadian TOs that are not on the NERC Compliance Registry voluntarily submitted TADS data. See *NERC ID Exceptions for TADS Data* posted at [NERC ID Exceptions](#).

<sup>2</sup> 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](#).

<sup>3</sup> 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.<sup>4</sup> 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 webTADS<sup>5</sup> 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

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

<sup>5</sup> 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 WECC 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 TADSTF<sup>6</sup> 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,<sup>7</sup> 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 reported by one TO.<sup>8</sup> 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 WECC:

1. AC Circuits – one TO reported all of the Underground 400-599 kV AC Circuit performance data in WECC. Therefore, no Underground 400-599 kV AC Circuit performance data is displayed in this report.
2. DC Circuits – one TO reported all the 500-599 kV DC Circuit performance data in WECC. Since this Voltage Class contains all of the DC Circuits in WECC, no DC Circuit performance data is displayed in this report.

Although the performance data above is excluded from this WECC report, with one exception, it is included in the NERC report since it is combined with data from other regions where TOs have the same type of facilities. The exception is the data for two Underground AC Circuits in the 400-599 kV class. These circuits are the only circuits with these characteristics in NERC.

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 is 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 WECC metrics and data for each of the reported Elements while Section 3 has more detailed data for these same Elements, with separate subsections

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<sup>6</sup> 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.

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

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

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 WECC 1-1 shows the assigned numbering scheme for the tables and figures in this report. The prefix “WECC” 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 WECC 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 WECC 1-2 shows the categories included in the NERC template.

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

### **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 WECC 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.<sup>9</sup>
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](mailto: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 the suggested change. NERC will use this feedback to develop and improve future reports.

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

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

**Table WECC 1-1 (cont'd)**

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

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

**Table WECC 1-2**  
**Categories Displayed in Report Tables and Figures with Performance Data**  
**Based upon the NERC Inventory<sup>10</sup>**

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		

<sup>10</sup> 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 WECC 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, WECC 2-1 and WECC 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 WECC 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
<b>AC Circuit - All</b>	1611.1	45097	136.5	11142	261.2	17928	0	0			2008.8	74167
<b>Overhead</b>	1570.0	44879	136.5	11142	259.2	17842	0	0			1965.7	73864
<b>Underground</b>	41.1	218	0	0	2	85	0	0			43.1	303
<b>AC Multi-Circuit Structure Miles*</b>		3936		112		2711		0		581		7340
<b>Transformer</b>	15		62		177		0				254	

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

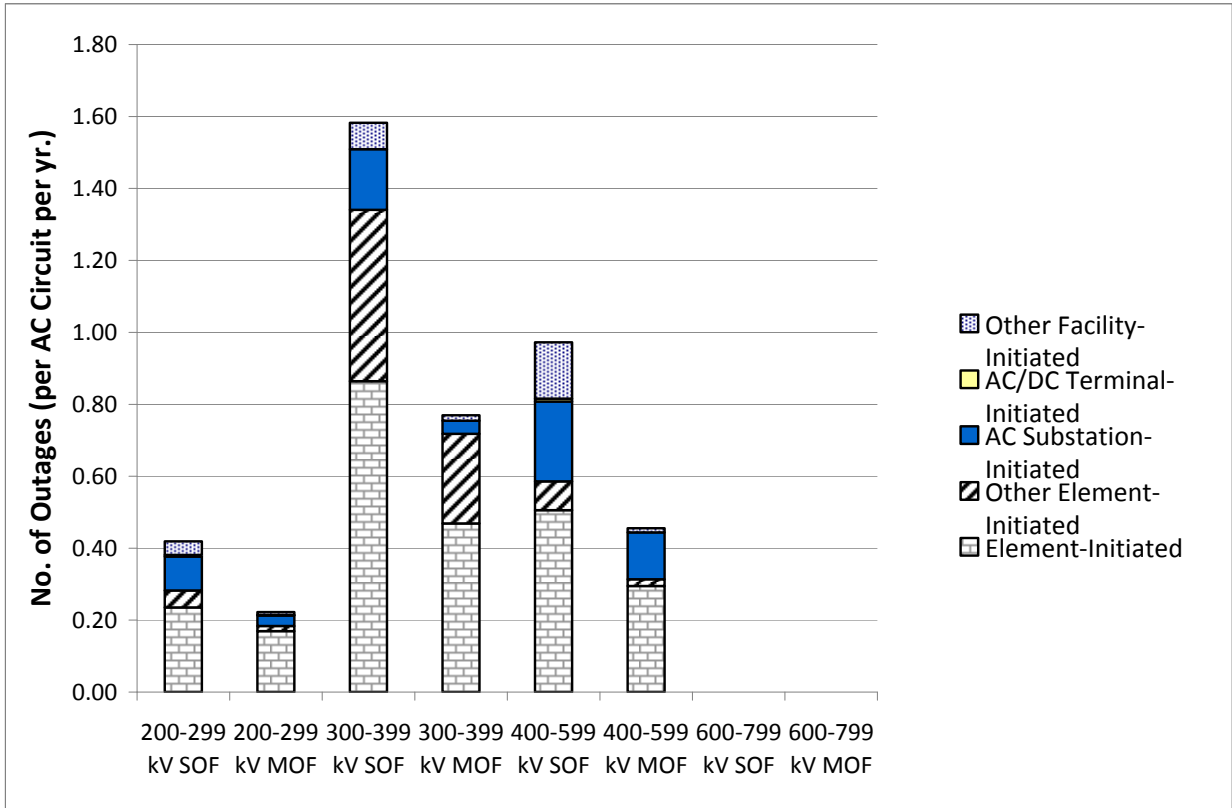
**Table WECC 2-2  
Inventory of DC Transmission Equipment**

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
<b>DC Circuit - All</b>	0	0	0	0	0	0	4	2137	0	0	4	2137
<b>Overhead</b>	0	0	0	0	0	0	4	2137	0	0	4	2137
<b>Underground</b>	0	0	0	0	0	0	0	0	0	0	0	0
<b>DC Multi-Circuit Structure Miles*</b>		0		0		0		1068		0		1068
<b>Name</b>	<b>200-299 kV</b>		<b>300-399 kV</b>		<b>400-599 kV</b>				<b>600-799 kV</b>		<b>All Voltages</b>	
<b>AC/DC BTB Converters**</b>	5.6		2		0				0		7.6	

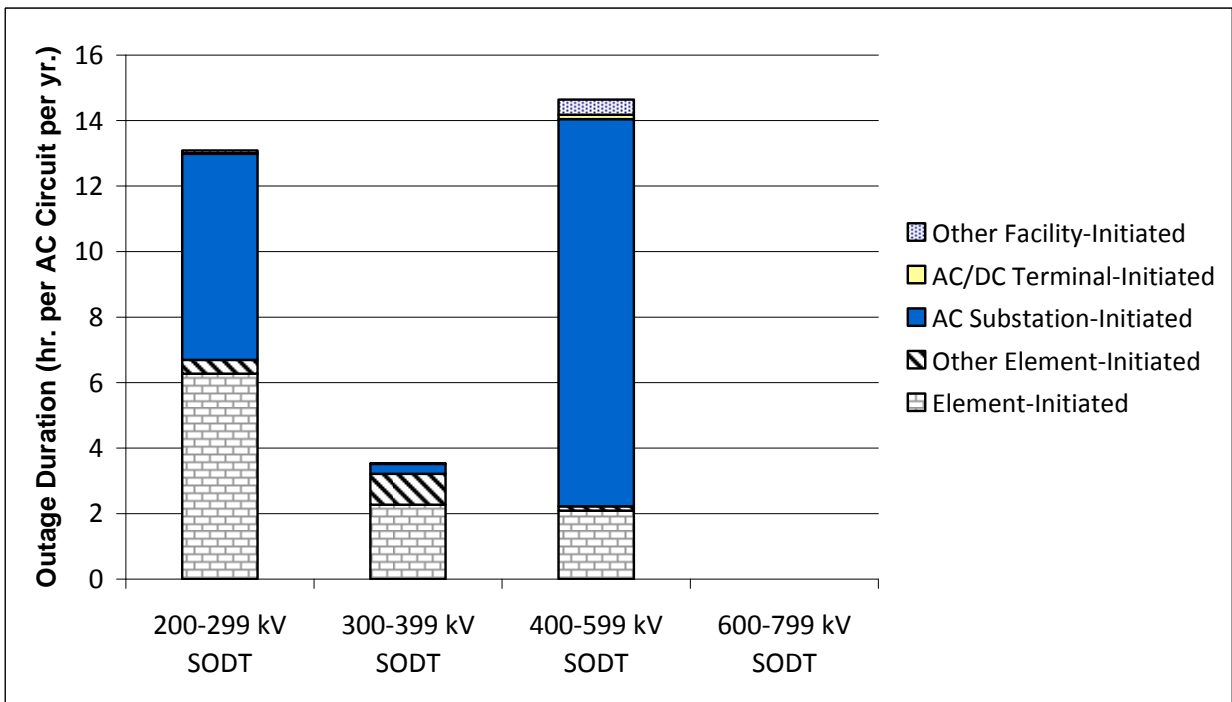
\* The data shown for DC Multi-Circuit Structure Miles is Multi-Circuit Structure Miles, not Circuit Miles.

