



ATCO ELECTRIC LTD.
(Transmission System)

**SERVICE QUALITY AND RELIABILITY PERFORMANCE,
MEASURES AND INDICES**

**EUB Decision 2007-071
Board Direction 52**

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INTRODUCTION

In EUB Decision 2007-071, Board Direction 52, the Alberta Energy and Utilities Board directed ATCO Electric to provide a comprehensive listing of all transmission related service quality and reliability measures or indices that are currently being prepared for external use, and any reports being prepared for internal use, that AE considers may be appropriate for this purpose. Further, the Board directed AE to file these measures, indices and reports in conjunction with AE's Annual Quality of Service Report.

In compliance with EUB Decision 2007-071, Board Direction 52, ATCO Electric has compiled the attached report.

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1.0 DELIVERY POINT PERFORMANCE

1.1 INTRODUCTION

This section of the report deals with the measurement of actual reliability of ATCO Electric's (AE's) Bulk Electricity System (BES) for the year 2009. It compares BES reliability for the last 5 years to indicate trends.

A delivery point (DP) is considered interrupted when its voltage supply is interrupted due to a problem with the bus or due to problems within the BES. DP interruptions caused by problems originating on the customer's equipment or the distribution system are not considered, unless the BES fails to limit their impact to other delivery points.

An interruption to a DP is defined as being momentary when the duration of the interruption is less than one minute. These are interruptions of a transient nature, generally restored by automatic reclosing or auto-sectionalizing facilities. A DP interruption is defined as being sustained when the loss of supply voltage to the DP has a duration of one minute or more.

1.2 DELIVERY POINTS MONITORED

A delivery point is a point where an end use customer is fed from a transmission substation. There are two types of supply to the delivery points. One type is supplied from a single transmission line, and is designated as single - circuit supplied. The other type is supplied from more than one transmission line, and is called multi - circuit supplied. Out of a total of 153 delivery points monitored in 2009, 74 are multi-circuit supplied delivery points, and the remaining 79 are single - circuit supplied delivery points.

1.3 DEFINITION OF INDICIES

A description of each of the indices and the method of calculating them is shown below.

System Average Interruption Frequency Index – Sustained Interruptions (SAIFI - SI):

SAIFI - SI = (Number of Sustained Interruptions) / (Delivery Point - Years).

units: interruptions per delivery point per year.

System Average Interruption Frequency Index – Momentary Interruptions (SAIFI - MI):

SAIFI - MI = (Number of Momentary Interruptions) / (Delivery Point - Years).

units: interruptions per delivery point per year.

System Average Interruption Duration Index (SAIDI):

SAIDI = (Sum of Interruption Durations) / (Delivery Point - Years).

units: minutes per delivery point per year.

System Average Restoration Index (SARI):

SARI = (Sum of Interruption Durations) / (Number of Interruptions).
units: minutes per interruption.

System Average Load Interrupted Index (SALI):

SALI = (Sum of MW Interrupted) / (Delivery Point - Years).
units: MW per delivery point per year.

System Average Unsupplied Energy Index (SAUEI):

SAUEI = (Sum of Unsupplied Energy) / (Delivery Point - Years).
units: MW- minutes per delivery point per year.

Delivery Point Unreliability Index (DPUI):

DPUI = (Total Unsupplied Energy in MW-Min) / (System Peak Load in MW).
units: System Minutes

Customer SAIFI - SI (Transmission related) =

(Number of Sustained Customer Interruptions) / (Customer - Years).
units: interruptions per customer served per year.

Customer SAIDI (Transmission related) =

(Sum of Customer Interruption Durations) / (Customer - Years).
units: minutes per customer served per year.

1.4 PERFORMANCE INDICIES

Standard performance indices have been calculated for 2009, as well as the 5-year period between 2005 and 2009, using statistics as reported to CEA.

Table 1- Performance Indices for the 2005 - 2009 operating period.

SAIFI-SI							SAIFI-MI						
	2005	2006	2007	2008	2009	05-09 Avg		2005	2006	2007	2008	2009	05-09 Avg
Single	0.54	1.10	0.41	0.63	0.70	0.67	Single	2.91	3.29	2.59	1.80	2.38	2.56
Multiple	0.17	0.38	0.25	0.33	0.38	0.30	Multiple	0.26	0.64	0.03	0.16	0.07	0.24
All	0.35	0.72	0.34	0.49	0.54	0.49	All	1.51	1.88	1.42	1.03	1.26	1.42

SAIDI							SARI						
	2005	2006	2007	2008	2009	05-09 Avg		2005	2006	2007	2008	2009	05-09 Avg
Single	79.4	165.8	107.2	100.2	62.6	101.9	Single	145.9	150.3	259.9	158.3	89.9	152.4
Multiple	18.8	66.6	72.7	55.3	65.9	55.4	Multiple	110.2	176.8	286.4	168.3	174.1	183.4
All	47.4	113.1	91.5	79.1	64.2	79.0	All	136.6	157.7	268.9	161.4	118.3	161.9

SALI							SAUEI						
	2005	2006	2007	2008	2009	05-09 Avg		2005	2006	2007	2008	2009	05-09 Avg
Single	2.32	2.67	1.67	2.32	2.82	2.35	Single	435.4	769.9	350.8	407.3	459.9	477.4
Multiple	1.55	2.83	2.16	3.51	2.62	2.53	Multiple	218.3	303.8	506.4	483.9	544.4	406.8
All	1.91	2.76	1.89	2.88	2.72	2.44	All	320.8	522.4	421.7	443.3	500.8	442.6

DPUI							Customer SAIFI						
	2005	2006	2007	2008	2009	05-09 Avg		2005	2006	2007	2008	2009	05-09 Avg
Single	19.56	33.16	17.55	20.34	22.43	22.62	Single	1.13	1.38	0.30	0.74	0.85	0.84
Multiple	10.96	14.82	21.22	21.41	24.87	18.76	Multiple	0.28	0.28	0.18	0.42	0.21	0.27
All	30.51	47.97	38.77	41.75	47.30	41.37	All	0.51	0.52	0.22	0.51	0.39	0.43

Customer SAIDI						
	2005	2006	2007	2008	2009	05-09 Avg
Single	80.5	149.6	24.4	73.4	64.1	74.0
Multiple	29.3	13.1	23.4	40.0	23.4	25.8
All	43.5	43.1	23.7	49.1	34.5	38.7

Chart 1 – Plot of SAIFI-SI for the 5-yr period 2005-2009.

