NERC

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Transmission Availability Data System Automatic Outage Metrics and Data

Region: FRCC – 2009 Report

June 14, 2010

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 Working Group (TADSWG), Open Access Technologies International (OATI),) and in 2009 the 192 reporting Transmission Owners (TOs) in NERC. The 2009 "Reporting TOs" are TOs that own any TADS facilities, as described in Section 1.3 below, as of January 1, 2009.

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

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

1.2 TADS History

The TADS effort began with the establishment of a task force (TADSTF) under the direction of 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. Phase I covers Automatic Outage data (and the reader is referred to Appendix 1 for the definition of capitalized Phase I terms).

Subsequently, on October 29, 2008, the NERC Board approved the collection of Non-Automatic Outage data that will begin in calendar year 2010 (Phase II). On July 1, 2009 the TADSTF was converted to the TADSWG by the NERC Planning Committee.

1.3 Scope

This report covers Phase I Automatic Outage data[2]. The 2009 Report is based upon 2009 calendar year data submitted by Transmission Owners by March 1, 2010.

Phase I TADS includes Momentary and Sustained Automatic Outages of the following Elements:

- AC Circuits ≥ 200 kV (Overhead and Underground Circuits). Radial circuits are included;
- DC Circuits with ≥ +/-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.

The following basic information is collected:

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

[2] Phase II data will be reported next year with the Phase I data in the same report

- 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

For calendar year 2009, one NERC-wide report and eight regional reports have been produced, using a common format, and these reports are posted on the TADSWG page on the NERC Web site. 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. These definitions were posted on September 11, 2008 for use during calendar year 2009 data collection.

In addition, each report has an associated Excel workbook that contains non-confidential data from webTADS as well as all of the associated 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.

The purpose of this report is to provide the results of the annual 2009 data collection. Moving forward the TADSWG and other NERC groups may separately provide observations, interpretations of the annual results, and suggest further areas for study. It is recommended that readers of this report not draw conclusions based on the 2008 and 2009 calendar year data collection as it will take a number of years of data to provide interpretations with a high degree of confidence.

1.5 Confidential Data Not Publicly Reported

Per the data confidentiality policy, the report does not display performance data associated with a TADS Element in a Voltage Class or for circuits of a particular construction type (Overhead or Underground) if all of the Elements in that Voltage Class and applicable construction type are reported by one TO.[3] Since none of the FRCC performance data met any exclusion criterion, all FRCC performance data is displayed in this report.

[3] NERC will ask the impacted TOs for permission beginning with the calendar year 2010 report.

1.6 Report Organization

Section 2 has summary FRCC 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 FRCC 1-1 shows the assigned numbering scheme for the tables and figures in this report. The prefix "FRCC" 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 FRCC 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 working group 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 FRCC 1-2 shows the categories included in the NERC template.

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

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 working group 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 FRCC 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.[4]
6. If a cell is not supposed to contain data, a grayed pattern is inserted in that cell. For example, Circuit Miles are not applicable to Transformers.

1.7 Feedback and Comments

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

[4] The Excel "SUM" function treats text such as "C" or "NC" as a zero.

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

Table FRCC 1-1 (cont'd)

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

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

Table FRCC 1-2
Categories Displayed in Report Tables and Figures with Performance Data Based upon the FRCC Inventory[5]

No categories of this type exist within NERC

Category	Voltage Class	Construction type (Overhead or Underground)	
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		

[5] 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 FRCC 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. Figure FRCC 2-1 through Figure FRCC 2-8 show frequency and duration metrics on 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, FRCC 2-1 and FRCC 2-2 shows the average Element inventory for calendar year 2009 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 FRCC 2-1
Inventory of AC Transmission Equipment

	200-299 kV		300-399 kV		400-599 kV		600-799 kV		Mixed Voltages		All Voltages	
Name	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	389.0	5880	0.0	0	19	1201	0	0			408	7081
Overhead	378.0	5823	0	0	19	1201	0	0			397	7023
Underground	11.0	57	0	0	0	0	0	0			11	57
AC Multi-Circuit Structure Miles*		1355		0		0		0		0		1355
Transformer	0		0		26		0				26	

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

Table FRCC 2-2
Inventory of DC Transmission Equipment

	200-299 kV		300-399 kV		400-499 kV		500-599 kV		600-799 kV		All Voltages	
Name	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

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 FRCC 2-1
AC Circuit Outage Frequency by Outage Initiation Code