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

**Figure WECC 2-1**  
**AC Circuit Outage Frequency by Outage Initiation Code**



**Figure WECC 2-2**  
**AC Circuit Outage Duration by Outage Initiation Code**



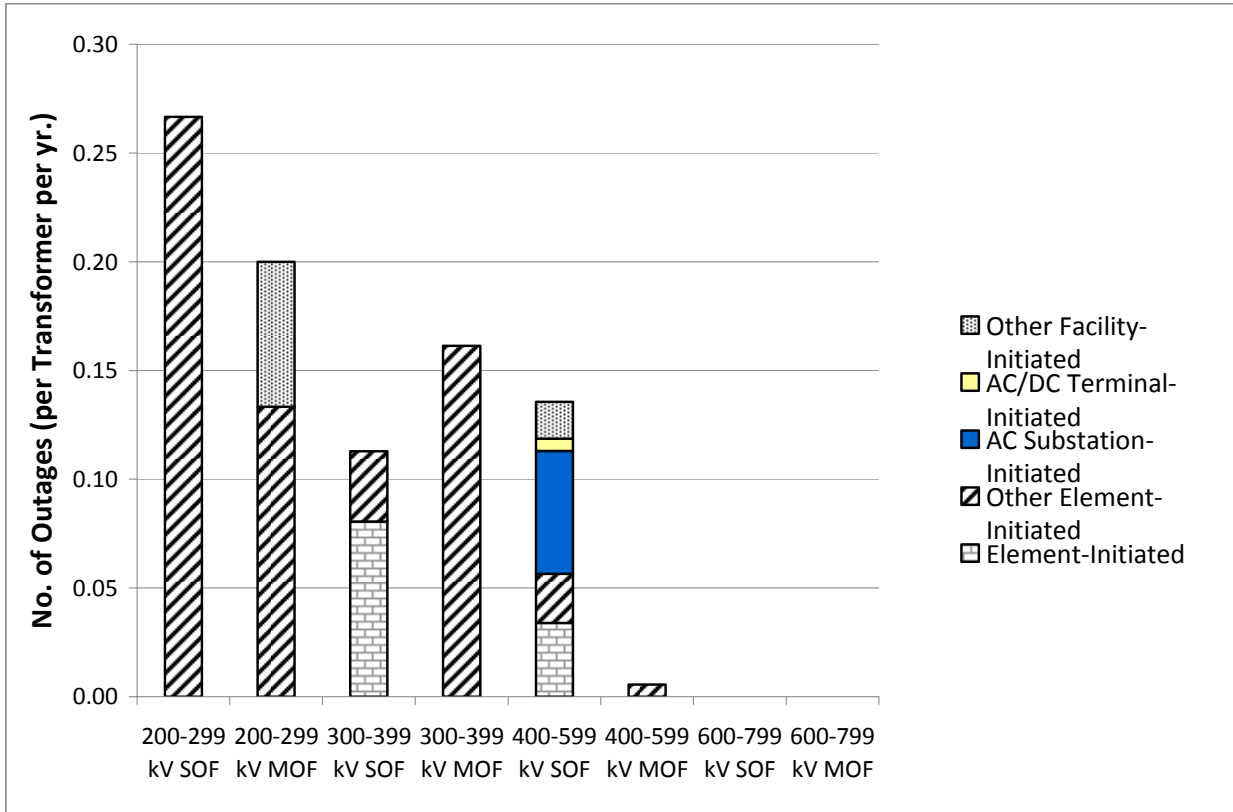
**Figure WECC 2-3**  
**DC Circuit Outage Frequency by Outage Initiation Code**

This category of data is not displayed because it would reveal confidential Transmission Owner information. See Section 1.5 of this report.

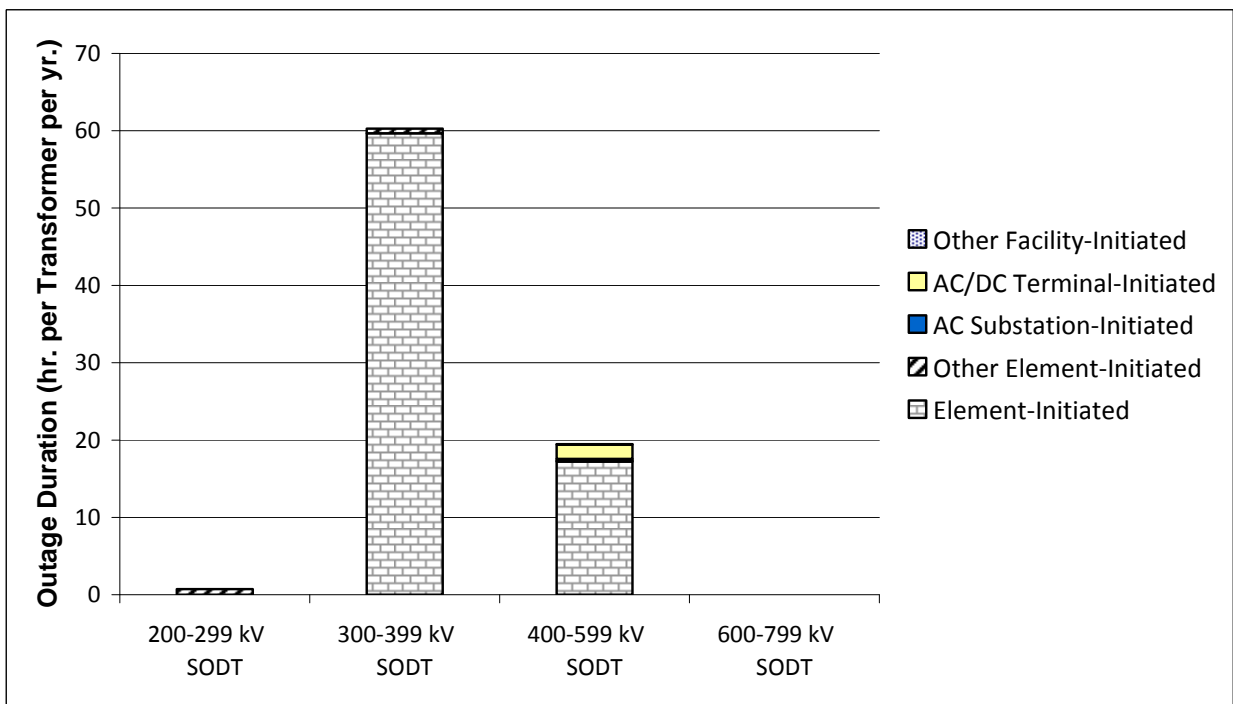
**Figure WECC 2-4**  
**DC Circuit Outage Duration by Outage Initiation Code**

This category of data is not displayed because it would reveal confidential Transmission Owner information. See Section 1.5 of this report.