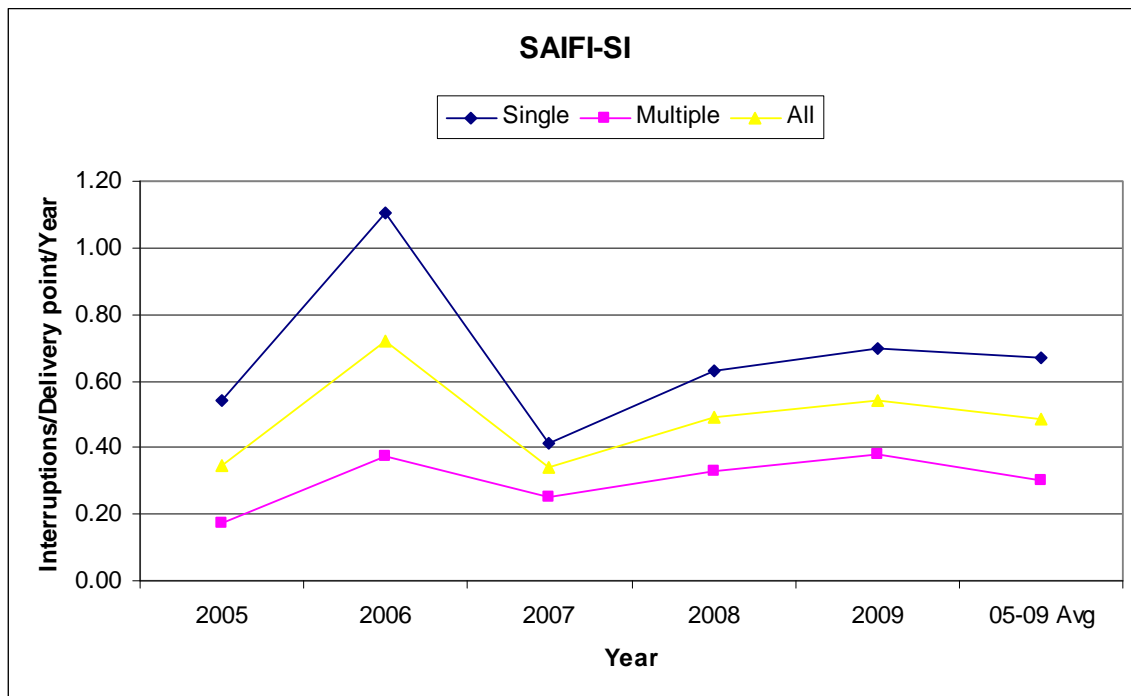


Chart 2 – Plot of SAIFI-MI for the 5-yr period 2005-2009.

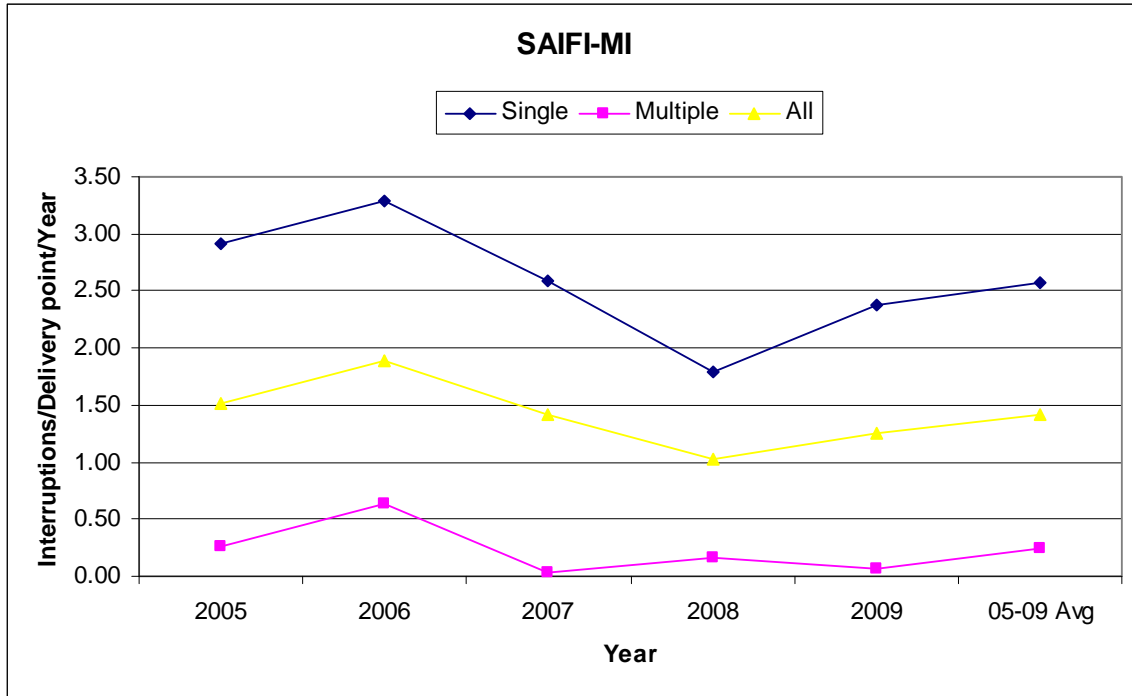


Chart 3 – Plot of SAIDI for the 5-yr period 2005-2009.

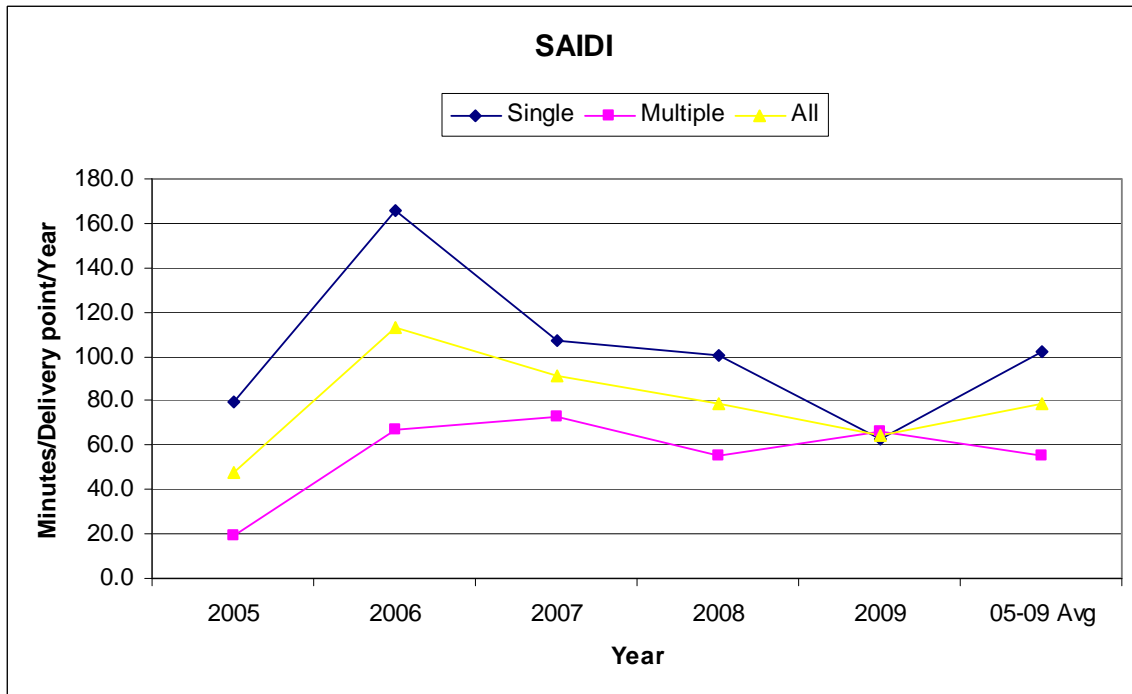


Chart 4 – Plot of SARI for the 5-yr period 2005-2009.