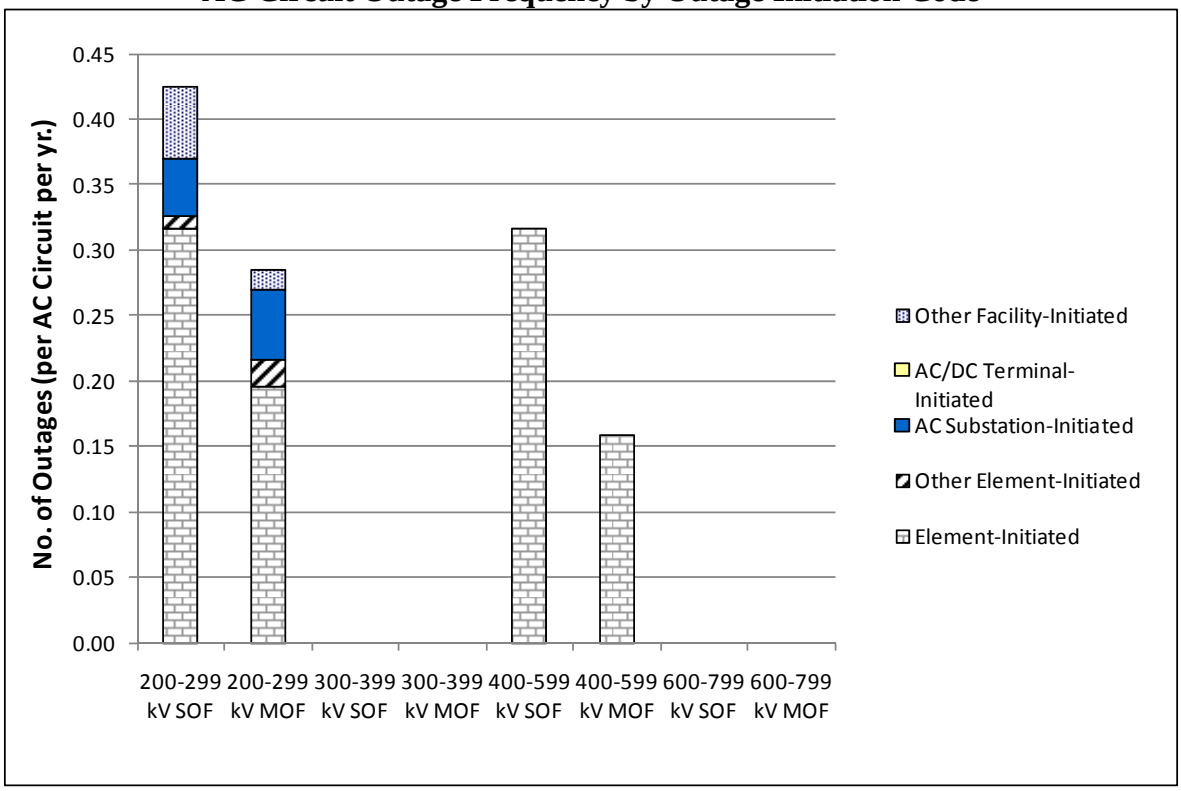

Figure FRCC 2-2
AC Circuit Outage Duration by Outage Initiation Code

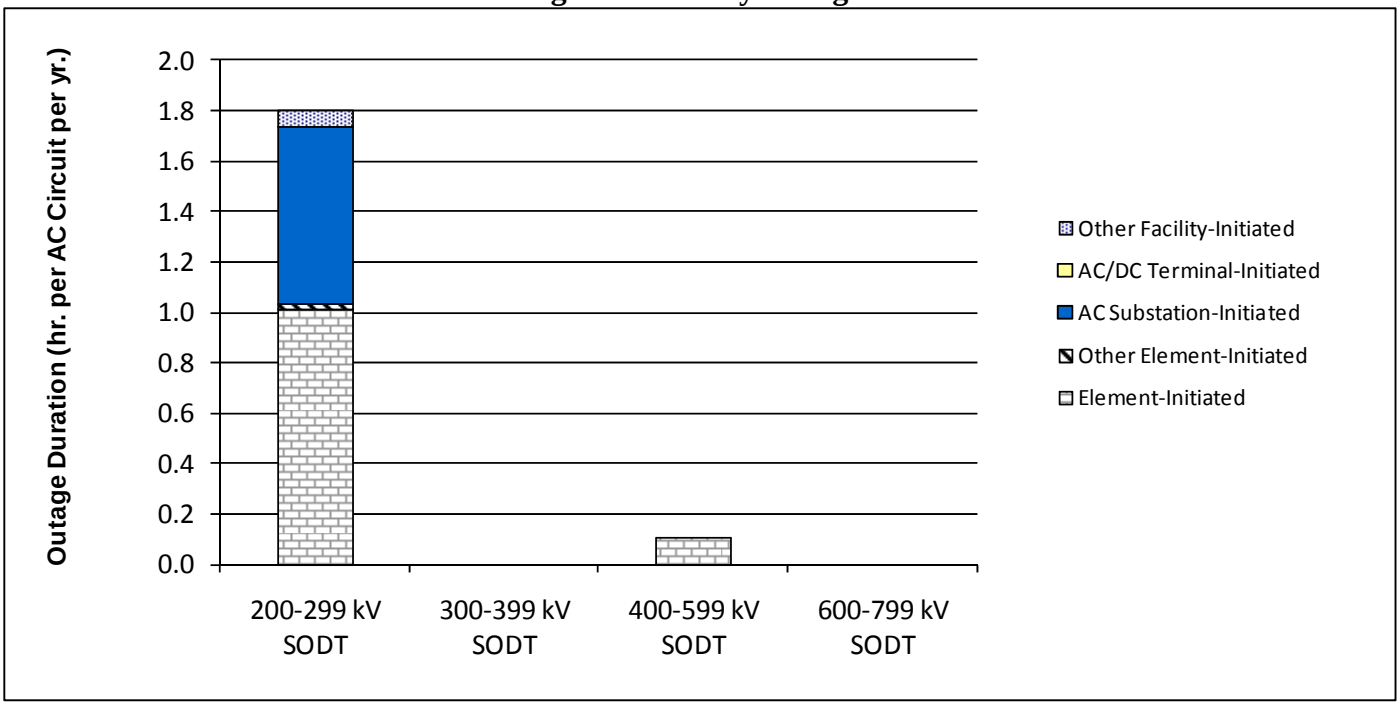

Figure FRCC 2-3
DC Circuit Outage Frequency by Outage Initiation Code

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

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

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This category of data is not displayed because there is no inventory in the voltage classes.