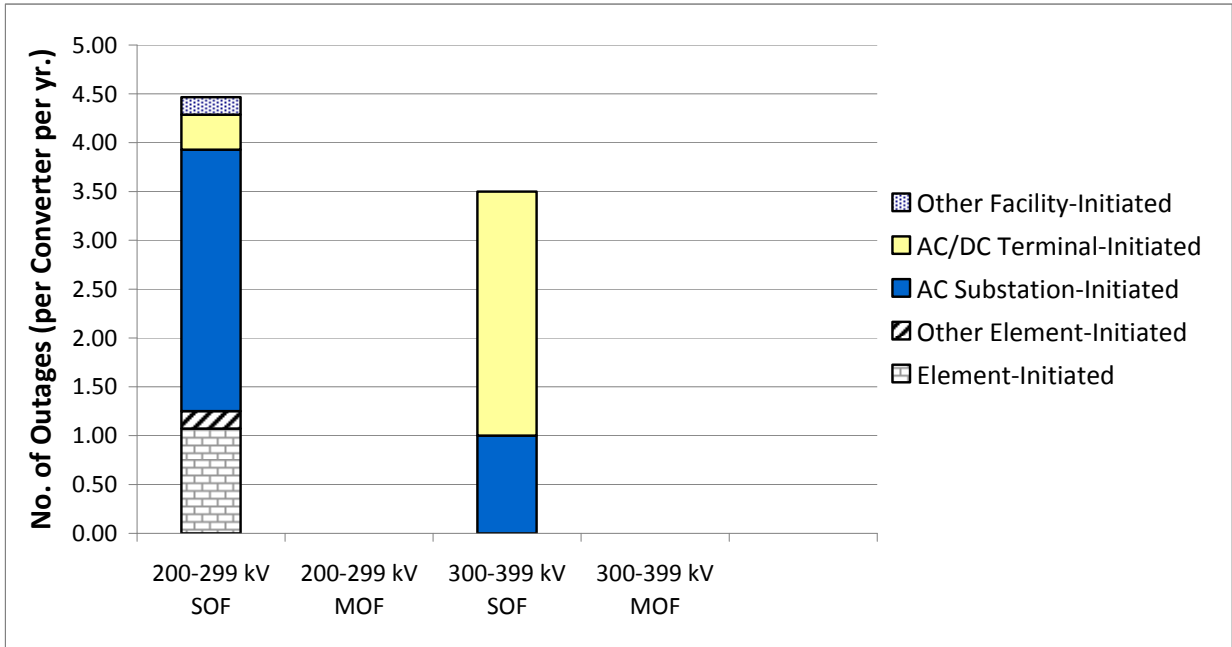
**Figure WECC 2-5  
Transformer Outage Frequency by Outage Initiation Code**



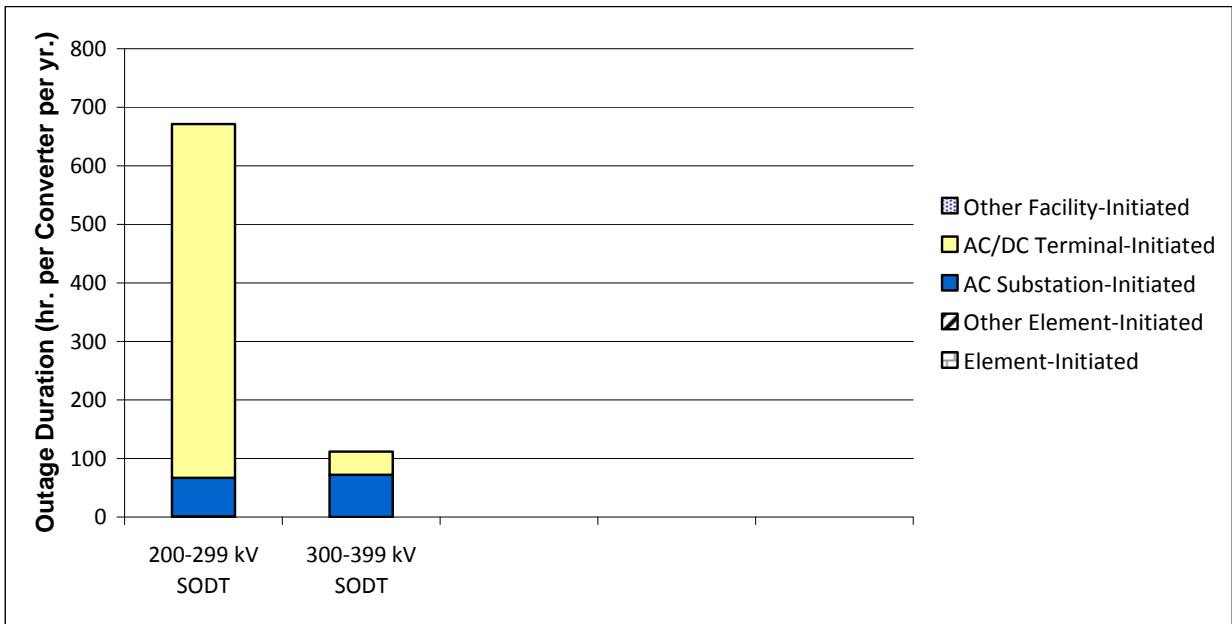
**Figure WECC 2-6  
Transformer Outage Duration by Outage Initiation**



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



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



## 2.3 Event Types

Event Type data, shown in Table WECC 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 confidential data exclusions for Event Types 20 and 40 that are associated with DC Circuits since, as explained in Section 1.5, one TO reported all the performance data for DC Circuits in WECC.

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

Event Type	Events		Outages	
	# Events	%	# Outages	%
10	1402	86.9%	1402	77.4%
20	C	C	C	C
30	66	4.1%	143	7.9%
40	C	C	C	C
50	145	9.0%	266	14.7%
TOTAL	1613	100.0%	1811	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 WECC 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 WECC 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 provides a frequency calculation on a per 100 Circuit Miles (CM) basis.
- Table WECC 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 WECC 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	45097	1611.1	379	10108.2	0.8404	0.2352	26.7
300-399 kV	11142	136.5	118	310.4	1.0591	0.8645	2.6
400-599 kV	17928	261.2	132	546.6	0.7363	0.5054	4.1
600-799 kV	0	0.0	-	-	-	-	-
All Voltages	74167	2008.8	629	10965.2	0.8481	0.3131	17.4

**Table WECC 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	1611.1	296	10978.6	0.1837	37.1
300-399 kV	136.5	98	172.1	0.7179	1.8
400-599 kV	261.2	122	3277.4	0.4671	26.9
600-799 kV	0.0	-	-	-	-
All Voltages	2008.8	516	14428.0	0.2569	28.0

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

**Table WECC 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	82	12.1%	47	7.0%	946.3	4.5%	25	11.6%	15	6.9%	42.3	8.8%
Lightning	50	7.4%	11	1.6%	5.9	0.0%	15	6.9%	9	4.2%	3.4	0.7%
Environmental	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Contamination	13	1.9%	4	0.6%	47.6	0.2%	3	1.4%	3	1.4%	0.4	0.1%
Foreign Interference	25	3.7%	16	2.4%	91.5	0.4%	6	2.8%	5	2.3%	1.2	0.2%
Fire	66	9.8%	57	8.4%	2722.4	12.9%	6	2.8%	1	0.5%	0.0	0.0%
Vandalism, Terrorism, or Malicious Acts	5	0.7%	2	0.3%	50.7	0.2%	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	67	9.9%	41	6.1%	1281.4	6.1%	19	8.8%	13	6.0%	55.5	11.5%
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	25	3.7%	19	2.8%	63.3	0.3%	3	1.4%	2	0.9%	1.9	0.4%
Failed AC Circuit Equipment	66	9.8%	67	9.9%	4158.6	19.7%	15	6.9%	20	9.3%	158.1	32.8%
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	12	1.8%	6	0.9%	372.3	1.8%	1	0.5%	0	0.0%	0.0	0.0%
Power System Condition	21	3.1%	20	3.0%	30.5	0.1%	3	1.4%	2	0.9%	0.2	0.0%
Human Error	70	10.4%	35	5.2%	26.9	0.1%	14	6.5%	10	4.6%	3.2	0.7%
Unknown	146	21.6%	187	27.7%	2048.6	9.7%	99	45.8%	100	46.3%	93.6	19.4%
Other	27	4.0%	27	4.0%	72.5	0.3%	0	0.0%	11	5.1%	2.1	0.4%
Unavailable	0	0.0%	136	20.1%	9168.2	43.5%	7	3.2%	25	11.6%	120.7	25.0%
<b>TOTAL</b>	<b>675</b>	<b>100.0%</b>	<b>675</b>	<b>100.0%</b>	<b>21086.8</b>	<b>100.0%</b>	<b>216</b>	<b>100.0%</b>	<b>216</b>	<b>100.0%</b>	<b>482.5</b>	<b>100.0%</b>