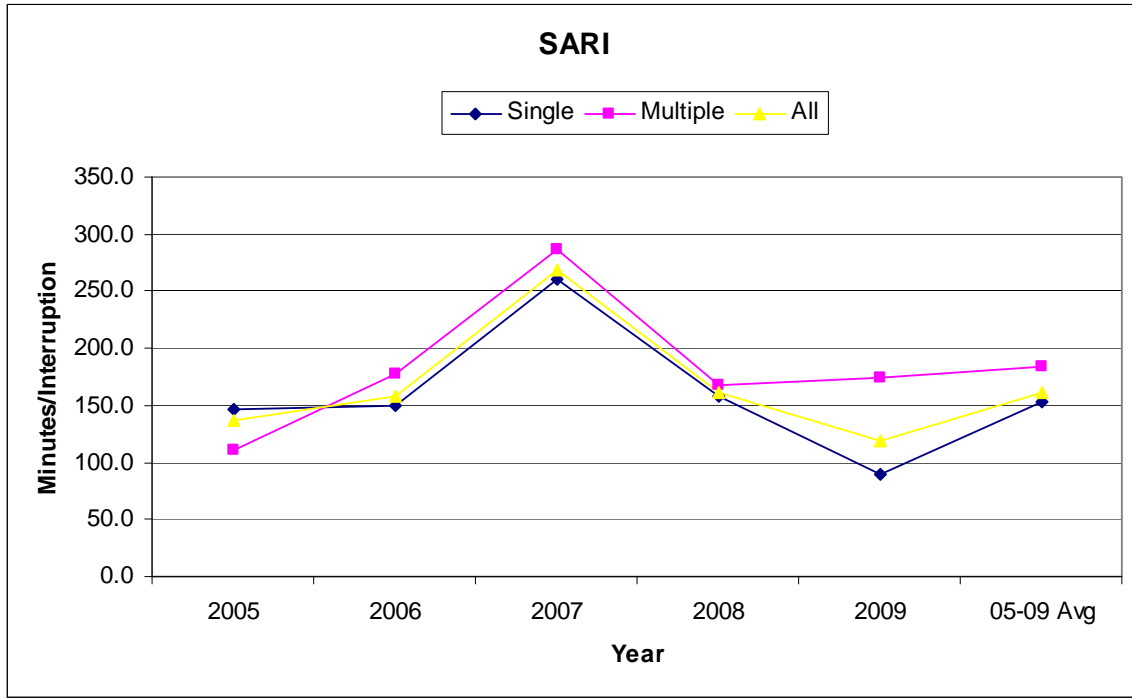


Chart 5 – Plot of SALI for the 5-yr period 2005-2009.

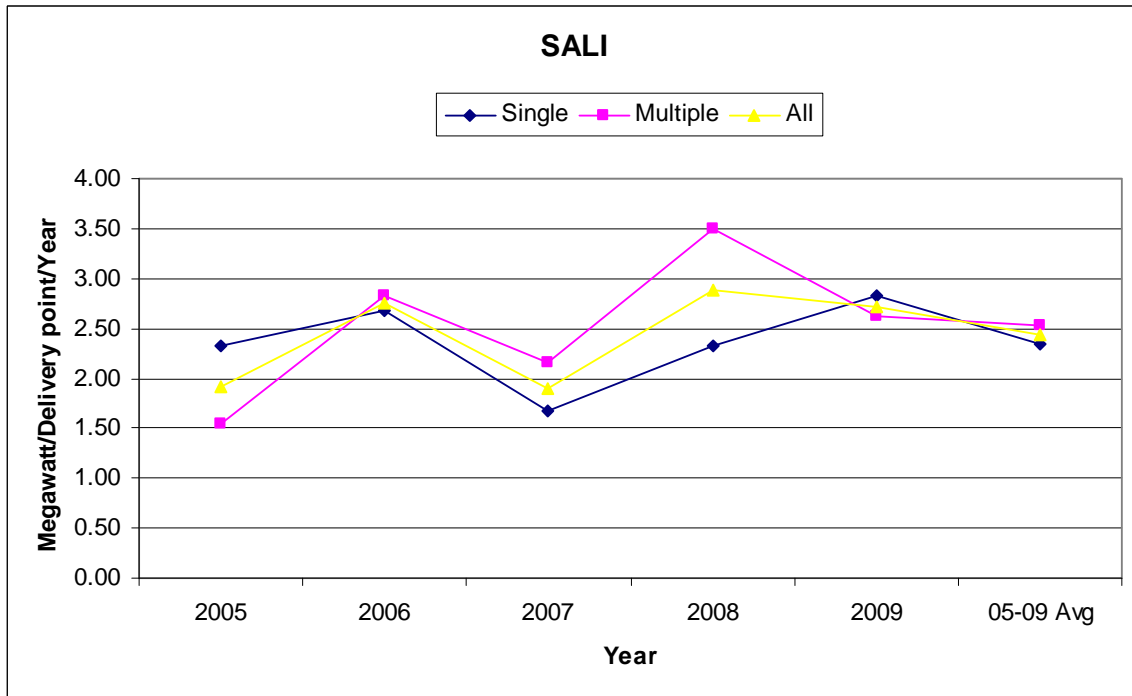


Chart 6 – Plot of SAUEI for the 5-yr period 2005-2009.

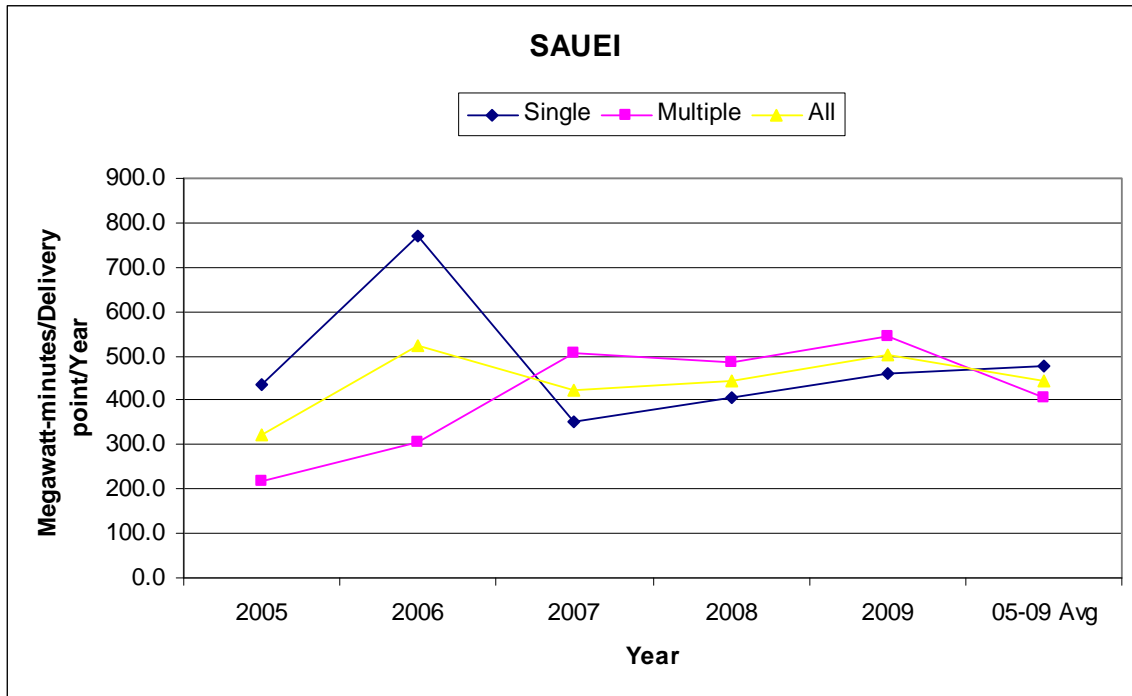


Chart 7 – Plot of DPUI for the 5-yr period 2005-2009.