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

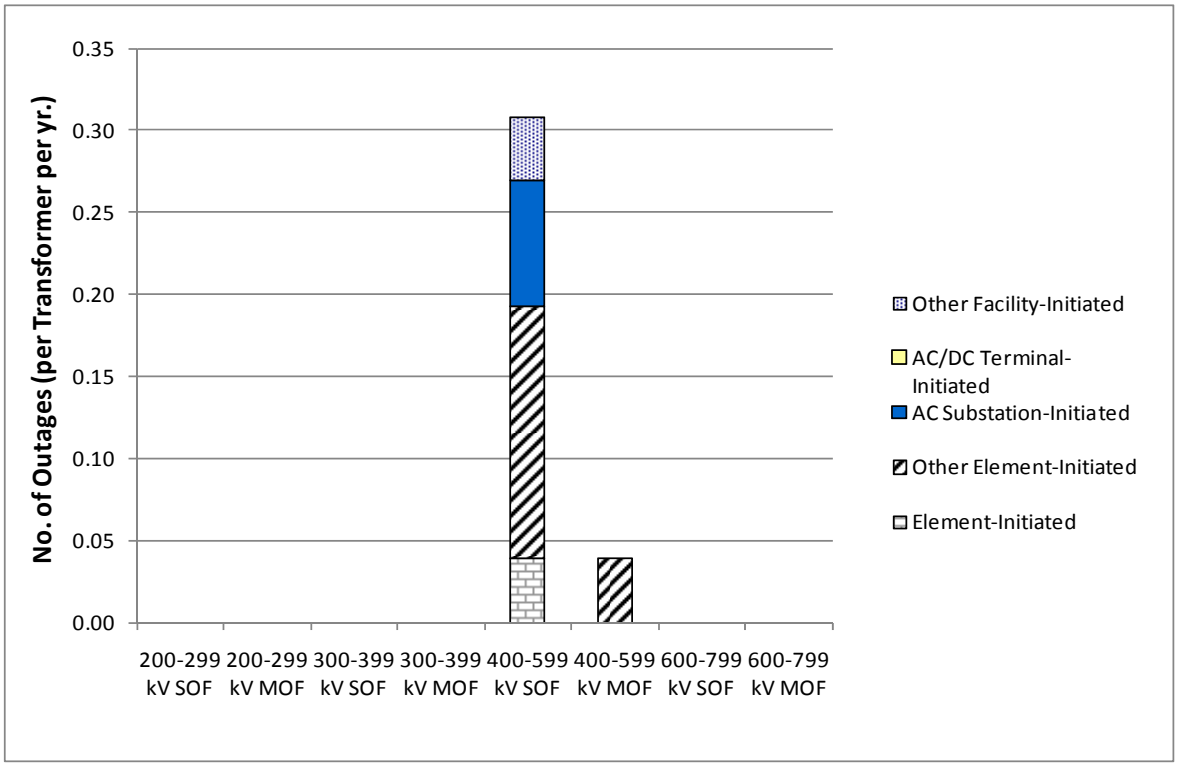

Figure FRCC 2-6
Transformer Outage Duration by Outage Initiation

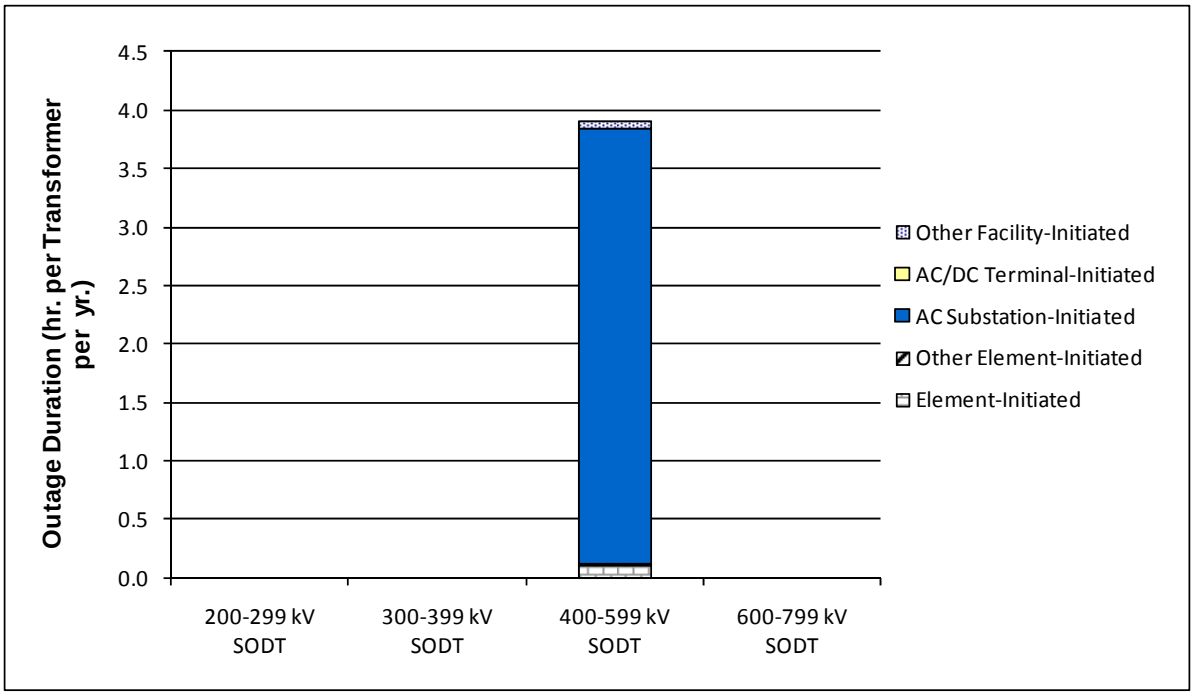

Figure FRCC 2-7
AC/DC BTB Converter Outage Frequency by Outage Initiation Code

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

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

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

2.3 Event Types

Event Type data, shown in Table FRCC 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.

Table FRCC 2-3
Event Types and Outages

	Events		Outages	
Event Type	# Events	%	# Outages	%
10	223	82.9%	223	75.9%
20	0	0.0%	0	0.0%
30	2	0.7%	4	1.4%
40	0	0.0%	0	0.0%
50	44	16.4%	67	22.8%
TOTAL	269	100.0%	294	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 FRCC 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 FRCC 3.1-1 on the next page 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 FRCC 3.1-2 on the next page 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 FRCC 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	5880	389.0	123	393.8	2.0918	0.3162	3.2
300-399 kV	0	0.0	-	-	-	-	-
400-599 kV	1201	19.0	6	2.0	0.4998	0.3158	0.3
600-799 kV	0	0.0	-	-	-	-	-
All Voltages	7081	408.0	129	395.8	1.8219	0.3162	3.1

Table FRCC 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	389.0	42	306.4	0.1080	7.3
300-399 kV	0.0	-	-	-	-
400-599 kV	19.0	0	0.0	0.0000	~
600-799 kV	0.0	-	-	-	-
All Voltages	408.0	42	306.4	0.1029	7.3

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

Table FRCC 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	4	2.4%	4	2.4%	6.1	0.9%	-	-	-	-	-	-
Lightning	26	15.8%	15	9.1%	18.3	2.6%	-	-	-	-	-	-
Environmental	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Contamination	6	3.6%	6	3.6%	6.9	1.0%	-	-	-	-	-	-
Foreign Interference	45	27.3%	45	27.3%	77.6	11.1%	-	-	-	-	-	-
Fire	2	1.2%	2	1.2%	2.0	0.3%	-	-	-	-	-	-
Vandalism, Terrorism, or Malicious Acts	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Failed AC Substation Equipment	13	7.9%	14	8.5%	253.3	36.2%	-	-	-	-	-	-
Failed AC/DC Terminal Equipment	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Failed Protection System Equipment	15	9.1%	15	9.1%	37.1	5.3%	-	-	-	-	-	-
Failed AC Circuit Equipment	29	17.6%	31	18.8%	262.1	37.4%	-	-	-	-	-	-
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Vegetation	2	1.2%	2	1.2%	13.4	1.9%	-	-	-	-	-	-
Power System Condition	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Human Error	6	3.6%	7	4.2%	10.9	1.6%	-	-	-	-	-	-
Unknown	13	7.9%	11	6.7%	6.4	0.9%	-	-	-	-	-	-
Other	4	2.4%	13	7.9%	6.1	0.9%	-	-	-	-	-	-
TOTAL	165	100.0%	165	100.0%	700.1	100.0%	-	-	-	-	-	-