**Table WECC 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	42	16.5%	27	10.6%	9.5	0.2%	-	-	-	-	-	-
Lightning	24	9.4%	9	3.5%	6.7	0.2%	-	-	-	-	-	-
Environmental	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Contamination	4	1.6%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Foreign Interference	4	1.6%	2	0.8%	122.5	3.2%	-	-	-	-	-	-
Fire	22	8.7%	13	5.1%	23.5	0.6%	-	-	-	-	-	-
Vandalism, Terrorism, or Malicious Acts	2	0.8%	1	0.4%	0.2	0.0%	-	-	-	-	-	-
Failed AC Substation Equipment	36	14.2%	14	5.5%	232.3	6.1%	-	-	-	-	-	-
Failed AC/DC Terminal Equipment	1	0.4%	1	0.4%	30.7	0.8%	-	-	-	-	-	-
Failed Protection System Equipment	15	5.9%	11	4.3%	20.6	0.5%	-	-	-	-	-	-
Failed AC Circuit Equipment	8	3.1%	7	2.8%	93.7	2.4%	-	-	-	-	-	-
Failed DC Circuit Equipment	1	0.4%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Vegetation	2	0.8%	1	0.4%	0.1	0.0%	-	-	-	-	-	-
Power System Condition	16	6.3%	12	4.7%	18.2	0.5%	-	-	-	-	-	-
Human Error	30	11.8%	14	5.5%	12.3	0.3%	-	-	-	-	-	-
Unknown	45	17.7%	34	13.4%	66.1	1.7%	-	-	-	-	-	-
Other	2	0.8%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Unavailable	0	0.0%	108	42.5%	3187.5	83.4%	-	-	-	-	-	-
<b>TOTAL</b>	<b>254</b>	<b>100.0%</b>	<b>254</b>	<b>100.0%</b>	<b>3823.9</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

**Table WECC 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	149	13.0%	89	7.8%	998.1	3.9%
Lightning	89	7.8%	29	2.5%	15.9	0.1%
Environmental	0	0.0%	0	0.0%	0.0	0.0%
Contamination	20	1.7%	7	0.6%	48.0	0.2%
Foreign Interference	35	3.1%	23	2.0%	215.2	0.8%
Fire	94	8.2%	71	6.2%	2745.9	10.8%
Vandalism, Terrorism, or Malicious Acts	7	0.6%	3	0.3%	50.9	0.2%
Failed AC Substation Equipment	122	10.7%	68	5.9%	1569.1	6.2%
Failed AC/DC Terminal Equipment	1	0.1%	1	0.1%	30.7	0.1%
Failed Protection System Equipment	43	3.8%	32	2.8%	85.8	0.3%
Failed AC Circuit Equipment	89	7.8%	94	8.2%	4410.4	17.4%
Failed DC Circuit Equipment	1	0.1%	0	0.0%	0.0	0.0%
Vegetation	15	1.3%	7	0.6%	372.4	1.5%
Power System Condition	40	3.5%	34	3.0%	48.9	0.2%
Human Error	114	10.0%	59	5.2%	42.5	0.2%
Unknown	290	25.3%	321	28.0%	2208.3	8.7%
Other	29	2.5%	38	3.3%	74.6	0.3%
Unavailable	7	0.6%	269	23.5%	12476.5	49.1%
<b>TOTAL</b>	<b>1145</b>	<b>100.0%</b>	<b>1145</b>	<b>100.0%</b>	<b>25393.2</b>	<b>100.0%</b>

### 3.1.1.3 Other AC Circuit Sustained Outage Data

Table WECC 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 WECC 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	184	27.3%	1099.5	5.2%	38	17.6%	34.1	7.1%	93	36.6%	2939.1	76.9%	-	-	-	-
P-P fault	52	7.7%	1496.8	7.1%	5	2.3%	27.9	5.8%	21	8.3%	158.2	4.1%	-	-	-	-
Single P-G fault	231	34.2%	14929.7	70.8%	93	43.1%	260.0	53.9%	100	39.4%	398.2	10.4%	-	-	-	-
P-P-G, 3 P, or 3P-G fault	63	9.3%	1478.6	7.0%	4	1.9%	15.1	3.1%	8	3.1%	15.7	0.4%	-	-	-	-
Unknown fault type	145	21.5%	2082.1	9.9%	76	35.2%	145.4	30.1%	32	12.6%	312.7	8.2%	-	-	-	-
<b>TOTAL</b>	<b>675</b>	<b>100.0%</b>	<b>21086.8</b>	<b>100.0%</b>	<b>216</b>	<b>100.0%</b>	<b>482.5</b>	<b>100.0%</b>	<b>254</b>	<b>100.0%</b>	<b>3823.93</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

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	379	56.1%	10108.2	47.9%	118	54.6%	310.4	64.3%	132	52.0%	2939.1	76.9%	-	-	-	-
Other Element-Initiated	76	11.3%	676.0	3.2%	65	30.1%	128.6	26.7%	21	8.3%	158.2	4.1%	-	-	-	-
AC Substation-Initiated	152	22.5%	10138.8	48.1%	23	10.6%	40.8	8.5%	58	22.8%	398.2	10.4%	-	-	-	-
AC/DC Terminal-Initiated	7	1.0%	26.4	0.1%	0	0.0%	0.0	0.0%	2	0.8%	15.7	0.4%	-	-	-	-
Other Facility-Initiated	61	9.0%	137.4	0.7%	10	4.6%	2.6	0.5%	41	16.1%	312.7	8.2%	-	-	-	-
<b>TOTAL</b>	<b>675</b>	<b>100.0%</b>	<b>21086.8</b>	<b>100.0%</b>	<b>216</b>	<b>100.0%</b>	<b>482.5</b>	<b>100.0%</b>	<b>254</b>	<b>100.0%</b>	<b>3823.93</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

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	482	71.4%	17902.9	84.9%	184	85.2%	310.4	64.3%	183	72.0%	926.6	24.2%	-	-	-	-
Dependent Mode Initiating	23	3.4%	1085.4	5.1%	6	2.8%	128.6	26.7%	12	4.7%	81.6	2.1%	-	-	-	-
Dependent Mode	63	9.3%	1322.4	6.3%	12	5.6%	40.8	8.5%	24	9.4%	2784.5	72.8%	-	-	-	-
Common Mode	104	15.4%	625.2	3.0%	12	5.6%	0.0	0.0%	32	12.6%	25.5	0.7%	-	-	-	-
Common Mode Initiating	3	0.4%	150.9	0.7%	2	0.9%	2.6	0.5%	3	1.2%	5.8	0.2%	-	-	-	-
<b>TOTAL</b>	<b>675</b>	<b>100.0%</b>	<b>21086.8</b>	<b>100.0%</b>	<b>216</b>	<b>100.0%</b>	<b>482.5</b>	<b>100.0%</b>	<b>254</b>	<b>100.0%</b>	<b>3823.93</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

**Table WECC 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	469	69.5%	19644.7	93.2%	185	85.6%	462.1	95.8%	189	74.4%	929.4	24.3%	-	-	-	-
30	77	11.4%	1101.8	5.2%	22	10.2%	16.2	3.4%	28	11.0%	108.8	2.8%	-	-	-	-
50	129	19.1%	340.3	1.6%	9	4.2%	4.2	0.9%	37	14.6%	2785.8	72.9%	-	-	-	-
<b>TOTAL</b>	<b>675</b>	<b>100.0%</b>	<b>21086.8</b>	<b>100.0%</b>	<b>216</b>	<b>100.0%</b>	<b>482.5</b>	<b>100.0%</b>	<b>254</b>	<b>100.0%</b>	<b>3823.9</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

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	181	26.8%	130	60.2%	90	35.4%	-	-
6-10 Minutes	62	9.2%	18	8.3%	34	13.4%	-	-
11-30 Minutes	81	12.0%	19	8.8%	31	12.2%	-	-
31-120 Minutes	106	15.7%	17	7.9%	37	14.6%	-	-
> 120 Minutes	245	36.3%	32	14.8%	62	24.4%	-	-
<b>TOTAL</b>	<b>675</b>	<b>100.0%</b>	<b>216</b>	<b>100.0%</b>	<b>254</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>

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

Fault Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
No fault	315	27.5%	4072.8	16.0%
P-P fault	78	6.8%	1683.0	6.6%
Single P-G fault	424	37.0%	15587.9	61.4%
P-P-G, 3 P, or 3P-G fault	75	6.6%	1509.4	5.9%
Unknown fault type	253	22.1%	2540.3	10.0%
<b>TOTAL</b>	<b>1145</b>	<b>100.0%</b>	<b>25393.2</b>	<b>100.0%</b>

Outage Initiation Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	629	54.9%	13357.7	52.6%
Other Element-Initiated	162	14.1%	962.8	3.8%
AC Substation-Initiated	233	20.3%	10577.8	41.7%
AC/DC Terminal-Initiated	9	0.8%	42.1	0.2%
Other Facility-Initiated	112	9.8%	452.7	1.8%
<b>TOTAL</b>	<b>1145</b>	<b>100.0%</b>	<b>25393.2</b>	<b>100.0%</b>

Outage Mode Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Single Mode	849	74.1%	19139.9	75.4%
Dependent Mode Initiating	41	3.6%	1295.6	5.1%
Dependent Mode	99	8.6%	4147.7	16.3%
Common Mode	148	12.9%	650.7	2.6%
Common Mode Initiating	8	0.7%	159.3	0.6%
<b>TOTAL</b>	<b>1145</b>	<b>100.0%</b>	<b>25393.2</b>	<b>100.0%</b>