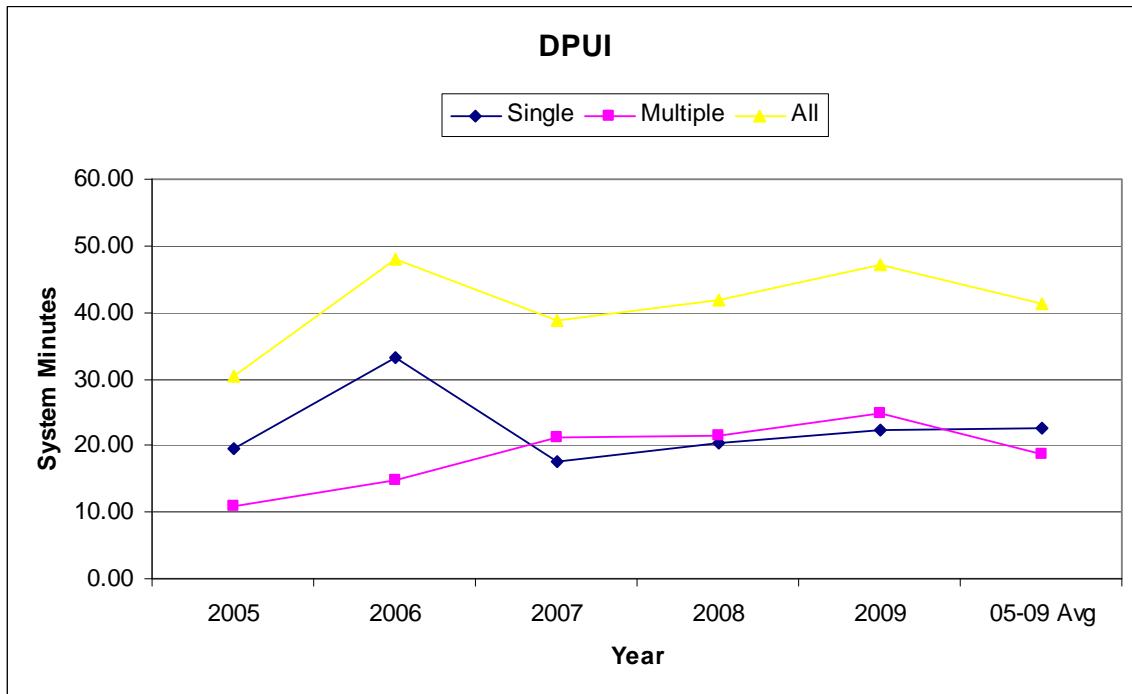


Chart 8 – Plot of Customer SAIFI for the 5-yr period 2005-2009.

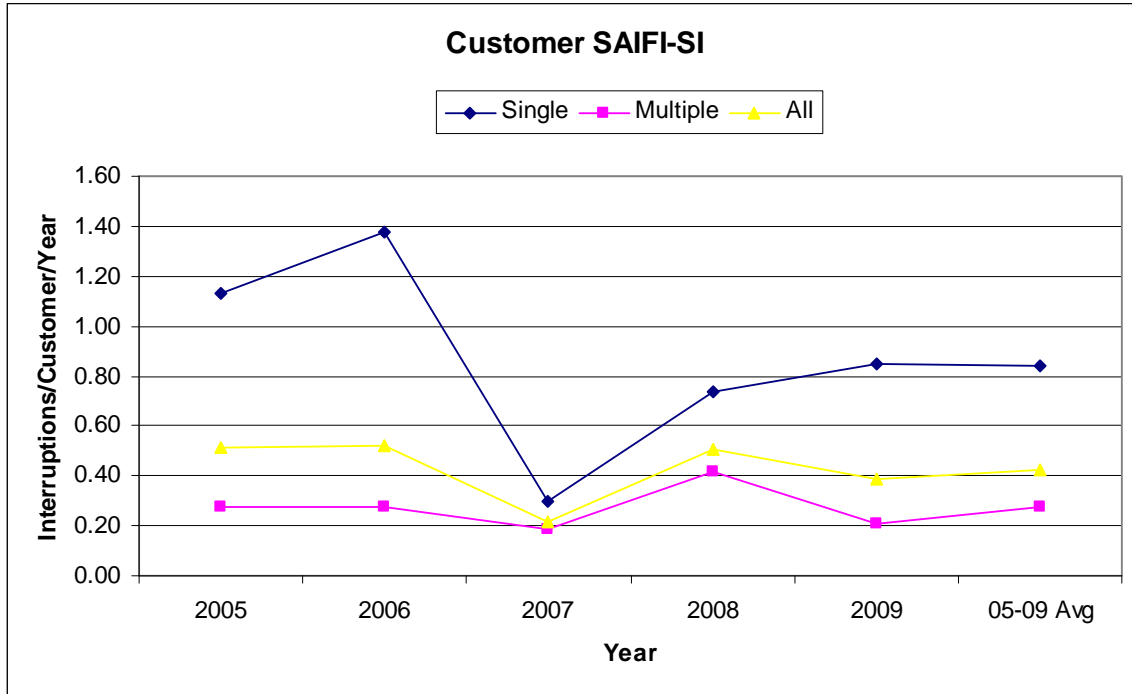
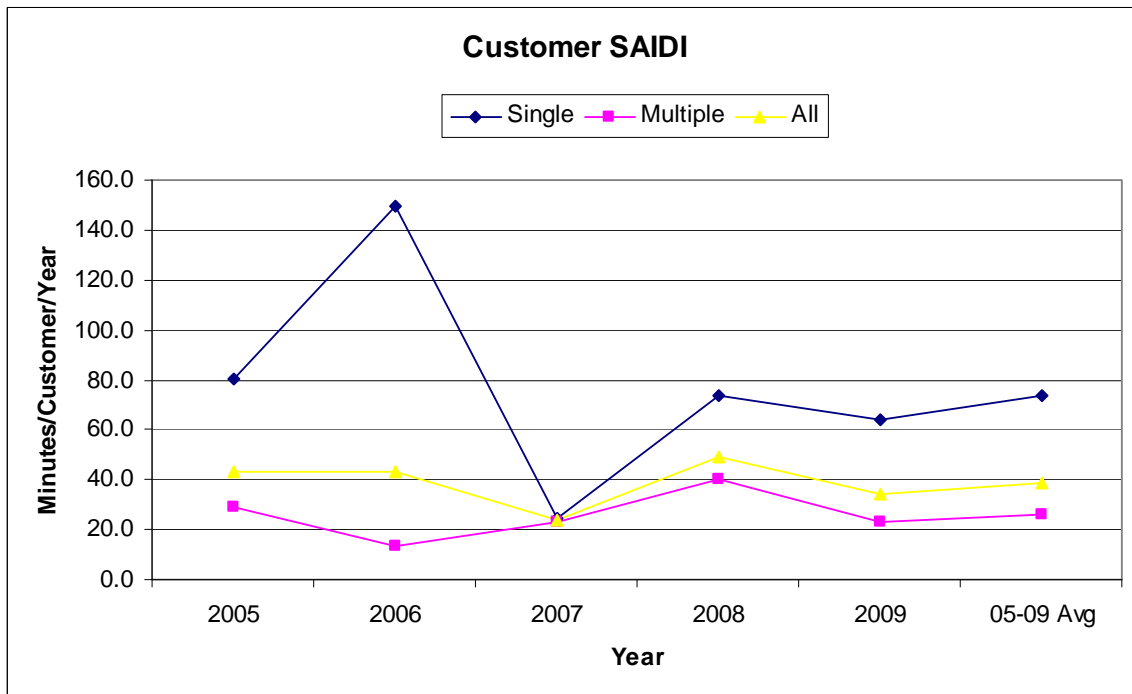


Chart 9 – Plot of Customer SAIDI for the 5-yr period 2005-2009.



2.0 MAJOR EQUIPMENT PERFORMANCE

2.1 INTRODUCTION

This section of the report on the performance of transmission lines, transformers and circuit breakers is based on ATCO Electric's transmission equipment outage data for the period January 1, 2005 to December 31, 2009. For comparison purposes, one-year statistics for the 2009 operating year as well as the five-year average statistics for the 2005 – 2009 operating period are presented.