Table FRCC 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	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Lightning	0	0.0%	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	4	66.7%	4	66.7%	0.1	6.4%	-	-	-	-	-	-
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	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%	-	-	-	-	-	-
Failed Protection System Equipment	1	16.7%	1	16.7%	1.9	91.6%	-	-	-	-	-	-
Failed AC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Vegetation	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Power System Condition	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Human Error	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Unknown	1	16.7%	1	16.7%	0.0	1.5%	-	-	-	-	-	-
Other	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
TOTAL	6	100.0%	6	100.0%	2.0	100.0%	-	-	-	-	-	-

Table FRCC 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	4	2.3%	4	2.3%	6.1	0.9%
Lightning	26	15.2%	15	8.8%	18.3	2.6%
Environmental	0	0.0%	0	0.0%	0.0	0.0%
Contamination	6	3.5%	6	3.5%	6.9	1.0%
Foreign Interference	49	28.7%	49	28.7%	77.8	11.1%
Fire	2	1.2%	2	1.2%	2.0	0.3%
Vandalism, Terrorism, or Malicious Acts	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Substation Equipment	13	7.6%	14	8.2%	253.3	36.1%
Failed AC/DC Terminal Equipment	0	0.0%	0	0.0%	0.0	0.0%
Failed Protection System Equipment	16	9.4%	16	9.4%	39.0	5.5%
Failed AC Circuit Equipment	29	17.0%	31	18.1%	262.1	37.3%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	2	1.2%	2	1.2%	13.4	1.9%
Power System Condition	0	0.0%	0	0.0%	0.0	0.0%
Human Error	6	3.5%	7	4.1%	10.9	1.6%
Unknown	14	8.2%	12	7.0%	6.5	0.9%
Other	4	2.3%	13	7.6%	6.1	0.9%
TOTAL	171	100.0%	171	100.0%	702.1	100.0%

3.1.1.3 Other AC Circuit Sustained Outage Data

Table FRCC 3.1-4 on the next page shows other AC Circuit Sustained Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type, and Outage Duration Interval.

Table FRCC 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	24	14.5%	56.8	8.1%	-	-	-	-	1	16.7%	1.9	91.6%	-	-	-	-
P-P fault	15	9.1%	13.2	1.9%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Single P-G fault	113	68.5%	467.5	66.8%	-	-	-	-	5	83.3%	0.2	8.4%	-	-	-	-
P-P-G, 3 P, or 3P-G fault	5	3.0%	136.7	19.5%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Unknown fault type	8	4.8%	26.0	3.7%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
TOTAL	165	100.0%	700.1	100.0%	-	-	-	-	6	100.0%	2.02	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	123	74.5%	393.8	56.2%	-	-	-	-	6	100.0%	1.9	91.6%	-	-	-	-
Other Element-Initiated	4	2.4%	7.9	1.1%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
AC Substation-Initiated	17	10.3%	274.2	39.2%	-	-	-	-	0	0.0%	0.2	8.4%	-	-	-	-
AC/DC Terminal-Initiated	0	0.0%	0.0	0.0%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Other Facility-Initiated	21	12.7%	24.2	3.5%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
TOTAL	165	100.0%	700.1	100.0%	-	-	-	-	6	100.0%	2.02	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	135	81.8%	562.9	80.4%	-	-	-	-	6	100.0%	2.0	100.0%	-	-	-	-
Dependent Mode Initiating	7	4.2%	17.0	2.4%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Dependent Mode	15	9.1%	8.8	1.3%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Common Mode	7	4.2%	105.0	15.0%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Common Mode Initiating	1	0.6%	6.5	0.9%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
TOTAL	165	100.0%	700.1	100.0%	-	-	-	-	6	100.0%	2.02	100.0%	-	-	-	-

Table FRCC 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	132	80.0%	545.6	77.9%	-	-	-	-	1	16.7%	0.0	1.5%	-	-	-	-
30	1	0.6%	6.5	0.9%	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
50	32	19.4%	148.0	21.1%	-	-	-	-	5	83.3%	2.0	98.0%	-	-	-	-
TOTAL	165	100.0%	700.1	100.0%	-	-	-	-	6	100.0%	2.0	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	73	44.2%	-	-	5	83.3%	-	-
6-10 Minutes	12	7.3%	-	-	0	0.0%	-	-
11-30 Minutes	6	3.6%	-	-	0	0.0%	-	-
31-120 Minutes	14	8.5%	-	-	1	16.7%	-	-
121 Minutes to 24 Hours	56	33.9%	-	-	0	0.0%	-	-
> 24 Hours to 48 Hours	2	1.2%	-	-	0	0.0%	-	-
> 48 Hours	2	1.2%	-	-	0	0.0%	-	-
TOTAL	165	100.0%	-	-	6	100.0%	-	-

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

Fault Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
No fault	25	14.6%	58.6	8.3%
P-P fault	15	8.8%	13.2	1.9%
Single P-G fault	118	69.0%	467.7	66.6%
P-P-G, 3 P, or 3P-G fault	5	2.9%	136.7	19.5%
Unknown fault type	8	4.7%	26.0	3.7%
TOTAL	171	100.0%	702.1	100.0%

Outage Initiation Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	129	75.4%	395.6	56.3%
Other Element-Initiated	4	2.3%	7.9	1.1%
AC Substation-Initiated	17	9.9%	274.4	39.1%
AC/DC Terminal-Initiated	0	0.0%	0.0	0.0%
Other Facility-Initiated	21	12.3%	24.2	3.5%
TOTAL	171	100.0%	702.1	100.0%

Outage Mode Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Single Mode	141	82.5%	564.9	80.5%
Dependent Mode Initiating	7	4.1%	17.0	2.4%
Dependent Mode	15	8.8%	8.8	1.3%
Common Mode	7	4.1%	105.0	15.0%
Common Mode Initiating	1	0.6%	6.5	0.9%
TOTAL	171	100.0%	702.1	100.0%