Event Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
10	843	73.6%	21036.1	82.8%
30	127	11.1%	1226.8	4.8%
50	175	15.3%	3130.3	12.3%
<b>TOTAL</b>	<b>1145</b>	<b>100.0%</b>	<b>25393.2</b>	<b>100.0%</b>

Outage Duration Interval	All Voltages	
	No. Sust.	%
1-5 Minutes	401	35.0%
6-10 Minutes	114	10.0%
11-30 Minutes	131	11.4%
31-120 Minutes	160	14.0%
> 120 Minutes	339	29.6%
<b>TOTAL</b>	<b>1145</b>	<b>100.0%</b>

### 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 WECC 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 WECC 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 WECC 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	45097	1611.1	273	0.6054	0.1694
300-399 kV	11142	136.5	64	0.5744	0.4689
400-599 kV	17928	261.2	77	0.4295	0.2948
600-799 kV	0	0.0	-	-	-
All Voltages	74167	2008.8	414	0.5582	0.2061

**Table WECC 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	1611.1	86	0.0534
300-399 kV	136.5	41	0.3004
400-599 kV	261.2	42	0.1608
600-799 kV	0.0	-	-
All Voltages	2008.8	169	0.0841

#### 3.1.2.2 AC Circuit Momentary Outage Cause Code Data

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

**Table WECC 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	35	9.7%	2	1.9%	3	2.5%	-	-	40	6.9%
Lightning	130	36.2%	11	10.5%	44	37.0%	-	-	185	31.7%
Environmental	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
Contamination	11	3.1%	2	1.9%	0	0.0%	-	-	13	2.2%
Foreign Interference	14	3.9%	1	1.0%	0	0.0%	-	-	15	2.6%
Fire	10	2.8%	0	0.0%	5	4.2%	-	-	15	2.6%
Vandalism, Terrorism, or Malicious Acts	1	0.3%	0	0.0%	0	0.0%	-	-	1	0.2%
Failed AC Substation Equipment	8	2.2%	0	0.0%	1	0.8%	-	-	9	1.5%
Failed AC/DC Terminal Equipment	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
Failed Protection System Equipment	3	0.8%	2	1.9%	3	2.5%	-	-	8	1.4%
Failed AC Circuit Equipment	9	2.5%	2	1.9%	1	0.8%	-	-	12	2.1%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
Vegetation	1	0.3%	0	0.0%	0	0.0%	-	-	1	0.2%
Power System Condition	1	0.3%	0	0.0%	0	0.0%	-	-	1	0.2%
Human Error	7	1.9%	1	1.0%	1	0.8%	-	-	9	1.5%
Unknown	127	35.4%	83	79.0%	61	51.3%	-	-	271	46.5%
Other	2	0.6%	1	1.0%	0	0.0%	-	-	3	0.5%
Unavailable	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
<b>TOTAL</b>	<b>359</b>	<b>100.0%</b>	<b>105</b>	<b>100.0%</b>	<b>119</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>583</b>	<b>100.0%</b>

### 3.1.2.3 Other AC Circuit Momentary Outage Data

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

**Table WECC 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	18	5.0%	2	1.9%	3	2.5%	-	-	23	3.9%
P-P fault	10	2.8%	3	2.9%	1	0.8%	-	-	14	2.4%
Single P-G fault	230	64.1%	59	56.2%	99	83.2%	-	-	388	66.6%
P-P-G, 3 P, or 3P-G fault	39	10.9%	0	0.0%	6	5.0%	-	-	45	7.7%
Unknown fault type	62	17.3%	41	39.0%	10	8.4%	-	-	113	19.4%
<b>TOTAL</b>	<b>359</b>	<b>100.0%</b>	<b>105</b>	<b>100.0%</b>	<b>119</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>583</b>	<b>100.0%</b>

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	273	76.0%	64	61.0%	77	64.7%	-	-	414	71.0%
Other Element-Initiated	23	6.4%	34	32.4%	5	4.2%	-	-	62	10.6%
AC Substation-Initiated	47	13.1%	5	4.8%	34	28.6%	-	-	86	14.8%
AC/DC Terminal-Initiated	3	0.8%	0	0.0%	0	0.0%	-	-	3	0.5%
Other Facility-Initiated	13	3.6%	2	1.9%	3	2.5%	-	-	18	3.1%
<b>TOTAL</b>	<b>359</b>	<b>100.0%</b>	<b>105</b>	<b>100.0%</b>	<b>119</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>583</b>	<b>100.0%</b>

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	332	92.5%	96	91.4%	114	95.8%	-	-	542	93.0%
Dependent Mode Initiating	5	1.4%	7	6.7%	1	0.8%	-	-	13	2.2%
Dependent Mode	12	3.3%	2	1.9%	2	1.7%	-	-	16	2.7%
Common Mode	10	2.8%	0	0.0%	2	1.7%	-	-	12	2.1%
Common Mode Initiating	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
<b>TOTAL</b>	<b>359</b>	<b>100.0%</b>	<b>105</b>	<b>100.0%</b>	<b>119</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>583</b>	<b>100.0%</b>

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	335	93.3%	96	91.4%	115	96.6%	-	-	546	93.7%
30	10	2.8%	4	3.8%	2	1.7%	-	-	16	2.7%
50	14	3.9%	5	4.8%	2	1.7%	-	-	21	3.6%
<b>TOTAL</b>	<b>359</b>	<b>100.0%</b>	<b>105</b>	<b>100.0%</b>	<b>119</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>583</b>	<b>100.0%</b>

### 3.1.3 Total AC Circuit Metrics

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

**Table WECC 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	0.65	0.43	0.23	13.42	31.49	31.49	31.49	0.62	20582.68	99.85	65.34	2.43
300-399 kV	Overhead	2.35	1.58	0.77	3.53	2.23	2.23	2.23	0.05	5548.8	99.96	41.43	1.56
400-599 kV	Overhead	C	C	C	C	C	C	C	C	C	C	C	C
600-799 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
200-299 kV	Underground	0.15	0.15	0.00	0.45	2.75	3.07	3.38	1.11	60167.33	100.00	81.82	0.00
300-399 kV	Underground	-	-	-	-	-	-	-	-	-	-	-	-
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	2.29	1.45	1.49	0.84	0.80	0.61	2.21	1.96	0.25	359	669	21068.4
300-399 kV	Overhead	2.88	1.63	1.94	1.06	0.94	0.57	23.15	3.56	19.59	105	216	482.5
400-599 kV	Overhead	C	C	C	C	C	C	1.11	1.03	0.07	C	C	C
600-799 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
Mixed Voltages	Overhead							0.00	0.00	0.00			
200-299 kV	Underground	2.75	1.38	2.75	1.38	0.00	0.00				0	6	18.4
300-399 kV	Underground	-	-	-	-	-	-				-	-	-
400-599 kV	Underground	C	C	C	C	C	C				C	C	C
<b>TOTAL</b>											464	891	21569.3

### **3.2 DC Circuit Metrics and Data**

This category of data is not displayed because it would reveal confidential Transmission Owner information. See Section 1.5 of this report.

### 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 WECC 3.3-1 shows metrics for Transformer Sustained Outages that were “Element-Initiated,” which means they were initiated on or within the Element (Transformer in this case) being reported.
- Table WECC 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 WECC 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	15.0	0	0.0	0.0000	~
300-399 kV	62.0	5	3699.4	0.0806	739.9
400-599 kV	177.0	6	3049.6	0.0339	508.3
600-799 kV	0.0	-	-	-	-
All Voltages	254.0	11	6749.1	0.0433	613.6

**Table WECC 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	15.0	4	11.0	0.2667	2.8
300-399 kV	62.0	2	38.2	0.0323	19.1
400-599 kV	177.0	18	397.7	0.1017	22.1
600-799 kV	0.0	-	-	-	-
All Voltages	254.0	24	446.9	0.0945	18.6

### 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 WECC 3.3-3 shows the two Outage Cause Codes (Initiating and Sustained) plus the number of outage hours associated with each Cause Code.