This report covers the outage statistics for transmission lines, transformers and circuit breakers with an operating voltage of 72 kV and above and includes sustained and momentary outage data for the period 2005 – 2009.

2.2 DEFINITIONS

Transmission Equipment means all equipment with an operating voltage of 72 kV and above and includes those elements associated with transmission systems such as synchronous and static compensators and also shunt reactors and capacitors.

Major Component means a unit of Transmission Equipment (line, transformer, breaker, etc.) including all the associated auxiliaries that make it a functional entity within a power system.

A Terminal means a transmission line end or cable end which is equipped with primary protection.

A Unit of Transmission Equipment means a three-phase installation whether this installation is made up of one three-phase element or three single-phase elements.

Primary Cause means the reason to which one can attribute the outage or malfunction of a Major Component.

Component Forced Outage refers to the automatic or emergency removal of a Major Component directly caused by defective equipment, adverse weather, adverse environment, system condition, human element or foreign interference.

Common Mode Outage means a failure event where more than one component forced outage results from a single primary cause at the same time and where the outages are not consequences of each other.

Failure Mode means a description of the type of fault or malfunction, which the system sustains as a result of a Component Forced Outage.

Sustained Forced Outage refers to a forced outage the duration of which is one minute or more. It, therefore, does not include automatic reclosure events.

Transient/Momentary Forced Outage refers to a forced outage the duration of which is less than one minute and is, therefore, recorded as zero. It covers only automatic reclosure events.

Line Related Forced Outage means a forced outage which originated on the line (includes such items as structures, conductors, grounds, insulators, hardware).

Terminal Related Forced Outage means a forced outage which originated on the line terminals (includes such items as protection equipment, PTs, CTs).

Forced Unavailable Time is the elapsed time required to restore the Major Component to service or to repair it in the case where it has been replaced. All sustained events have a Forced Unavailable Time of one minute or more. All momentary events (automatic reclosures on Transmission Lines) have a forced unavailable time of zero.

Kilometer Years (km.a) is the summation of the product of the length in kilometers and the period duration in years, for the transmission lines or cables under consideration.

Terminal Years (a) is the summation of the product of the number of terminals and the period duration in years, for the transmission lines or cables under consideration. A terminal refers to a transmission line or cable end which is equipped with primary protection.

Component Years (a) is the summation of the product of the number of units of a Major Component and the period duration in years for the major component under consideration.

Number of Outages is the number of major component related forced outages.

Frequency (Per 100 km.a) is the Number of Outages divided by kilometer years, which are in turn divided by 100.

Frequency (Per a) is the Number of Outages divided by the Component Years or Terminal Years.

Total Time (h) is the sum of the forced unavailable times in hours of Major Component related sustained forced outages involving the indicated subcomponent or primary cause. Forced unavailable time is the elapsed time required to completely restore a major component to service.

Mean Duration (h) is the Total Time divided by the Number of Outages.

Unavailability (%) is the product of Frequency and Mean Duration in years expressed as a percentage.

2.3 TRANSMISSION LINES

Forced outages of transmission lines have been categorized into line - related and terminal - related outages. The transmission line performance statistics are given on a 100 kilometer-year basis for the line - related outages and on a terminal - year basis for terminal - related outages.

Tables 2 and 3 summarize ATCO Electric's transmission line statistics for line-related and terminal-related forced outages for the 2009 operating year. Outage statistics for three transmission voltage levels (72 kV, 144 kV, and 240 kV) are presented.

Table 2 - Summary of ATCO Electric's Total Transmission Line Outage Statistics for Line-Related Forced Outages for the 2009 Operating Year

Voltage Class	Kilometer Years (km-a)	No of Sustained Outages	Total Time (hr)	Frequency (per 100 km.a)	Mean Duration (hr)	Unavailability (%)	Number of Momentary Outages	Frequency (per 100 km.a)
72 kV	1243.64	17	71.57	1.37	4.21	0.06584	60	4.82
144 kV	5090.78	25	511.42	0.49	20.46	0.11445	20	0.39
240 kV	2762.43	7	76.15	0.25	10.88	0.03105	5	0.18
All	9096.85	49	659.13	0.54	13.45	0.08291	85	0.93

Table 3 - Summary of ATCO Electric's Total Transmission Line Outage Statistics for Terminal-Related Forced Outages for the 2009 Operating Year

Voltage Class	Terminal Years (a)	No of Sustained Outages	Total Time (hr)	Frequency (per a)	Mean Duration (hr)	Unavailability (%)	Number of Momentary Outages	Frequency (per a)
72 kV	44	2	2.57	0.05	1.28	0.00073	25	0.568
144 kV	153	15	23.12	0.10	1.54	0.00176	22	0.144

240 kV	68	3	3.03	0.04	1.01	0.00051	5	0.074
All	265	20	28.72	0.08	1.44	0.00132	52	0.196

Tables 4 and 5 present average statistics by voltage classification for the 2005-2009 five-year operating period.

Table 4 -Summary of ATCO Electric's Total Transmission Line Outage Statistics for Line-Related Forced Outages for the Period 2005 - 2009

Voltage Class	Kilometer Years (km.a)	No of Sustained Outages	Total Time (hr)	Frequency (per 100 km.a)	Mean Duration (hr)	Unavailability (%)	Number of Momentary Outages	Frequency (per 100 km.a)
72 kV	6414.81	82	483.52	1.28	5.90	0.08621	519	8.09
144 kV	25358.05	139	1407.68	0.55	10.13	0.06360	241	0.95
240 kV	13740.31	42	581.62	0.31	13.85	0.04901	62	0.45
All	45513.18	263	2472.82	0.58	9.40	0.06224	822	1.81

Table 5 -Summary of ATCO Electric's Total Transmission Line Outage Statistics for Terminal-Related Forced Outages for the Period 2005 - 2009

Voltage Class	Terminal Years (a)	No of Sustained Outages	Total Time (hr)	Frequency (per a)	Mean Duration (hr)	Unavailability (%)	Number of Momentary Outages	Frequency (per a)
72 kV	232	6	52.62	0.026	8.77	0.00260	41	0.18
144 kV	761	36	79.03	0.047	2.20	0.00118	40	0.05
240 kV	328	8	53.83	0.024	6.73	0.00184	12	0.04
All	1321	50	185.48	0.038	3.71	0.00161	93	0.07

Table 6 and Chart 10 present the frequency (per 100 km.a) of Line - Related Sustained Forced Outages for the years 2005 to 2009.