Event Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
10	133	77.8%	545.7	77.7%
30	1	0.6%	6.5	0.9%
50	37	21.6%	150.0	21.4%
TOTAL	171	100.0%	702.1	100.0%

Outage Duration Interval	All Voltages	
	No. Sust.	%
1-5 Minutes	78	45.6%
6-10 Minutes	12	7.0%
11-30 Minutes	6	3.5%
31-120 Minutes	15	8.8%
121 Minutes to 24 Hours	56	32.7%
> 24 Hours to 48 Hours	2	1.2%
> 48 Hours	2	1.2%
TOTAL	171	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 FRCC 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 FRCC 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 FRCC 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	5880	389.0	76	1.2925	0.1954
300-399 kV	0	0.0	-	-	-
400-599 kV	1201	19.0	3	0.2499	0.1579
600-799 kV	0	0.0	-	-	-
All Voltages	7081	408.0	79	1.1157	0.1936

Table FRCC 3.1-6
AC Circuit Momentary Outage Metrics - Other than "Element-Initiated"

Voltage Class	No. of Circuits	No. of Outages	Frequency (MOF) (per circuit per yr)
200-299 kV	389.0	35	0.0900
300-399 kV	0.0	-	-
400-599 kV	19.0	0	0.0000
600-799 kV	0.0	-	-
All Voltages	408.0	35	0.0858

3.1.2.2 AC Circuit Momentary Outage Cause Code Data

For Momentary Outages, TADS requests one Cause Code: an Initiating Cause Code. Table FRCC 3.1-7 on the next page reports Cause Code data for AC Circuit Momentary Outages.

Table FRCC 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	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
Lightning	25	22.5%	-	-	1	33.3%	-	-	26	22.8%
Environmental	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
Contamination	3	2.7%	-	-	0	0.0%	-	-	3	2.6%
Foreign Interference	31	27.9%	-	-	2	66.7%	-	-	33	28.9%
Fire	1	0.9%	-	-	0	0.0%	-	-	1	0.9%
Vandalism, Terrorism, or Malicious Acts	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
Failed AC Substation Equipment	5	4.5%	-	-	0	0.0%	-	-	5	4.4%
Failed AC/DC Terminal Equipment	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
Failed Protection System Equipment	7	6.3%	-	-	0	0.0%	-	-	7	6.1%
Failed AC Circuit Equipment	5	4.5%	-	-	0	0.0%	-	-	5	4.4%
Failed DC Circuit Equipment	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
Vegetation	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
Power System Condition	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
Human Error	15	13.5%	-	-	0	0.0%	-	-	15	13.2%
Unknown	18	16.2%	-	-	0	0.0%	-	-	18	15.8%
Other	1	0.9%	-	-	0	0.0%	-	-	1	0.9%
TOTAL	111	100.0%	-	-	3	100.0%	-	-	114	100.0%

3.1.2.3 Other AC Circuit Momentary Outage Data

Table FRCC 3.1-8 on the next page shows other AC Circuit Momentary Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type.

Table FRCC 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	12	10.8%	-	-	0	0.0%	-	-	12	10.5%
P-P fault	6	5.4%	-	-	0	0.0%	-	-	6	5.3%
Single P-G fault	92	82.9%	-	-	3	100.0%	-	-	95	83.3%
P-P-G, 3 P, or 3P-G fault	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
Unknown fault type	1	0.9%	-	-	0	0.0%	-	-	1	0.9%
TOTAL	111	100.0%	-	-	3	100.0%	-	-	114	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	76	68.5%	-	-	3	100.0%	-	-	79	69.3%
Other Element-Initiated	8	7.2%	-	-	0	0.0%	-	-	8	7.0%
AC Substation-Initiated	21	18.9%	-	-	0	0.0%	-	-	21	18.4%
AC/DC Terminal-Initiated	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
Other Facility-Initiated	6	5.4%	-	-	0	0.0%	-	-	6	5.3%
TOTAL	111	100.0%	-	-	3	100.0%	-	-	114	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	77	69.4%	-	-	3	100.0%	-	-	80	70.2%
Dependent Mode Initiating	2	1.8%	-	-	0	0.0%	-	-	2	1.8%
Dependent Mode	19	17.1%	-	-	0	0.0%	-	-	19	16.7%
Common Mode	13	11.7%	-	-	0	0.0%	-	-	13	11.4%
Common Mode Initiating	0	0.0%	-	-	0	0.0%	-	-	0	0.0%
TOTAL	111	100.0%	-	-	3	100.0%	-	-	114	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	84	75.7%	-	-	2	66.7%	-	-	86	75.4%
30	3	2.7%	-	-	0	0.0%	-	-	3	2.6%
50	24	21.6%	-	-	1	33.3%	-	-	25	21.9%
TOTAL	111	100.0%	-	-	3	100.0%	-	-	114	100.0%

3.1.3 Total AC Circuit Metrics

Table FRCC 3.1-9 on the next page displays AC Circuit metrics that are defined in Appendix 2.

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

		Element Outage Frequency (1-3)			Element Outage Duration, Repair Time, and Update Time (4-7)						Element Availability (8-10)		
Voltage Class	OH/UG	TOF	SOF	MOF	SODT	MTTR P(5%) <	MTTR 50/50	MTTR P(5%) >	MdTTR	MTBF	APC %	PCZO %	PCDR %
200-299 kV	Overhead	0.71	0.43	0.28	1.85	4.31	4.31	4.31	0.16	20427.24	99.94	61.74	0.37
300-399 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
400-599 kV	Overhead	0.47	0.32	0.16	0.11	0.28	0.34	0.40	0.03	27739.7	100.00	73.68	0.00
600-799 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
200-299 kV	Underground	0.73	0.27	0.45	0.20	0.22	0.74	1.27	0.65	32119.26	100.00	63.64	0.00
300-399 kV	Underground	-	-	-	-	-	-	-	-	-	-	-	-
400-599 kV	Underground	-	-	-	-	-	-	-	-	-	-	-	-

		Circuit Outage Frequency (11-13)						Multiple Circuit Outage Frequency (14-16)			Outage Totals		
		TCOF	TCOF	SCOF	SCOF	MCOF	MCOF						
Voltage Class	OH/UG	All	Elemt. Init.	All	Elemt. Init.	All	Elemt. Init.	TMCOF	SMCOF	MMCOF	Momentary Outages	Sustained Outages	Sustained Outages Hours
200-299 kV	Overhead	4.60	3.38	2.78	2.08	1.82	1.31	0.15	0.07	0.15	106	162	697.9
300-399 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
400-599 kV	Overhead	0.75	0.75	0.50	0.50	0.25	0.25	-	-	-	3	6	2.0
600-799 kV	Overhead	-	-	-	-	-	-	-	-	-	-	-	-
Mixed Voltages	Overhead							-	-	-			
200-299 kV	Underground	13.94	3.48	5.23	3.48	8.71	0.00				5	3	2.2
300-399 kV	Underground	-	-	-	-	-	-				-	-	-
400-599 kV	Underground	-	-	-	-	-	-				-	-	-
										TOTAL	114	171	702.1

3.2 DC Circuit Metrics and Data

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

3.2.1 DC Circuit Sustained Outages

3.2.1.1 DC Circuit Sustained Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

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

Table FRCC 3.2-1

DC Circuit Sustained Outage Metrics

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This category of data is not displayed because there is no inventory in the voltage classes.