**Table WECC 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%	0	0.0%	0.0	0.0%
Lightning	2	50.0%	0	0.0%	0.0	0.0%	1	14.3%	1	14.3%	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	14.3%	1	14.3%	0.0	0.0%
Fire	0	0.0%	0	0.0%	0.0	0.0%	2	28.6%	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	0	0.0%	0	0.0%	0.0	0.0%	2	28.6%	2	28.6%	3699.1	99.0%
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%	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Circuit Equipment	1	25.0%	0	0.0%	0.0	0.0%	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	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%	0	0.0%	0	0.0%	0.0	0.0%
Human Error	0	0.0%	0	0.0%	0.0	0.0%	1	14.3%	1	14.3%	0.1	0.0%
Unknown	1	25.0%	2	50.0%	10.5	95.5%	0	0.0%	0	0.0%	0.0	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	50.0%	0.5	4.5%	0	0.0%	2	28.6%	38.2	1.0%
<b>TOTAL</b>	<b>4</b>	<b>100.0%</b>	<b>4</b>	<b>100.0%</b>	<b>11.0</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>3737.7</b>	<b>100.0%</b>

**Table WECC 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	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Lightning	1	4.2%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Environmental	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Contamination	1	4.2%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Foreign Interference	1	4.2%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Fire	1	4.2%	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	10	41.7%	4	16.7%	318.0	9.2%	-	-	-	-	-	-
Failed AC/DC Terminal Equipment	1	4.2%	1	4.2%	10.4	0.3%	-	-	-	-	-	-
Failed Protection System Equipment	1	4.2%	1	4.2%	1.0	0.0%	-	-	-	-	-	-
Failed AC Circuit Equipment	1	4.2%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Vegetation	1	4.2%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Power System Condition	0	0.0%	1	4.2%	1.8	0.1%	-	-	-	-	-	-
Human Error	3	12.5%	3	12.5%	337.5	9.8%	-	-	-	-	-	-
Unknown	3	12.5%	4	16.7%	10.9	0.3%	-	-	-	-	-	-
Other	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Unavailable	0	0.0%	10	41.7%	2767.7	80.3%	-	-	-	-	-	-
<b>TOTAL</b>	<b>24</b>	<b>100.0%</b>	<b>24</b>	<b>100.0%</b>	<b>3447.3</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

**Table WECC 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	0	0.0%	0	0.0%	0.0	0.0%
Lightning	4	11.4%	1	2.9%	0.2	0.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%
Contamination	1	2.9%	0	0.0%	0.0	0.0%
Foreign Interference	2	5.7%	1	2.9%	0.0	0.0%
Fire	3	8.6%	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	12	34.3%	6	17.1%	4017.1	55.8%
Failed AC/DC Terminal Equipment	1	2.9%	1	2.9%	10.4	0.1%
Failed Protection System Equipment	1	2.9%	1	2.9%	1.0	0.0%
Failed AC Circuit Equipment	2	5.7%	0	0.0%	0.0	0.0%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	1	2.9%	0	0.0%	0.0	0.0%
Power System Condition	0	0.0%	1	2.9%	1.8	0.0%
Human Error	4	11.4%	4	11.4%	337.5	4.7%
Unknown	4	11.4%	6	17.1%	21.4	0.3%
Other	0	0.0%	0	0.0%	0.0	0.0%
Unavailable	0	0.0%	14	40.0%	2806.5	39.0%
<b>TOTAL</b>	<b>35</b>	<b>100.0%</b>	<b>35</b>	<b>100.0%</b>	<b>7196.0</b>	<b>100.0%</b>

### 3.3.1.3 Other Transformer Sustained Outage Data

Table WECC 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 WECC 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	2	50.0%	0.5	4.5%	3	42.9%	38.3	1.0%	15	62.5%	67.1	1.9%	-	-	-	-
P-P fault	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-
Single P-G fault	1	25.0%	10.1	91.2%	3	42.9%	1.0	0.0%	2	8.3%	2738.5	79.4%	-	-	-	-
P-P-G, 3 P, or 3P-G fault	0	0.0%	0.0	0.0%	1	14.3%	3698.3	98.9%	1	4.2%	331.3	9.6%	-	-	-	-
Unknown fault type	1	25.0%	0.5	4.3%	0	0.0%	0.0	0.0%	6	25.0%	310.4	9.0%	-	-	-	-
<b>TOTAL</b>	<b>4</b>	<b>100.0%</b>	<b>11.0</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>3737.7</b>	<b>100.0%</b>	<b>24</b>	<b>100.0%</b>	<b>3447.3</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

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%	5	71.4%	3699.4	99.0%	6	25.0%	3049.6	88.5%	-	-	-	-
Other Element-Initiated	4	100.0%	11.0	100.0%	2	28.6%	38.2	1.0%	4	16.7%	18.1	0.5%	-	-	-	-
AC Substation-Initiated	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	10	41.7%	41.1	1.2%	-	-	-	-
AC/DC Terminal-Initiated	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	1	4.2%	331.3	9.6%	-	-	-	-
Other Facility-Initiated	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	3	12.5%	7.2	0.2%	-	-	-	-
<b>TOTAL</b>	<b>4</b>	<b>100.0%</b>	<b>11.0</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>3737.7</b>	<b>100.0%</b>	<b>24</b>	<b>100.0%</b>	<b>3447.3</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

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	0	0.0%	0.0	0.0%	5	71.4%	3699.4	99.0%	11	45.8%	512.4	14.9%	-	-	-	-
Dependent Mode Initiating	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	3	12.5%	2902.5	84.2%	-	-	-	-
Dependent Mode	4	100.0%	11.0	100.0%	0	0.0%	0.0	0.0%	7	29.2%	28.0	0.8%	-	-	-	-
Common Mode	0	0.0%	0.0	0.0%	2	28.6%	38.2	1.0%	1	4.2%	1.0	0.0%	-	-	-	-
Common Mode Initiating	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	2	8.3%	3.4	0.1%	-	-	-	-
<b>TOTAL</b>	<b>4</b>	<b>100.0%</b>	<b>11.0</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>3737.7</b>	<b>100.0%</b>	<b>24</b>	<b>100.0%</b>	<b>3447.3</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

**Table WECC 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	2	50.0%	10.5	95.5%	2	28.6%	3699.1	99.0%	8	33.3%	184.7	5.4%	-	-	-	-
50	2	50.0%	0.5	4.5%	5	71.4%	38.5	1.0%	16	66.7%	3262.6	94.6%	-	-	-	-

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	25.0%	2	28.6%	2	8.3%	-	-
6-10 Minutes	0	0.0%	0	0.0%	1	4.2%	-	-
11-30 Minutes	2	50.0%	1	14.3%	2	8.3%	-	-
31-120 Minutes	0	0.0%	1	14.3%	4	16.7%	-	-
> 120 Minutes	1	25.0%	3	42.9%	15	62.5%	-	-
TOTAL	4	100.0%	7	100.0%	24	100.0%	-	-

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

Fault Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
No fault	20	57.1%	105.9	1.5%
P-P fault	0	0.0%	0.0	0.0%
Single P-G fault	6	17.1%	2749.6	38.2%
P-P-G, 3 P, or 3P-G fault	2	5.7%	4029.7	56.0%
Unknown fault type	7	20.0%	310.9	4.3%
<b>TOTAL</b>	<b>35</b>	<b>100.0%</b>	<b>7196.0</b>	<b>100.0%</b>

Outage Initiation Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	11	31.4%	6749.1	93.8%
Other Element-Initiated	10	28.6%	67.4	0.9%
AC Substation-Initiated	10	28.6%	41.1	0.6%
AC/DC Terminal-Initiated	1	2.9%	331.3	4.6%
Other Facility-Initiated	3	8.6%	7.2	0.1%
<b>TOTAL</b>	<b>35</b>	<b>100.0%</b>	<b>7196.0</b>	<b>100.0%</b>

Outage Mode Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Single Mode	16	45.7%	4211.8	58.5%
Dependent Mode Initiating	3	8.6%	2902.5	40.3%
Dependent Mode	11	31.4%	39.0	0.5%
Common Mode	3	8.6%	39.3	0.5%
Common Mode Initiating	2	5.7%	3.4	0.0%
<b>TOTAL</b>	<b>35</b>	<b>100.0%</b>	<b>7196.0</b>	<b>100.0%</b>

Event Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
10	12	34.3%	3894.4	54.1%
50	23	65.7%	3301.6	45.9%
<b>TOTAL</b>	<b>35</b>	<b>100.0%</b>	<b>7196.0</b>	<b>100.0%</b>

Outage Duration Interval	All Voltages	
	No. Sust.	%
1-5 Minutes	5	14.3%
6-10 Minutes	1	2.9%
11-30 Minutes	5	14.3%
31-120 Minutes	5	14.3%
> 120 Minutes	19	54.3%
<b>TOTAL</b>	<b>35</b>	<b>100.0%</b>

