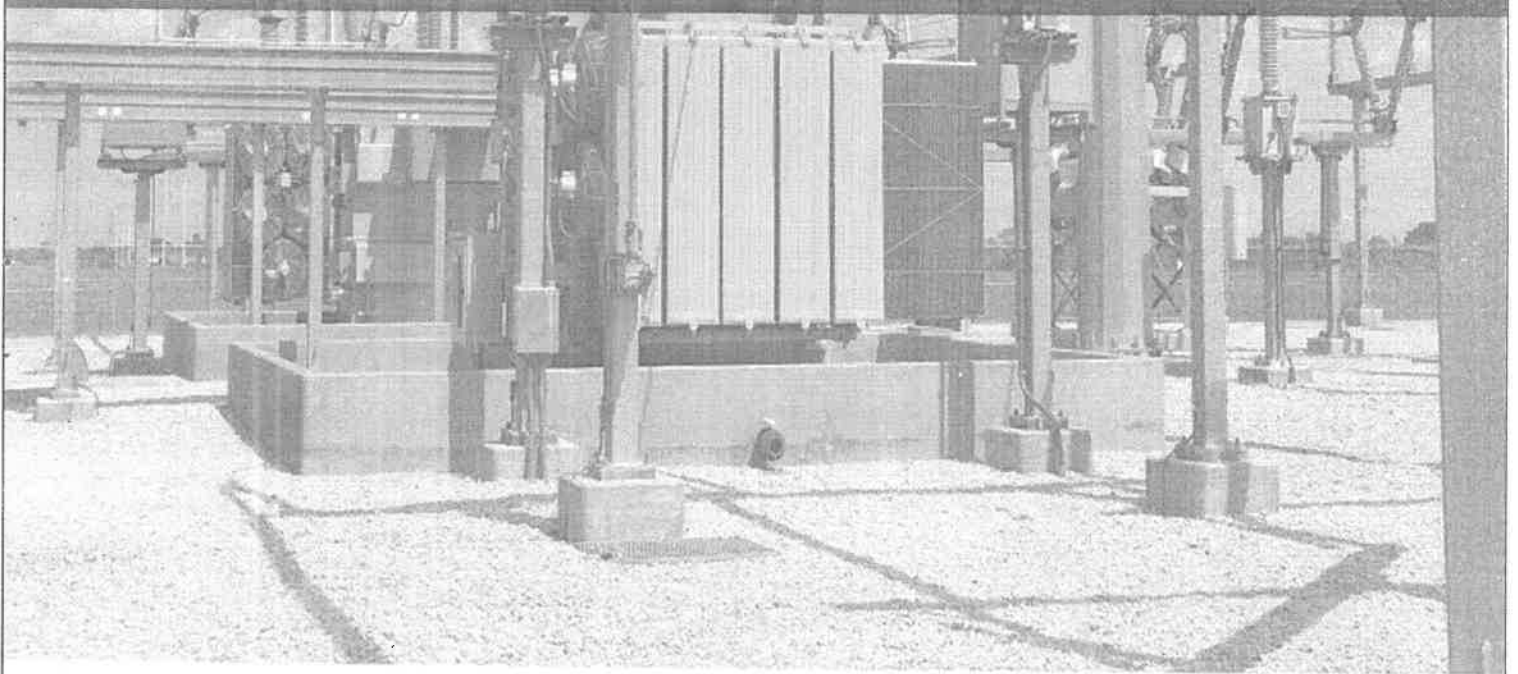


**A Report
On**

**RELIABILITY INDICES (RI) FOR
DNH POWER DISTRIBUTION CORPORATION LIMITED
FOR THE FY 2016-17**



DNH Power Distribution Corporation Limited
Vidyut Bhavan, 66 KV Road, Near Secretariat, Amli, Silvassa-396230.