Table 6 - ATCO Electric's Transmission Line Outage Statistics- Frequency (per 100 km.a) of Line - Related Sustained Forced Outages for years 2005 to 2009

Voltage Class	2005	2006	2007	2008	2009	05-09 Avg.
72 kV	1.67	0.64	1.53	1.13	1.37	1.28
144 kV	0.62	0.88	0.39	0.37	0.49	0.55
240 kV	0.18	0.37	0.33	0.40	0.25	0.31
All	0.65	0.69	0.53	0.48	0.54	0.58

Chart 10 - Frequency (per 100 km.a) of Line - Related Sustained Forced Outages for the years 2005 to 2009

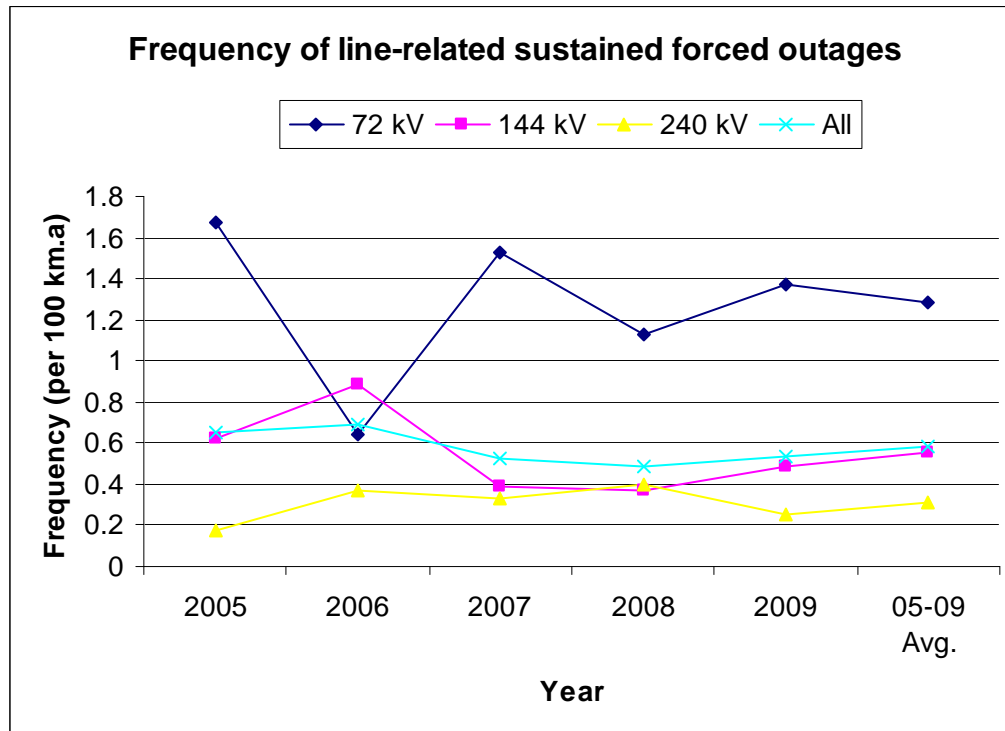


Table 7 and Chart 11 present the mean duration (h) of Line - Related Sustained Forced Outages for the years 2005 to 2009.

Table 7 - ATCO Electric's Transmission Line Outage Statistics- Mean Duration (h) of Line - Related Sustained Forced Outages for years 2005 to 2009

Voltage Class	2005	2006	2007	2008	2009	05-09 Avg.
72 kV	4.67	10.04	6.17	7.3	4.21	5.9
144 kV	13.67	4.78	6.33	7.61	20.46	10.13
240 kV	3.44	5.79	28.51	15.8	10.88	13.85
All	9.14	5.61	10.42	9.56	13.45	9.4

Chart 11 - Mean duration (h) of Line - Related Sustained Forced Outages for the years 2005 to 2009

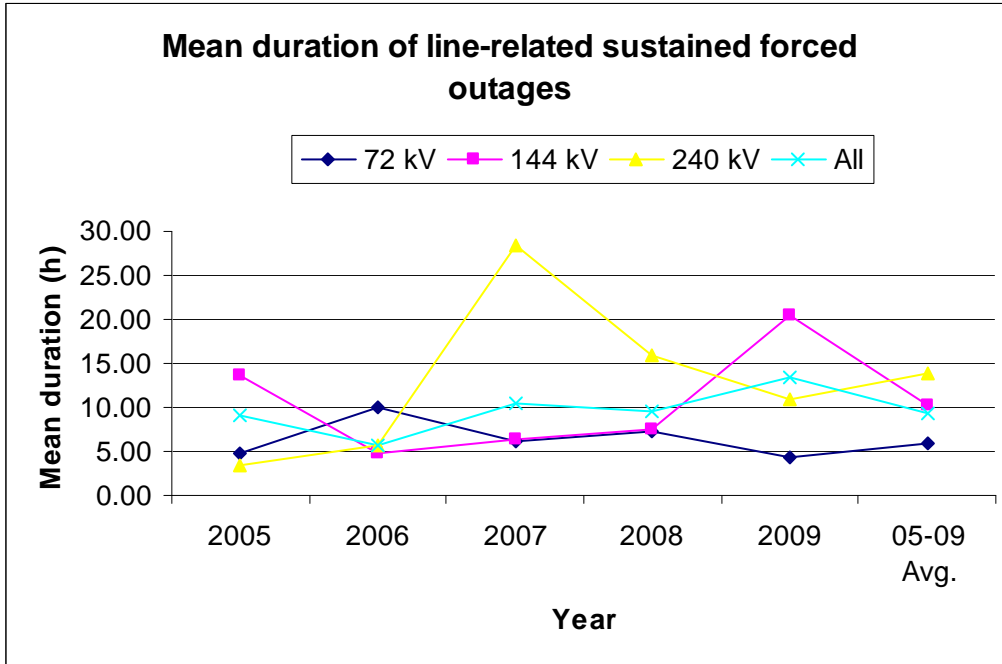
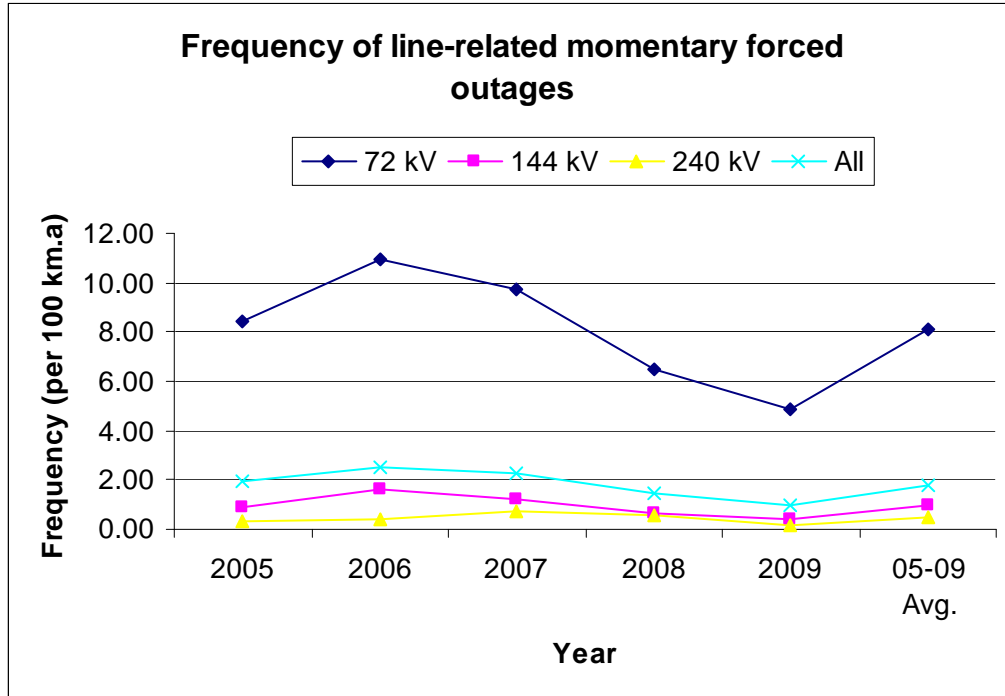


Table 8 and Chart 12 present the frequency (per 100 km.a) of Line - Related Momentary Forced Outages for the years 2005 to 2009.