### 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 WECC 3.3-5 shows metrics for Transformer Momentary Outages that were “Element-Initiated,” which means they were initiated on or within the Element (Transformer in this case) being reported.
- Table WECC 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 WECC 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	15.0	0	0.0000
300-399 kV	62.0	0	0.0000
400-599 kV	177.0	0	0.0000
600-799 kV	0.0	-	-
All Voltages	254.0	0	0.0000

**Table WECC 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	15.0	3	0.2000
300-399 kV	62.0	10	0.1613
400-599 kV	177.0	1	0.0056
600-799 kV	0.0	-	-
All Voltages	254.0	14	0.0551

#### 3.3.2.2 Transformer Momentary Outage Cause Code Data

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

**Table WECC 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%	0	0.0%	-	-	0	0.0%
Lightning	2	66.7%	6	60.0%	0	0.0%	-	-	8	57.1%
Environmental	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%
Foreign Interference	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%
Vandalism, Terrorism, or Malicious Acts	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%
Failed AC/DC Terminal Equipment	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
Failed Protection System Equipment	1	33.3%	0	0.0%	0	0.0%	-	-	1	7.1%
Failed AC Circuit Equipment	0	0.0%	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%
Vegetation	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%
Human Error	0	0.0%	0	0.0%	1	100.0%	-	-	1	7.1%
Unknown	0	0.0%	4	40.0%	0	0.0%	-	-	4	28.6%
Other	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
Unavailable	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
<b>TOTAL</b>	<b>3</b>	<b>100.0%</b>	<b>10</b>	<b>100.0%</b>	<b>1</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>14</b>	<b>100.0%</b>

### 3.3.2.3 Other Transformer Momentary Outage Data

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

**Table WECC 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	2	66.7%	10	100.0%	1	100.0%	-	-	13	92.9%
P-P fault	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%
P-P-G, 3 P, or 3P-G fault	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
Unknown fault type	1	33.3%	0	0.0%	0	0.0%	-	-	1	7.1%
<b>TOTAL</b>	<b>3</b>	<b>100.0%</b>	<b>10</b>	<b>100.0%</b>	<b>1</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>14</b>	<b>100.0%</b>

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%	0	0.0%	0	0.0%	-	-	0	0.0%
Other Element-Initiated	2	66.7%	10	100.0%	1	100.0%	-	-	13	92.9%
AC Substation-Initiated	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
AC/DC Terminal-Initiated	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
Other Facility-Initiated	1	33.3%	0	0.0%	0	0.0%	-	-	1	7.1%
<b>TOTAL</b>	<b>3</b>	<b>100.0%</b>	<b>10</b>	<b>100.0%</b>	<b>1</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>14</b>	<b>100.0%</b>

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%	0	0.0%	0	0.0%	-	-	0	0.0%
Dependent Mode Initiating	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
Dependent Mode	2	66.7%	10	100.0%	0	0.0%	-	-	12	85.7%
Common Mode	1	33.3%	0	0.0%	1	100.0%	-	-	2	14.3%
Common Mode Initiating	0	0.0%	0	0.0%	0	0.0%	-	-	0	0.0%
<b>TOTAL</b>	<b>3</b>	<b>100.0%</b>	<b>10</b>	<b>100.0%</b>	<b>1</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>14</b>	<b>100.0%</b>

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	33.3%	0	0.0%	0	0.0%	-	-	1	7.1%
50	2	66.7%	10	100.0%	1	100.0%	-	-	13	92.9%
<b>TOTAL</b>	<b>3</b>	<b>100.0%</b>	<b>10</b>	<b>100.0%</b>	<b>1</b>	<b>100.0%</b>	<b>-</b>	<b>-</b>	<b>14</b>	<b>100.0%</b>

**Table WECC 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	0.47	0.27	0.20	0.73	1.48	2.75	4.03	0.46	32937.25	99.99	120.00	0.00
300-399 kV	0.27	0.11	0.16	60.28	458.64	533.95	609.26	0.80	77267.19	99.31	82.26	0.00
400-599 kV	0.14	0.14	0.01	19.48	141.95	143.64	145.33	4.16	64638.36	99.78	86.59	16.00
600-799 kV	-	-	-	-	-	-	-	-	-	-	-	-

\*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	3	4	11.0
300-399 kV	10	7	3737.7
400-599 kV	1	24	3447.3
600-799 kV	-	-	-
<b>TOTAL</b>	<b>14</b>	<b>35</b>	<b>7196.0</b>

### 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 WECC 3.4-1 shows metrics for AC/DC BTB Converter Sustained Outages that were “Element-Initiated,” which means they were initiated on or within the Element (AC/DC BTB Converter Voltages Classes in this case) being reported.
- Table WECC 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 WECC 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	5.6	6	5.1	1.0714	0.9
300-399 kV	2.0	0	0.0	0.0000	~
All Voltages	7.6	6	5.1	0.7895	0.9

**Table WECC 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	5.6	19	3753.8	3.3929	197.6
300-399 kV	2.0	7	223.8	3.5000	32.0
All Voltages	7.6	26	3977.6	3.4211	153.0

### 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 WECC 3.4-3 shows the two Outage Cause Codes (Initiating and Sustained) plus the number of outage hours associated with each Cause Code.

**Table WECC 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	8.0%	1	4.0%	0.4	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Lightning	1	4.0%	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	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	32.0%	8	32.0%	58.6	1.6%	2	28.6%	2	28.6%	144.3	64.5%
Failed AC/DC Terminal Equipment	1	4.0%	1	4.0%	3382.9	90.0%	5	71.4%	5	71.4%	79.5	35.5%
Failed Protection System Equipment	2	8.0%	2	8.0%	274.2	7.3%	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Circuit Equipment	3	12.0%	3	12.0%	36.8	1.0%	0	0.0%	0	0.0%	0.0	0.0%
Failed DC Circuit Equipment	3	12.0%	3	12.0%	3.2	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	8.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Human Error	1	4.0%	1	4.0%	0.1	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Unknown	1	4.0%	3	12.0%	1.8	0.0%	0	0.0%	0	0.0%	0.0	0.0%
Other	1	4.0%	3	12.0%	1.0	0.0%	0	0.0%	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%
<b>TOTAL</b>	<b>25</b>	<b>100.0%</b>	<b>25</b>	<b>100.0%</b>	<b>3758.9</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>223.8</b>	<b>100.0%</b>

**Table WECC 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	2	6.3%	1	3.1%	0.4	0.0%
Lightning	1	3.1%	0	0.0%	0.0	0.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%
Contamination	0	0.0%	0	0.0%	0.0	0.0%
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	10	31.3%	10	31.3%	202.9	5.1%
Failed AC/DC Terminal Equipment	6	18.8%	6	18.8%	3462.4	86.9%
Failed Protection System Equipment	2	6.3%	2	6.3%	274.2	6.9%
Failed AC Circuit Equipment	3	9.4%	3	9.4%	36.8	0.9%
Failed DC Circuit Equipment	3	9.4%	3	9.4%	3.2	0.1%
Vegetation	0	0.0%	0	0.0%	0.0	0.0%
Power System Condition	2	6.3%	0	0.0%	0.0	0.0%
Human Error	1	3.1%	1	3.1%	0.1	0.0%
Unknown	1	3.1%	3	9.4%	1.8	0.0%
Other	1	3.1%	3	9.4%	1.0	0.0%
Unavailable	0	0.0%	0	0.0%	0.0	0.0%
<b>TOTAL</b>	<b>32</b>	<b>100.0%</b>	<b>32</b>	<b>100.0%</b>	<b>3982.7</b>	<b>100.0%</b>

### 3.4.1.3 Other AC/DC BTB Converter Sustained Outage Data

Table WECC 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 WECC 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	20	80.0%	3756.1	99.9%	7	100.0%	223.8	100.0%	27	84.4%	3979.9	99.9%
P-P fault	1	4.0%	0.8	0.0%	0	0.0%	0.0	0.0%	1	3.1%	0.8	0.0%
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	4	16.0%	2.0	0.1%	0	0.0%	0.0	0.0%	4	12.5%	2.0	0.1%
<b>TOTAL</b>	<b>25</b>	<b>100.0%</b>	<b>3758.9</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>223.8</b>	<b>100.0%</b>	<b>32</b>	<b>100.0%</b>	<b>3982.7</b>	<b>100.0%</b>

