

POWER INTERRUPTION INDICATORS

Pacific Power Association Benchmarking

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Training Notes

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Introduction:

SAIFI is the acronym for System Average Interruption Frequency Index and SAIDI is the acronym for System Average Interruption Duration Index.

SAIFI and SAIDI are power outage indicators useful for monitoring the reliability of power supply and benchmarking performance against other utilities.

This article shall define terms and definitions required to understand and determine SAIFI and SAIDI, describes the information that need to be captured and reported upon, and provide a step-by-step methodology for calculating these indicators.

Definitions:

Customer: A customer receive electrical power from the grid for end use purposes via a connection to the grid. The number of customers is therefore equal to the number of customer connections.

Power Interruption Event: An event on the high voltage distribution network that interrupts power supply to a customer for a duration of not less than a minute. Trips that are successfully reclosed on auto reclose protection function are not counted as a power Interruption event that impacts SAIFI and SAIDI.

Planned Interruption Event: A planned interruption event is caused by the need to carryout maintenance works on equipment.

Unplanned Interruption Event: An unplanned interruption event is an event caused by a failure to maintain power to the customers. This may be caused by a fault on the grid equipment, by human operator error or by an accident such as a vehicle running into a power pole. Unplanned events are also referred to as 'forced events.'

Key Reports:

Key reports required to determine SAIFI and SAIDI are:

1. Customer Distribution Report
2. Power Outage Event Report:

Customer Distribution Report (CDR):

The CDR provides the distribution of customer connections on the grid. This is best provided as the number of connections on each distribution transformer, feeder sections and feeders. An example of a CDR is provided in Appendix 2 for the grid single line diagram provided in Appendix 1.

Power Interruption Report (PIR):

The PIR is a report for a power interruption event report which provides the basic information required to determine the impact on the customer.

The Events/ Actions Table in the PIR completed correctly provides the number of customers impacted by the interruption and the duration of the interruption experienced by customers.

Report 1 shows a PIR. Using this report and referring to the single line diagram in Appendix 1 and extracting customer numbers from the CDR in Appendix 2 the determination of the power interruption indicators shall be demonstrated.

Report 1: Sample Power Interruption Report

Power Interruption Report			
Event No:	10		
Date:	3/03/2013		
Operator:	xxx		
Event Type:	Distribution		
Event Discription:	RMN tripped on earth fault due to a tree falling on the overhead line at EWA.		
Event/ Action	Date	Time	Comments
RMN tripped	3/03/2013	9:15	Earth fault feeder protection operated
Customer report received	"	9:17	Tree fell on the 11kV line at Ewa.
Line Team confirmed customer report.	"	9:25	Tree fell on the line between ABS 78 and 123
Open ABS 78	"	9:30	
Open ABS 123	"	9:35	
Closed RMN Feeder CB	"	9:40	Energised feeder to ABS 78
Closed ABS 232	"	9:55	Energise RMN feeder from RME to ABS 123 by closing opening point ABS 232
Issued PTW15 to Line team xxx	"	10:10	
Canceled PTW 15	"	15:30	Repairs confirm completed by xxx
Closed ABS 78	"	15:45	
Closed ABS 123	"	15:55	Parallel RMN and RME feeders
Open ABS 232	"	16:00	Restored Normal Opening Point
Supervisor's Comments			
Supervisor Signature			

Step	Key Events	Duration (Hours)	Number of customers affected	Customer Duration (Hours)
1	RMN feeder section from power station to ABS 78 power outage from 9:15 to 9:40	0.417	565	235.60
2	RMN feeder section from ABS 78 to ABS 123 outage from 9:15 to 9:55	0.667	250	166.75
3	RMN feeder section from ABS 78 to ABS 123 from 9:15 to 15:45	6.5	210	1,365.00
Total Number of Customers affected and Duration.			1,025	1,767.35
Total Number of Customers			3,000	
Impact on SAIFI		$= \frac{1,025}{3,000}$	0.312	Customer interruptions
Impact on SAIDI		$= \frac{1,767.35 \times 60}{3,000}$	35.347	Customer minutes

Switching Program:

A switching program is prepared for planned works on the grid. Its purpose is to ensure the section of the grid upon which works is required is made safe to work on.

A basic switching program is shown below:

Report 2: Sample Switching Program

Switching Program				
Switching Program No	6			
Date:	5/06/2013			
Operator:	xxx			
Field Operator	yyy			
Event Type:	Distribution			
Discription of Works	Carried out maintenance on the RMN line section between ABS 123 and ABS 150 and replacement of Anabar transformer			
Step	Action	Date	Time	Comments
1	Close ABS 232	5/06/2022	8:30	parallel RMN and RME
2	Open ABS 123	"	8:35	
3	Open ABS 150	"	8:45	Isolate line section between ABS 123 and 150
4	Attached earth on dead side of ABS 123	"	8:50	Make line section safe to work on
5	Attached earth on dead side of ABS 150	"	8:55	Make line section safe to work on
6	Issued Permit to Work No. xxx	"	9:00	Maintenance work may proceed
7	Cancel PTW No.	"	16:00	Confirm work is completed
8	Close ABS 123	"	16:15	Energise line section between ABS 123 & 150
9	Close ABS 150	"	16:20	Paralle RMN and RME
10	Open ABS 232	"	16:30	Restore normal Opening Point between RMN & RME
Supervisor's Comments				
Supervisor Signature				