Table 8 - ATCO Electric's Transmission Line Outage Statistics- Frequency (per 100 km.a) of Line - Related Momentary Forced Outages for years 2005 to 2009

Voltage Class	2005	2006	2007	2008	2009	05-09 Avg.
72 kV	8.41	10.92	9.73	6.51	4.82	8.09
144 kV	0.91	1.61	1.22	0.65	0.39	0.95
240 kV	0.33	0.44	0.72	0.54	0.18	0.45
All	1.93	2.54	2.23	1.42	0.93	1.81

Chart 12 - Frequency (per 100 km.a) of Line - Related Momentary Forced Outages for the years 2005 to 2009



2.4 TRANSFORMERS

In this section, Transformer performance statistics are summarized by voltage class. Forced outages involving integral sub-components (such as bushing) and terminal equipment (such as control and protection equipment) are combined in deriving transformer statistics. The one-year transformer outage statistics for the 2009 operating year and the 2005 – 2009 five-year average statistics are given in Tables 9 and 10, respectively.

Table 9 - Summary of ATCO Electric's Total Transformer Outage Statistics for the 2009 Operating Year

Voltage Class	Component Years (a)	No of Sustained Outages	Total Time (hr)	Frequency (per a)	Mean Duration (hr)	Unavailability (%)	Number of Momentary Outages	Frequency (per a)
72 kV	56	12	172.92	0.21	14.41	0.03525	3	0.05
144 kV	128	27	1355.18	0.21	50.19	0.12086	0	0.00
240 kV	23	4	364.05	0.17	91.01	0.18069	0	0.00

Table 10 - Summary of ATCO Electric's Total Transformer Outage Statistics for the Period 2005- 2009

Voltage Class	Component Years (a)	No of Sustained Outages	Total Time (hr)	Frequency (per a)	Mean Duration (hr)	Unavailability (%)	Number of Momentary Outages	Frequency (per a)
72 kV	280	26	6923.68	0.09	266.30	0.28228	4	0.014
144 kV	612	109	6945.40	0.18	63.72	0.12955	0	0.00
240 kV	111	19	531.48	0.17	27.97	0.05466	0	0.00

Table 11 and Chart 13 present the number of transformer sustained forced outages for the years 2005 to 2009.

**Table 11 - ATCO Electric's Transformer Outage Statistics-
Number of Sustained Forced Outages for the period 2005-2009**

Voltage Class	2005	2006	2007	2008	2009	05-09 Avg.
72 kV	5	3	2	4	12	5.20
144 kV	12	24	20	26	27	21.80
240 kV	1	7	3	4	4	3.80
Total	18	34	25	34	43	30.80

Chart 13 - Number of Transformer Sustained Forced Outages for the years 2005 to 2009

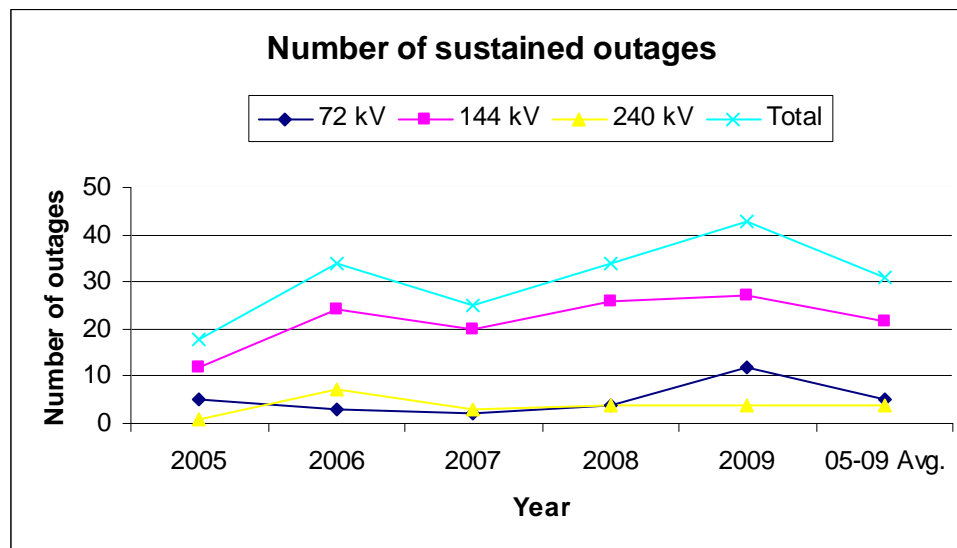
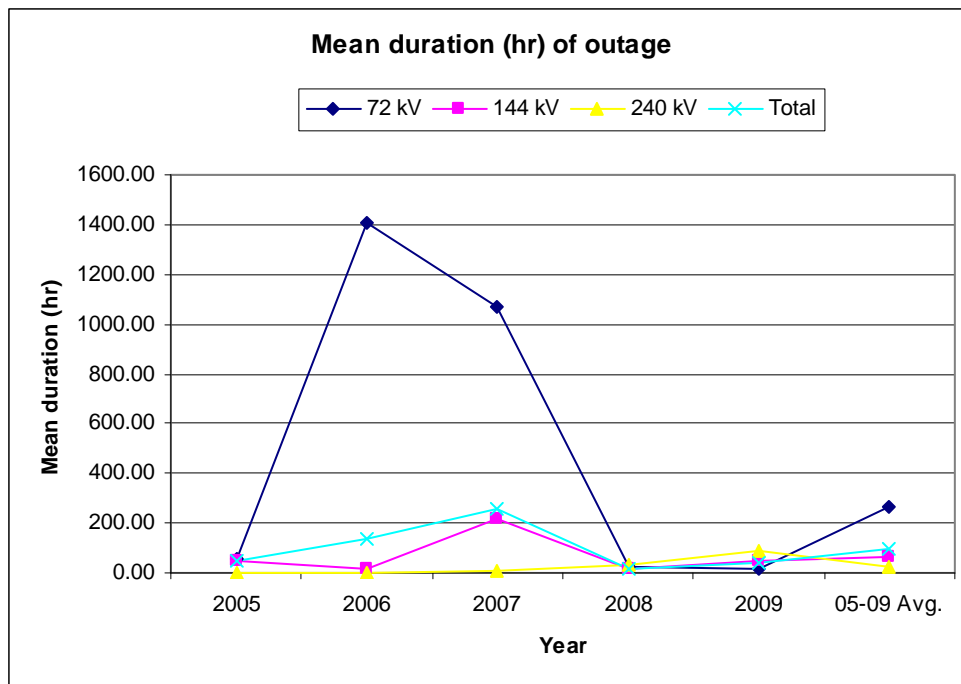


Table 12 and Chart 14 present the mean duration of transformer sustained forced outages for the years 2005 to 2009.

**Table 12 - ATCO Electric's Transformer Outage Statistics-
Mean Duration (hr) of Sustained Forced Outages for the period 2005-2009**

Voltage Class	2005	2006	2007	2008	2009	05-09 Avg.
72 kV	57.79	1406.11	1069.86	25.95	14.41	266.30
144 kV	46.54	13.33	217.25	14.10	50.19	63.72
240 kV	2.93	2.71	4.58	32.95	91.01	27.97
Total	47.24	134.04	259.94	17.71	44.00	93.51

Chart 14 - Mean Duration of Transformer Sustained Forced Outages for the years 2005 to 2009



2.5 CIRCUIT BREAKERS

In this section, Circuit Breaker performance statistics are summarized by voltage class. Forced outages involving integral sub-components (such as bushing) and terminal equipment (such as control and protection equipment) are combined in deriving breaker statistics. Table 13 provides the one-year statistics for the 2009 operating year and Table 14 gives the 2005-2009 five-year average statistics.