Table FRCC 3.2-2

DC Circuit Sustained Outage Metrics – Other than "Element Initiated"

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This category of data is not displayed because there is no inventory in the voltage classes.

3.2.1.2 DC Circuit Sustained Outage Cause Code Data

For Sustained Outages, TADS requests two Cause Codes – an Initiating Cause Code that describes the initiating cause and a Sustained Cause Code that describes the cause that contributes to the longest duration. Table FRCC 3.2-3 shows the two Outage Cause Codes (Initiating and Sustained) plus the number of outage hours associated with each Cause Code.

Table FRCC 3.2-3
DC Circuit Sustained Outages by Cause Code

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This category of data is not displayed because there is no inventory in the voltage classes.

3.2.1.3 Other DC Circuit Sustained Outage Data

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

Table FRCC 3.2-4
DC Circuit – Other Sustained Outage Attributes

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes or it would reveal confidential Transmission Owner information. See Section 1.5 and Table FRCC 2-2 of this report.

3.2.2 DC Circuit Momentary Outages

3.2.2.1 DC Circuit Momentary Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

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

Table FRCC 3.2-5

DC Circuit Momentary Outage Metrics – Element Initiated Only

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

Table FRCC 3.2-6

DC Circuit Momentary Outage Metrics – Other than Element Initiated

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

3.2.2.2 DC Circuit Momentary Outage Cause Code Data

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

Table FRCC 3.2-7

DC Circuit Momentary Outages by Cause Code

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

3.2.2.3 Other DC Circuit Momentary Outage Data

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

Table FRCC 3.2-8

DC Circuit – Other Momentary Outage Attributes

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

3.2.3 Total DC Circuit Metrics

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

Table FRCC 3.2-9

DC Circuit Metrics 1-16 per Appendix 2

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This category of data is not displayed because there is no inventory in the voltage classes.

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 FRCC 3.3-1 shows metrics for Transformer Sustained Outages that were "Element-Initiated," which means the outages were initiated on or within the Element (Transformer in this case) being reported.
- Table FRCC 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 FRCC 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	0.0	-	-	-	-
300-399 kV	0.0	-	-	-	-
400-599 kV	26.0	1	2.7	0.0385	2.7
600-799 kV	0.0	-	-	-	-
All Voltages	26.0	1	2.7	0.0385	2.7

Table FRCC 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	0.0	-	-	-	-
300-399 kV	0.0	-	-	-	-
400-599 kV	26.0	7	99.0	0.2692	14.1
600-799 kV	0.0	-	-	-	-
All Voltages	26.0	7	99.0	0.2692	14.1

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

Table FRCC 3.3-3 (p. 1 of 2)
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	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Environmental	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Contamination	1	12.5%	1	12.5%	3.1	3.0%	-	-	-	-	-	-
Foreign Interference	3	37.5%	3	37.5%	0.1	0.1%	-	-	-	-	-	-
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	1	12.5%	1	12.5%	94.2	92.6%	-	-	-	-	-	-
Failed AC/DC Terminal Equipment	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Failed Protection System Equipment	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Failed AC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Vegetation	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Power System Condition	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Human Error	0	0.0%	0	0.0%	0.0	0.0%	-	-	-	-	-	-
Unknown	2	25.0%	2	25.0%	2.7	2.7%	-	-	-	-	-	-
Other	1	12.5%	1	12.5%	1.6	1.6%	-	-	-	-	-	-
TOTAL	8	100.0%	8	100.0%	101.7	100.0%	-	-	-	-	-	-

Table FRCC 3.3-3 (p. 2 of 2)
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	0	0.0%	0	0.0%	0.0	0.0%
Environmental	0	0.0%	0	0.0%	0.0	0.0%
Contamination	1	12.5%	1	12.5%	3.1	3.0%
Foreign Interference	3	37.5%	3	37.5%	0.1	0.1%
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	1	12.5%	1	12.5%	94.2	92.6%
Failed AC/DC Terminal Equipment	0	0.0%	0	0.0%	0.0	0.0%
Failed Protection System Equipment	0	0.0%	0	0.0%	0.0	0.0%
Failed AC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%
Failed DC Circuit Equipment	0	0.0%	0	0.0%	0.0	0.0%
Vegetation	0	0.0%	0	0.0%	0.0	0.0%
Power System Condition	0	0.0%	0	0.0%	0.0	0.0%
Human Error	0	0.0%	0	0.0%	0.0	0.0%
Unknown	2	25.0%	2	25.0%	2.7	2.7%
Other	1	12.5%	1	12.5%	1.6	1.6%
TOTAL	8	100.0%	8	100.0%	101.7	100.0%

3.3.1.3 Other Transformer Sustained Outage Data

Table FRCC 3.3-4 on the next page shows other Transformer Sustained Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type, and Outage Duration Interval.