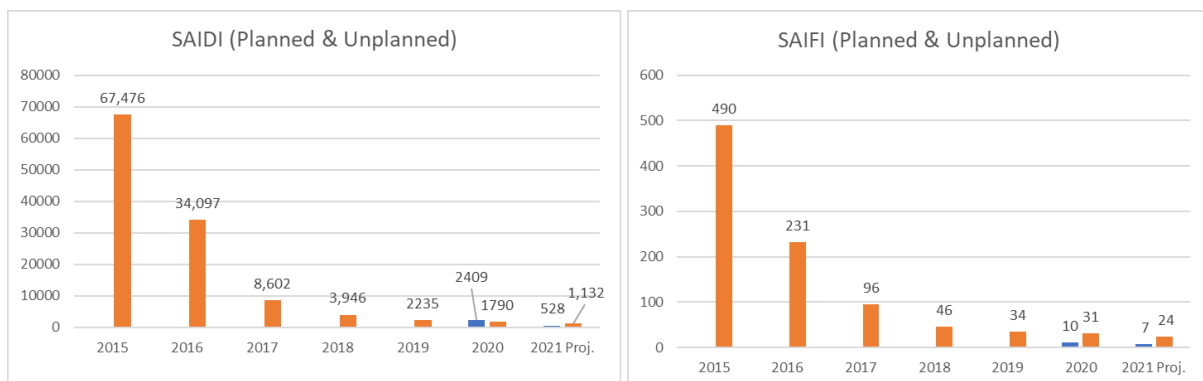
Step	Key Events	Duration (Hours)	Number of customers affected	Customer Duration (Hours)
1	Step 3: Open ABS 150			
2	Step 8: Close ABS 123	7.5	50	375
Total Number of Customers affected and Duration.			50	375
Total Number of Customers			3,000	
Impact on SAIFI		$= \frac{50}{3,000}$	0.017	Customer interruptions
Impact on SAIDI		$= \frac{1,767.35x}{3,000}$	7.5	Customer minutes

Determining SAIFI & SAIDI

When determining SAIFI and SAIDI the following applies:

1. SAIFI & SAIDI is generally reported for a period of a year.
2. The customers affected for all outages need to be totalled up and divided by the average number of customers to determine the SAIFI for the period.
3. The Customer minutes for all interruptions also need to be totalled up and divided by the average number of customers to determine the SAIDI for the period.
4. When interpreting performance it is useful to consider Planned and Unplanned SAIFI and SAIDI separately as they may indicate possible actions that may be hidden by the overall indicator.
5. When tracking performance on a monthly or quarterly basis, SAIFI and SAIDI could be determined for the period completed and annualized for comparison. For example, SAIDI and SAIFI could be determined for the first quarter of the year and multiplied by 4 to annualise for comparison with past years.