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	24.0%	5.1	0.1%	0	0.0%	0.0	0.0%	6	18.8%	5.1	0.1%
Other Element-Initiated	1	4.0%	0.1	0.0%	0	0.0%	0.0	0.0%	1	3.1%	0.1	0.0%
AC Substation-Initiated	15	60.0%	370.0	9.8%	2	28.6%	144.3	64.5%	17	53.1%	514.3	12.9%
AC/DC Terminal-Initiated	2	8.0%	3383.6	90.0%	5	71.4%	79.5	35.5%	7	21.9%	3463.1	87.0%
Other Facility-Initiated	1	4.0%	0.0	0.0%	0	0.0%	0.0	0.0%	1	3.1%	0.0	0.0%
<b>TOTAL</b>	<b>25</b>	<b>100.0%</b>	<b>3758.9</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>223.8</b>	<b>100.0%</b>	<b>32</b>	<b>100.0%</b>	<b>3982.7</b>	<b>100.0%</b>

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	19	76.0%	3721.6	99.0%	7	100.0%	223.8	100.0%	26	81.3%	3945.4	99.1%
Dependent Mode Initiating	1	4.0%	0.4	0.0%	0	0.0%	0.0	0.0%	1	3.1%	0.4	0.0%
Dependent Mode	5	20.0%	36.9	1.0%	0	0.0%	0.0	0.0%	5	15.6%	36.9	0.9%
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%
<b>TOTAL</b>	<b>25</b>	<b>100.0%</b>	<b>3758.9</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>223.8</b>	<b>100.0%</b>	<b>32</b>	<b>100.0%</b>	<b>3982.7</b>	<b>100.0%</b>

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	25	100.0%	3758.9	100.0%	7	100.0%	223.8	100.0%	32	100.0%	3982.7	100.0%
<b>TOTAL</b>	<b>25</b>	<b>100.0%</b>	<b>3758.9</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>223.8</b>	<b>100.0%</b>	<b>32</b>	<b>100.0%</b>	<b>3982.7</b>	<b>100.0%</b>

Outage Duration Interval	200-299 kV		300-399 kV		All Voltages	
	No. Sust.	%	No. Sust.	%	No. Sust.	%
1-5 Minutes	2	8.0%	1	14.3%	3	9.4%
6-10 Minutes	2	8.0%	0	0.0%	2	6.3%
11-30 Minutes	5	20.0%	0	0.0%	5	15.6%
31-120 Minutes	8	32.0%	1	14.3%	9	28.1%
> 120 Minutes	8	32.0%	5	71.4%	13	40.6%
<b>TOTAL</b>	<b>25</b>	<b>100.0%</b>	<b>7</b>	<b>100.0%</b>	<b>32</b>	<b>100.0%</b>

### **3.4.2 AC/DC BTB Converter Momentary Outages**

This category of data is not displayed because there were no Momentary Outages were reported on the AC/DC BTB Converters in WECC in 2008.

### **3.4.3 Total AC/DC BTB Converter Metrics**

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

**Table WECC 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	4.46	4.46	0.00	671.24	148.35	150.36	152.36	1.03	1817.26	91.73	35.09	0.00
300-399 kV	3.50	3.50	0.00	111.88	30.32	31.97	33.61	27.42	2477.75	98.71	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	25	3758.9
300-399 kV	0	7	223.8
<b>TOTAL</b>	0	32	3982.7

## **Appendix 1 TADS Definitions**

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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

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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 WECC 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
<b><i>Element Outage Frequency</i></b>				
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
<b><i>Element Outage Duration, Repair Time, and Up Time</i></b>				
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 <sup>1</sup>
<b><i>Element Availability</i></b>				
8	Element Availability Percentage	1- (Total Sustained Outage Hours / Total Element Hours) * 100	Percentage	APC <sup>1</sup>
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.

	<b>Metric</b>	<b>Formula</b>	<b>Units</b>	<b>Acronym</b>
	<b><i>Circuit Outage Frequency, per 100 Circuit Miles (Applies to AC and DC Circuits Only)</i></b>			
<b>11</b>	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 <sub>100CM</sub>
<b>12</b>	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 <sub>100CM</sub>
<b>13</b>	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 <sub>100CM</sub>
	<b><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></b>			
<b>14</b>	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 <sub>100SM</sub>
<b>15</b>	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 <sub>100SM</sub>
<b>16</b>	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 <sub>100SM</sub>

## Appendix 3 TADS Task Force Members

<b>Chair</b>	Jean-Marie Gagnon, Ing. Project Manager Interconnected Networks Assets Planning	Hydro-Quebec TransEnergie Complexe Desjardins, Tour Est 10th Floor, CP 10 000 Montreal, Quebec H5B 1H7	(514) 397-3939 Ext. 3498 (514) 289-3234 Fx gagnon.jean-marie@ hydro.qc.ca
<b>Secretary</b>	John L. Seelke, Jr., P.E. Manager of Planning	North American Electric Reliability Corporation 116-390 Village Boulevard Princeton, New Jersey 08540	(609) 452-8060 (609) 452-9550 Fx john.seelke@ nerc.net
	Salva R. Andiappan Principal Engineer (Until April 2009)	Midwest Reliability Organization 1970 Oakcrest Avenue Roseville, Minnesota 55113	(651) 294-7081 (651) 855-1712 Fx sr.andiappan@ midwestreliability.org
	Gary S. Brinkworth, P.E. Manager, Strategic Planning (Until February 2008)	City of Tallahassee 400 East Van Buren Street Tallahassee, Florida 32301	(850) 891-3066 gary.brinkworth@ talgov.com
	Julian Cox, C. Eng. Director, Operational Planning and Review	National Grid 25 Research Drive Westborough, Massachusetts 01582- 0001	(781) 907-2399 (781) 907 5707 Fx julian.cox@ us.ngrid.com
	Adam Flink Engineer	Midwest Reliability Organization 2774 Cleveland Avenue N. Roseville, Minnesota 55113	(651) 855-1705 (651) 855-1712 Fx ad.flink@ midwestreliability.org
	Peter Gelineau, P. Eng. Senior Advisor (Until December 2008)	Canadian Electricity Association 1010 de la Gauchetiere Street West Suite 2230 Montreal, Quebec H3B 2N2	(514) 866-5375 gelineau@ canelect.ca
	Peter Harris Manager, Outage Coordination (Until August 2007)	ISO New England, Inc. One Sullivan Road Holyoke, Massachusetts 01040	(413) 535-4385 (413) 535-4343 Fx pharris@ iso-ne.com
	Brian K. Keel Manager, Transmission System Planning	Salt River Project MS POB 100 P.O. Box 52025 Phoenix, Arizona 85072-2025	(602) 236-0970 (602) 236-3896 Fx brian.keel@ srpnet.com
	Jacob S. Langthorn, P.E. Transmission Tariff Coordinator	Oklahoma Gas and Electric Co. 321 N. Harvey MC 408 Oklahoma City, Oklahoma 73101- 0321	(405) 553-3409 (405) 553-3165 Fx langthjs@oge.com

	Jeffrey L. Mitchell, P.E. Director - Engineering (Until February 2009)	ReliabilityFirst Corporation 320 Springside Drive Suite 300 Akron, Ohio 44333	(330) 247-3043 (330) 456-3648 Fx jeff.mitchell@ rfirst.org
	Michael Pakeltis, P.E. Manager, Reliability Analysis & Technical Support, Transmission Operations	CenterPoint Energy P.O. Box 1700 Houston, Texas 77251-1700	(713) 207-6714 (713) 207-9122 Fx michael.pakeltis@ centerpointenergy.com
	Edward C. Pfeiffer, P.E. Manager, Electric Planning	Ameren Corp. 1901 Chouteau Avenue St. Louis, Missouri 63166-6149	(314) 554-3763 (314) 554-3260 Fx epfeiffer@ ameren.com
	Jason Shaver Reliability Standards and Performance Manager	American Transmission Company, LLC N19 W23993 Ridgeway Pkwy. W. Waukesha, Wisconsin 53187-0047	(262) 506-6885 jshaver@ atllc.com
	Rao Somayajula, P.E. Senior Engineer	ReliabilityFirst Corporation 320 Springside Drive Suite 300 Akron, Ohio 44333	(330) 247-3061 rao.somayajula@ rfirst.org
	Rambabu Adapa, P.E. Project Manager (until October 2007)	Electric Power Research Institute 3412 Hillview Avenue Palo Alt, California 94303-0813	(650) 855-8988 radapa@epri.com
<b>NERC Staff</b>	Ronald J. Niebo Reliability Performance and Analysis Coordinator	North American Electric Reliability Corporation 116-390 Village Boulevard Princeton, New Jersey 08540-5721	(609) 452-8060 (609) 452-9550 Fx ron.niebo@ nerc.net
<b>NERC Staff</b>	James K. Robinson, P.E. TADS Project Manager	North American Electric Reliability Corporation 116-390 Village Boulevard Princeton, New Jersey 08540-5721	(610) 841-3362 jim.robinson@ nerc.net