Table FRCC 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	-	-	-	-	-	-	-	-	7	87.5%	99.0	97.3%	-	-	-	-
P-P fault	-	-	-	-	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Single P-G fault	-	-	-	-	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
P-P-G, 3 P, or 3P-G fault	-	-	-	-	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Unknown fault type	-	-	-	-	-	-	-	-	1	12.5%	2.7	2.7%	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	8	100.0%	101.7	100.0%	-	-	-	-

Outage Initiation Code	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	-	-	-	-	-	-	-	-	1	12.5%	2.7	2.7%	-	-	-	-
Other Element-Initiated	-	-	-	-	-	-	-	-	4	50.0%	0.1	0.1%	-	-	-	-
AC Substation-Initiated	-	-	-	-	-	-	-	-	2	25.0%	97.2	95.7%	-	-	-	-
AC/DC Terminal-Initiated	-	-	-	-	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Other Facility-Initiated	-	-	-	-	-	-	-	-	1	12.5%	1.6	1.6%	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	8	100.0%	101.7	100.0%	-	-	-	-

Outage Mode Code	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
Single Mode	-	-	-	-	-	-	-	-	2	25.0%	4.3	4.2%	-	-	-	-
Dependent Mode Initiating	-	-	-	-	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Dependent Mode	-	-	-	-	-	-	-	-	6	75.0%	97.4	95.8%	-	-	-	-
Common Mode	-	-	-	-	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
Common Mode Initiating	-	-	-	-	-	-	-	-	0	0.0%	0.0	0.0%	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	8	100.0%	101.7	100.0%	-	-	-	-

Table FRCC 3.3-4 (p. 2 of 3)

Transformer - Other Sustained Outage Attributes

Event Type	200-299 kV				300-399 kV				400-599 kV				600-799 kV			
	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %	No. Sust.	%	No. Hrs.	Hours %
10	-	-	-	-	-	-	-	-	4	50.0%	101.5	99.9%	-	-	-	-
50	-	-	-	-	-	-	-	-	4	50.0%	0.1	0.1%	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	8	100.0%	101.7	100.0%	-	-	-	-

Transformer - Sustained Outage Duration Intervals

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	-	-	-	-	4	50.0%	-	-
6-10 Minutes	-	-	-	-	0	0.0%	-	-
11-30 Minutes	-	-	-	-	0	0.0%	-	-
31-120 Minutes	-	-	-	-	1	12.5%	-	-
121 Minutes to 24 Hours	-	-	-	-	2	25.0%	-	-
> 24 Hours to 48 Hours	-	-	-	-	0	0.0%	-	-
> 48 Hours	-	-	-	-	1	12.5%	-	-
TOTAL	-	-	-	-	8	100.0%	-	-

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

Fault Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
No fault	7	87.5%	99.0	97.3%
P-P fault	0	0.0%	0.0	0.0%
Single P-G fault	0	0.0%	0.0	0.0%
P-P-G, 3 P, or 3P-G fault	0	0.0%	0.0	0.0%
Unknown fault type	1	12.5%	2.7	2.7%
TOTAL	8	100.0%	101.7	100.0%

Outage Initiation Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Element-Initiated	1	12.5%	2.7	2.7%
Other Element-Initiated	4	50.0%	0.1	0.1%
AC Substation-Initiated	2	25.0%	97.2	95.7%
AC/DC Terminal-Initiated	0	0.0%	0.0	0.0%
Other Facility-Initiated	1	12.5%	1.6	1.6%
TOTAL	8	100.0%	101.7	100.0%

Outage Mode Code	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
Single Mode	2	25.0%	4.3	4.2%
Dependent Mode Initiating	0	0.0%	0.0	0.0%
Dependent Mode	6	75.0%	97.4	95.8%
Common Mode	0	0.0%	0.0	0.0%
Common Mode Initiating	0	0.0%	0.0	0.0%
TOTAL	8	100.0%	101.7	100.0%

Event Type	All Voltages			
	No. Sust.	%	No. Hrs.	Hours %
10	4	50.0%	101.5	99.9%
50	4	50.0%	0.1	0.1%
TOTAL	8	100.0%	101.7	100.0%

Outage Duration Interval	All Voltages	
	No. Sust.	%
1-5 Minutes	4	50.0%
6-10 Minutes	0	0.0%
11-30 Minutes	0	0.0%
31-120 Minutes	1	12.5%
121 Minutes to 24 Hours	2	25.0%
> 24 Hours to 48 Hours	0	0.0%
> 48 Hours	1	12.5%
TOTAL	8	100.0%

3.3.2 Transformer Momentary Outages

3.3.2.1 Transformer Momentary Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

- Table FRCC 3.3-5 shows metrics for Transformer Momentary Outages that were "Element-Initiated," which means the outages were initiated on or within the Element (Transformer in this case) being reported.
- Table FRCC 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 FRCC 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	0.0	-	-
300-399 kV	0.0	-	-
400-599 kV	26.0	0	0.0000
600-799 kV	0.0	-	-
All Voltages	26.0	0	0.0000

Table FRCC 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	0.0	-	-
300-399 kV	0.0	-	-
400-599 kV	26.0	1	0.0385
600-799 kV	0.0	-	-
All Voltages	26.0	1	0.0385

3.3.2.2 Transformer Momentary Outage Cause Code Data

For Momentary Outages, TADS requests one Cause Code: an Initiating Cause Code. Table FRCC 3.3-7 on the next page reports Cause Code data for Transformer Momentary Outages.

Table FRCC 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%
Lightning	-	-	-	-	1	100.0%	-	-	1	100.0%
Environmental	-	-	-	-	0	0.0%	-	-	0	0.0%
Contamination	-	-	-	-	0	0.0%	-	-	0	0.0%
Foreign Interference	-	-	-	-	0	0.0%	-	-	0	0.0%
Fire	-	-	-	-	0	0.0%	-	-	0	0.0%
Vandalism, Terrorism, or Malicious Acts	-	-	-	-	0	0.0%	-	-	0	0.0%
Failed AC Substation Equipment	-	-	-	-	0	0.0%	-	-	0	0.0%
Failed AC/DC Terminal Equipment	-	-	-	-	0	0.0%	-	-	0	0.0%
Failed Protection System Equipment	-	-	-	-	0	0.0%	-	-	0	0.0%
Failed AC Circuit Equipment	-	-	-	-	0	0.0%	-	-	0	0.0%
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	-	-	-	-	0	0.0%	-	-	0	0.0%
Unknown	-	-	-	-	0	0.0%	-	-	0	0.0%
Other	-	-	-	-	0	0.0%	-	-	0	0.0%
TOTAL	-	-	-	-	1	100.0%	-	-	1	100.0%

3.3.2.3 Other Transformer Momentary Outage Data

Table FRCC 3.3-8 on the next page shows other Transformer Momentary Outage attributes by Fault Type, Outage Initiation Code, Outage Mode Code, and Event Type.