Understanding SAIFI & SAIDI



Graph 1: SAIDI SAIFI for Nauru Utility 2015 to 2021

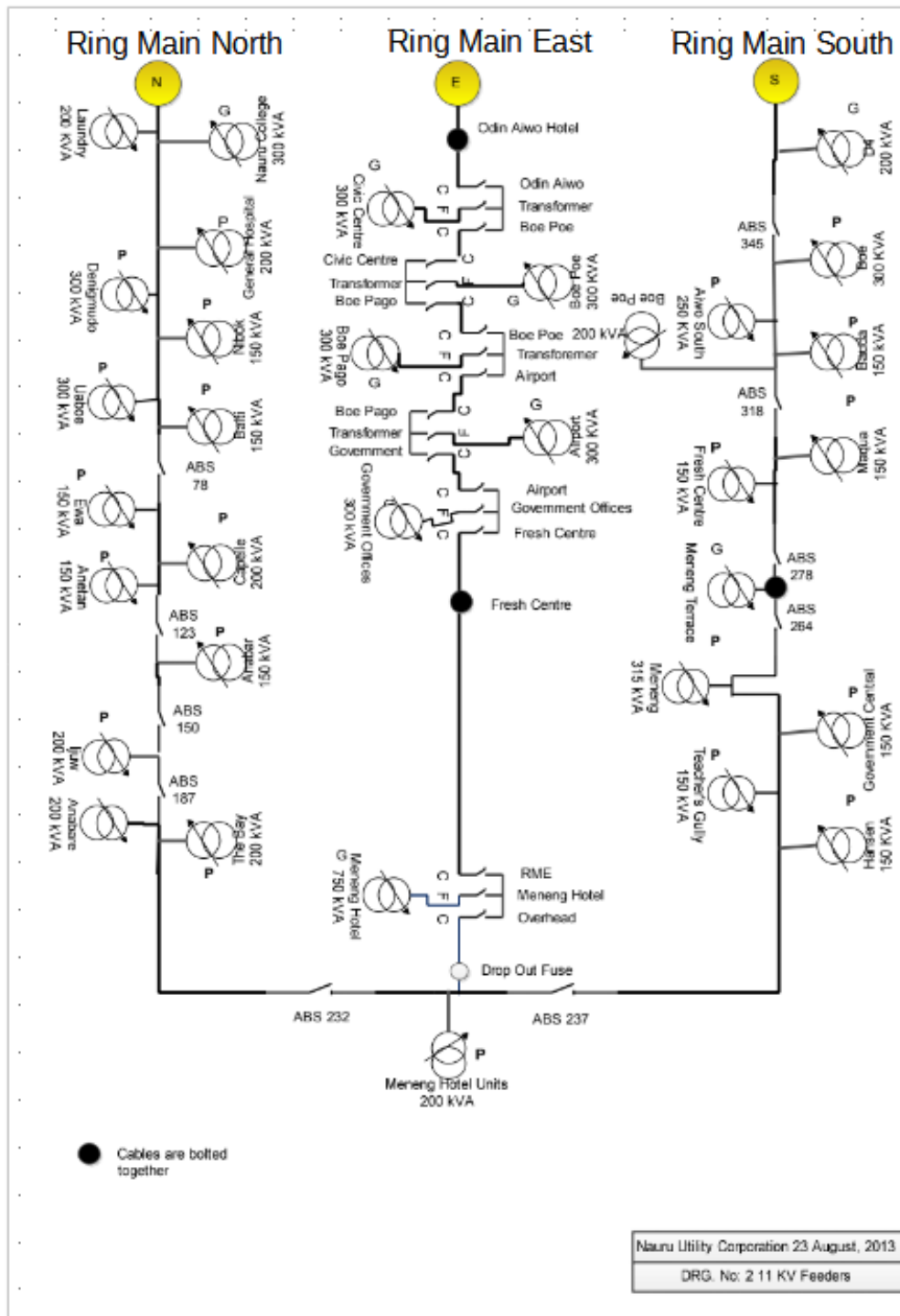
Graph 1 shows the trend in SAIDI and SAIFI over 7 years from 2015 to 2021. The annual period is the financial year which runs from 1 July to the 30th of June. Thus, the year 2021 is the period from 1 July 2020 to 30th June 2021. The projected 2021 data is the running total to March 2021 annualized by multiplying by a factor of 12/9.

The following are interesting observations from Graph 1:

1. SAIFI for 2015 was 490 interruptions per customer. On average a customer experienced 1.34 interruptions per day or at least one interruption per day and for one third of the year a second interruption.
2. The SAIDI for 2015 was 67,476 minutes. On average a customer experienced a interruption duration of almost 47 days of power interruptions during the year.
3. As a result of the interruptions customers were extremely dissatisfied with the utility service reliability and the public perception of the utility was a utility that was incompetent, uncaring, lazy, unresponsive, and poorly managed.²
4. The trend year on year from 2015 to 2018 was a reduction of SAIDI and SAIFI by around 50%. As reliability of power supply increased, the public perception of the utility began changing for the better.
5. For the first five years unplanned interruptions swamped planned interruption. By 2020 planned interruptions had become a significant component.

6. In 2020 planned SAIDI and SAIFI exceeded unplanned SAIDI and SAIFI. That was the year when major rehabilitation works were carried on the distribution network. These works continued to January 2021.
7. In 2021 unplanned SAIFI was projected to be 24 events. This on average meant a customer experienced a interruption once every 15 days.
8. Unplanned SAIDI for 2021 was projected to be 1,132 minutes or almost 19 hours of interruptions for the year
9. There is still some way to go on improvement as the long-term target was 200 minutes and 10 events for SAIDI and SAIFI respectively.
10. The public perception of the utility was the hardest and most competent workers on the island.

Appendix 1: Nauru Utilities Corporation: Single Line Diagram 2013



Appendix 2: Customer Distribution Report

Total Connections		3000				
Total 11 KV Feeder Connections		2126				
Feeder	Transformer	ABS	No of Customers	Number of Customers Before ABS	Number of Customers After ABS	Number of Customers Feeder
Ring Main North	Laundry		30			1025
	Nauru College		70			
	General Hospital		75			
	Denigomodu		100			
	Nibok		120			
	Uaboe		95			
	Baiti		75			
		78		565	460	
	Ewa		65			
	Capelle		65			
	Anetan		80			
		123		775	250	
	Anabar		50			
		150		825	200	
	Ijuw		55			
		187		880	145	
	Anabare		80			
	The Bay		65			
		232				
Ring Main South	D4		70			835
		345		70	765	
	Boe		10			
	Aiwo South		120			
	Boe Poe 1		20			
	Bauda		130			
		318		350	485	
	Maqua		40			
	Fresh Centre		80			
		278		470	365	
	Meneng Terrance		100			
		264		570	265	
	Meneng		120			
	Government Central		50			
	Teachers Gully		35			
	Hasan		60			
		237				
Ring Main East	Odin Aiwo		5			266
	Civic Centre		60			
	Boe Poe 2		80			
	Boe Pago		85			
	Airport		10			
	Government Offices		20			
	Meneng Hotel		1			
	Meneg Hotel Units		5			
3.3 KV Feeders						874