Table 13 - Summary of ATCO Electric's Total Circuit Breaker Outage Statistics for the 2009 Operating Year

Voltage Class	Component Years (a)	No of Sustained Outages	Total Time (hr)	Frequency (per a)	Mean Duration (hr)	Unavailability (%)	Number of Momentary Outages	Frequency (per a)
72 kV	78	0	0.00	0.00	0.00	0.00000	2	0.026
144 kV	238	16	83.87	0.07	5.24	0.00402	0	0.000
240 kV	93	2	0.50	0.02	0.25	0.00006	0	0.000

Table 14 - Summary of ATCO Electric's Total Circuit Breaker Outage Statistics for the Period 2005 – 2009

Voltage Class	Component Years (a)	No of Sustained Outages	Total Time (hr)	Frequency (per a)	Mean Duration (hr)	Unavailability (%)	Number of Momentary Outages	Frequency (per a)
72 kV	388	3	1441.05	0.01	480.35	0.04240	7	0.018
144 kV	1055	43	507.93	0.04	11.81	0.00550	5	0.005
240 kV	450	16	10.98	0.04	0.69	0.00028	1	0.002

Table 15 and Chart 15 present the number of circuit breaker sustained forced outages for the years 2005 to 2009.

Table 15 - ATCO Electric's Circuit Breaker Outage Statistics- Number of Sustained Forced Outages for the period 2005-2009

Voltage Class	2005	2006	2007	2008	2009	05-09 Avg.
72 kV	0	0	2	1	0	0.60
144 kV	5	6	7	9	16	8.60
240 kV	4	8	0	2	2	3.20
Total	9	14	9	12	18	12.40

Chart 15 - Number of Circuit Breaker Sustained Forced Outages for the years 2005 to 2009

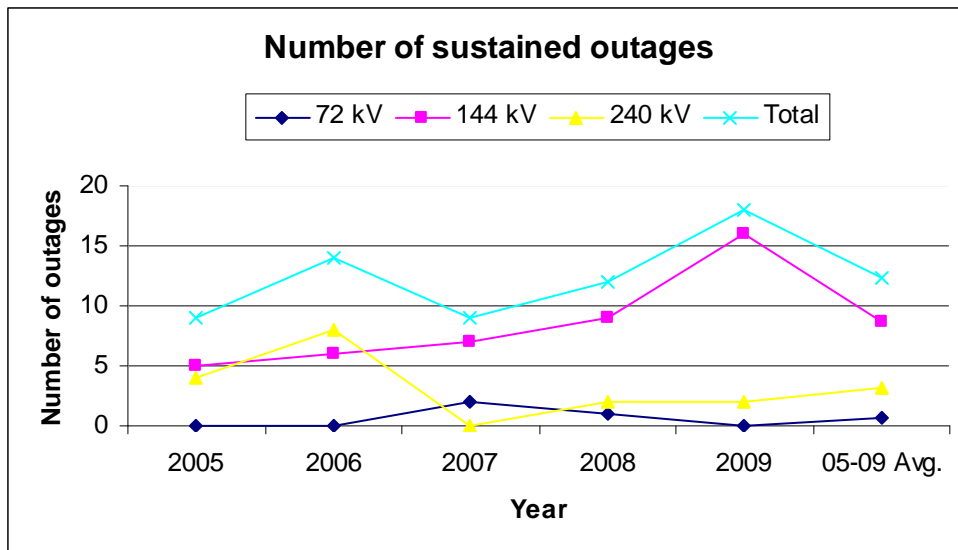
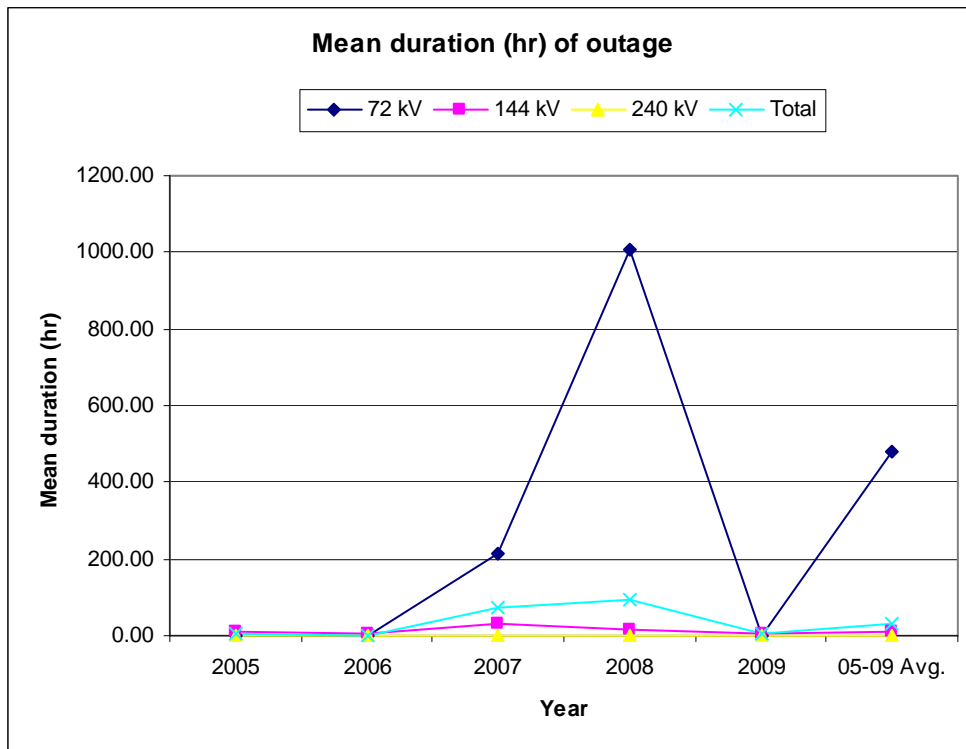


Table 16 and Chart 16 present the mean duration of circuit breaker sustained forced outages for the years 2005 to 2009.

**Table 16 - ATCO Electric's Circuit Breaker
Outage Statistics-
Mean Duration (hr) of Sustained Forced
Outages for the period 2005-2009**

Voltage Class	2005	2006	2007	2008	2009	05-09 Avg.
72 kV	0.00	0.00	216.19	1008.67	0.00	480.35
144 kV	9.34	3.18	32.75	14.34	5.24	11.81
240 kV	0.65	0.81	0.00	0.68	0.25	0.69
Total	5.48	1.83	73.51	94.92	4.69	31.61

Chart 16 - Mean Duration of Circuit Breaker Sustained Forced Outages for the years 2005 to 2009



2.6 WECC REPORT

Table 17 presents a summary of vegetation related transmission line outages for 2009 as reported to WECC (Western Electricity Coordinating Council).

Table 17 - Summary of Vegetation Related Transmission Line Outages for 2009

Category	RRO Designated Critical Lines <200 kV miles: <u>0</u>	Transmission Lines		
		230 kV class miles: <u>1692</u>	345 kV class miles: <u>0</u>	500/765 kV class miles: <u>0</u>
Category 1 — Grow-ins: Outages caused by vegetation growing into lines from vegetation inside and/or outside of the right-of-way.	<u>n/a</u>	<u>0</u>	<u>n/a</u>	<u>n/a</u>
Category 2 — Fall-ins: Outages caused by vegetation falling into lines from inside the right-of-way.	<u>n/a</u>	<u>0</u>	<u>n/a</u>	<u>n/a</u>
Category 3 — Fall-ins: Outages caused by vegetation falling into lines from outside the right-of-way.	<u>n/a</u>	<u>0</u>	<u>n/a</u>	<u>n/a</u>