Table FRCC 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	-	-	-	-	1	100.0%	-	-	1	100.0%
P-P fault	-	-	-	-	0	0.0%	-	-	0	0.0%
Single P-G fault	-	-	-	-	0	0.0%	-	-	0	0.0%
P-P-G, 3 P, or 3P-G fault	-	-	-	-	0	0.0%	-	-	0	0.0%
Unknown fault type	-	-	-	-	0	0.0%	-	-	0	0.0%
TOTAL	-	-	-	-	1	100.0%	-	-	1	100.0%

Outage Initiation Code	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Element-Initiated	-	-	-	-	0	0.0%	-	-	0	0.0%
Other Element-Initiated	-	-	-	-	1	100.0%	-	-	1	100.0%
AC Substation-Initiated	-	-	-	-	0	0.0%	-	-	0	0.0%
AC/DC Terminal-Initiated	-	-	-	-	0	0.0%	-	-	0	0.0%
Other Facility-Initiated	-	-	-	-	0	0.0%	-	-	0	0.0%
TOTAL	-	-	-	-	1	100.0%	-	-	1	100.0%

Outage Mode Code	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
Single Mode	-	-	-	-	0	0.0%	-	-	0	0.0%
Dependent Mode Initiating	-	-	-	-	0	0.0%	-	-	0	0.0%
Dependent Mode	-	-	-	-	1	100.0%	-	-	1	100.0%
Common Mode	-	-	-	-	0	0.0%	-	-	0	0.0%
Common Mode Initiating	-	-	-	-	0	0.0%	-	-	0	0.0%
TOTAL	-	-	-	-	1	100.0%	-	-	1	100.0%

Event Type	200-299 kV		300-399 kV		400-599 kV		600-799 kV		All Voltages	
	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%	No. Mom.	%
10	-	-	-	-	0	0.0%	-	-	0	0.0%
50	-	-	-	-	1	100.0%	-	-	1	100.0%
TOTAL	-	-	-	-	1	100.0%	-	-	1	100.0%

3.3.3 Total Transformer Metrics

Table FRCC 3.3-9 on the next page displays Transformer metrics that are defined in Appendix 2.

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

	Element Outage Frequency (1-3)			Element Outage Duration, Repair Time, and Update Time (4-7)						Element Availability (8-10)		
Voltage Class	TOF	SOF	MOF	SODT	MTTR P(5%) <	MTTR 50/50	MTTR P(5%) >	MdTTR	MTBF	APC %	PCZO %	PCDR %
200-299 kV	-	-	-	-	-	-	-	-	-	-	-	-
300-399 kV	-	-	-	-	-	-	-	-	-	-	-	-
400-599 kV	0.35	0.31	0.04	3.91	11.43	12.71	13.98	0.82	28457.29	99.96	80.77	0.00
600-799 kV	-	-	-	-	-	-	-	-	-	-	-	-

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

	Outage Totals		
Voltage Class	Momentary Outages	Sustained Outages	Sustained Outages Hours
200-299 kV	-	-	-
300-399 kV	-	-	-
400-599 kV	1	8	101.7
600-799 kV	-	-	-
TOTAL	1	8	101.7

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 FRCC 3.4-1 shows metrics for AC/DC BTB Converter Sustained Outages that were "Element-Initiated," which means the outages were initiated on or within the Element (AC/DC BTB Converter in this case) being reported.
- Table FRCC 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 FRCC 3.4-1
AC/DC BTD Converter Sustained Outage Metrics
Element Initiated Only

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

Table FRCC 3.4-2
AC/DC BTD Converter Sustained Outage Metrics
Other than Element Initiated

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

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

Table FRCC 3.4-3
AC/DC BTB Converter Sustained Outages by Cause Code

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

3.4.1.3 Other AC/DC BTB Converter Sustained Outage Data

Table FRCC 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 FRCC 3.4-4
AC/DC BTB Converter – Other Sustained Outage Attributes

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

3.4.2 AC/DC BTB Converter Momentary Outages

3.4.2.1 AC/DC BTB Converter Momentary Outage Initiation Code Metrics

The Outage Initiation Code describes where an outage initiated.

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

Table FRCC 3.4-5
AC/DC BTB Converter Momentary Outage Metrics
"Element Initiated" Only

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

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

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This category of data is not displayed because there is no inventory in the voltage classes.

3.4.2.2 AC/DC BTB Converter Momentary Outage Cause Code Data

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

Table FRCC 3.4-7
AC/DC BTB Converter Momentary Outages
By Cause Code

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This category of data is not displayed because there is no inventory in the voltage classes.

3.4.2.3 Other AC/DC BTB Converter Momentary Outage Data

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

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

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

3.4.3 Total AC/DC BTB Converter Metrics

Table FRCC 3.4-9 on the next page displays AC/DC BTB Converter metrics which are defined in Appendix 2.

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

This space intentionally left blank.
This category of data is not displayed because there is no inventory in the voltage classes.

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. These definitions were posted on September 11, 2008 for use during calendar year 2009 data collection.

Appendix 2 Metric Definitions

The TADS Metric 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 may be based upon a limited number of outages for smaller Regions or individual Transmission Owner organizations, 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 FRCC 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
	Element Outage Frequency			
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
	Element Outage Duration, Repair Time, and Up Time			
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 Sustained Outage Duration hours per outaged Element 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]
	Element Availability			
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
	Circuit Outage Frequency, per 100 Circuit Miles (Applies to AC and DC Circuits Only)			
11	Circuit Total Outage Frequency, Mileage Adjusted	(Total Circuit Automatic Outages *100) / Total Circuits Miles	No. Automatic Outages per 100 Circuit Miles per year	$TCOF_{100CM}$
12	Circuit Sustained Outage Frequency, Mileage Adjusted	(Total Circuit Sustained Outages *100) / Total Circuit Miles	No. Sustained Outages per 100 Circuit Miles per year	$SCOF_{100CM}$
13	Circuit Momentary Outage Frequency, Mileage Adjusted	(Total Circuit Momentary Outages *100) / Total Circuit Miles	No. Momentary Outages per 100 Circuit Miles per year	$MCOF_{100CM}$
	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.)			
14	Multi Circuit Total Outage Frequency, Mileage Adjusted	(Total Multi-Circuit Automatic Outages *100) / 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	(Total Multi-Circuit Sustained Outages *100) / 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	(Total Multi-Circuit Momentary Outages *100) / Total Multi-Circuit Structure Miles	No. Momentary Outages per 100 Multi-Circuit Structure Mles per year	$MMCOF_{100SM}$

Appendix 3 TADS Working Group Members as of April 23, 2010

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