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Index

Disclaimer	1
Index	3
List of Figures	5
List of Tables	7
Abbreviation and Acronyms	9
Chapter 1. Introduction and Background	13
Chapter 2. Approach and Methodology	17
Chapter 3. RI for FY 2016-17	23
Chapter 4. Conclusion	31

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List of Figures

Figure 1: Power Map of Dadra and Nagar Haveli.	16
Figure 2: Graphical representation of DNH Monthly RI for FY 2016-17.....	26
Figure 3: Graphical representation of NZ Monthly RI for FY 2016-17.	27
Figure 4: Graphical representation of NZ-II Monthly RI for FY 2016-17.....	27
Figure 5: Graphical representation of SZ Monthly RI for FY 2016-17.....	27
Figure 6: Graphical representation of DNH Quarterly RI for FY 2016-17.....	28
Figure 7: Graphical representation of NZ Quarterly RI for FY 2016-17.....	29
Figure 8: Graphical representation of NZ-II Quarterly RI for FY 2016-17.....	29
Figure 9: Graphical representation of SZ Quarterly RI for FY 2016-17.....	29
Figure 10: Graphical representation of DNH RI for FY 2016-17.	30

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List of Tables

Table 1: DNH Power Network Details	15
Table 2: List of Team Members.....	22
Table 3: Monthly RI for FY 2016-17.....	25
Table 4: Quarterly RI for FY 2016-17	28
Table 5: Financial Year wise RI from FY 2016-17	30

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Abbreviation and Acronyms

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CAIDI	:	Consumer Average Interruption Duration Index
D/C	:	Double Circuit
DNH	:	Dadra and Nagar Haveli
DNHPDCL	:	Dadra and Nagar Haveli Power Distribution Corporation Ltd.
JERC	:	Joint Electricity Regulatory Commission
KM	:	Kilo Meter
KV	:	Kilo Volt
MVA	:	Mega Volt Ampere
MW	:	Mega Watt
NZ	:	North Zone
PGCIL	:	Power Grid Corporation Of India Limited.
RI	:	Reliability Indices
SAIDI	:	System Average Interruption Duration Index
SAIFI	:	System Average Interruption Frequency Index
SZ	:	South Zone
UT	:	Union Territory

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Chapter 1. Introduction and Background

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1.1 Introduction to DNH Power Distribution Corporation Ltd.

The Union Territory (U.T.) of Dadra and Nagar Haveli (DNH) is situated on the western region surrounded by states of Gujarat and Maharashtra. The total area of territory is 491 sq. Kms. There are about 72 villages in this territory and the capital is Silvassa. The total population of the U.T. as per 2011 census is 3.4 lacks with 78 % tribal population.

DNH Power Distribution Corporation Ltd. (DNHPDCL) is part of the administration of Union Territory of Dadra & Nagar Haveli. The DNHPDCL is headed by the Managing Director (M.D). DNHPDCL is mainly engaged in the procurement, transmission and distribution of electricity to the various categories of consumers. The DNHPDCL does not own or operate any generating stations. Hence, based on allocation, power is drawn from the central sector power stations. The power in U.T. of DNH is being received from central sector power stations through central sector at 220 KV level. At present, 220 KV Kharadpada and Khadoli substations are fed through 220 KV D/C line from PGCIL 400/220 KV Vapi (Ambheti) and 400/220 KV Kala substations. Also, power is drawn at 220 kV level from Kala-New Kharadpada D/C line, Ambheti-Sayli line and Ambheti-Khadoli S/C line as per requirement. Figure 1 shows power map of Dadra and Nagar Haveli.

Power distribution in U.T. of DNH is carried out by DNHPDCL. The profile of power system of U.T. is as below.

Table 1: DNH Power Network Details

Max Demand	740 MW
220 KV Substations	4 Nos (Including two switching station at New Kharadpada and Sayli)
220/66 KV transformer	520 MVA at Kharadpada and 480 MVA at Khadoli
66 KV substations	13 Nos
66/11 KV Transformer	712 MVA
11KV feeders	199 Nos
Distribution transformers	1091 Nos
Length of 220 KV Line	35 km
Length of 66 KV Line	269.2 km
Length of 11 KV Line	830.88 km
Length of LT line	1775.22 km
No. of consumers	66750 Nos

In this report, Monthly, Quarterly and Yearly Reliability Indices (RI) of Dadra and Nagar Haveli for the FY 2016-17 as per the standards of JERC are prepared and presented.

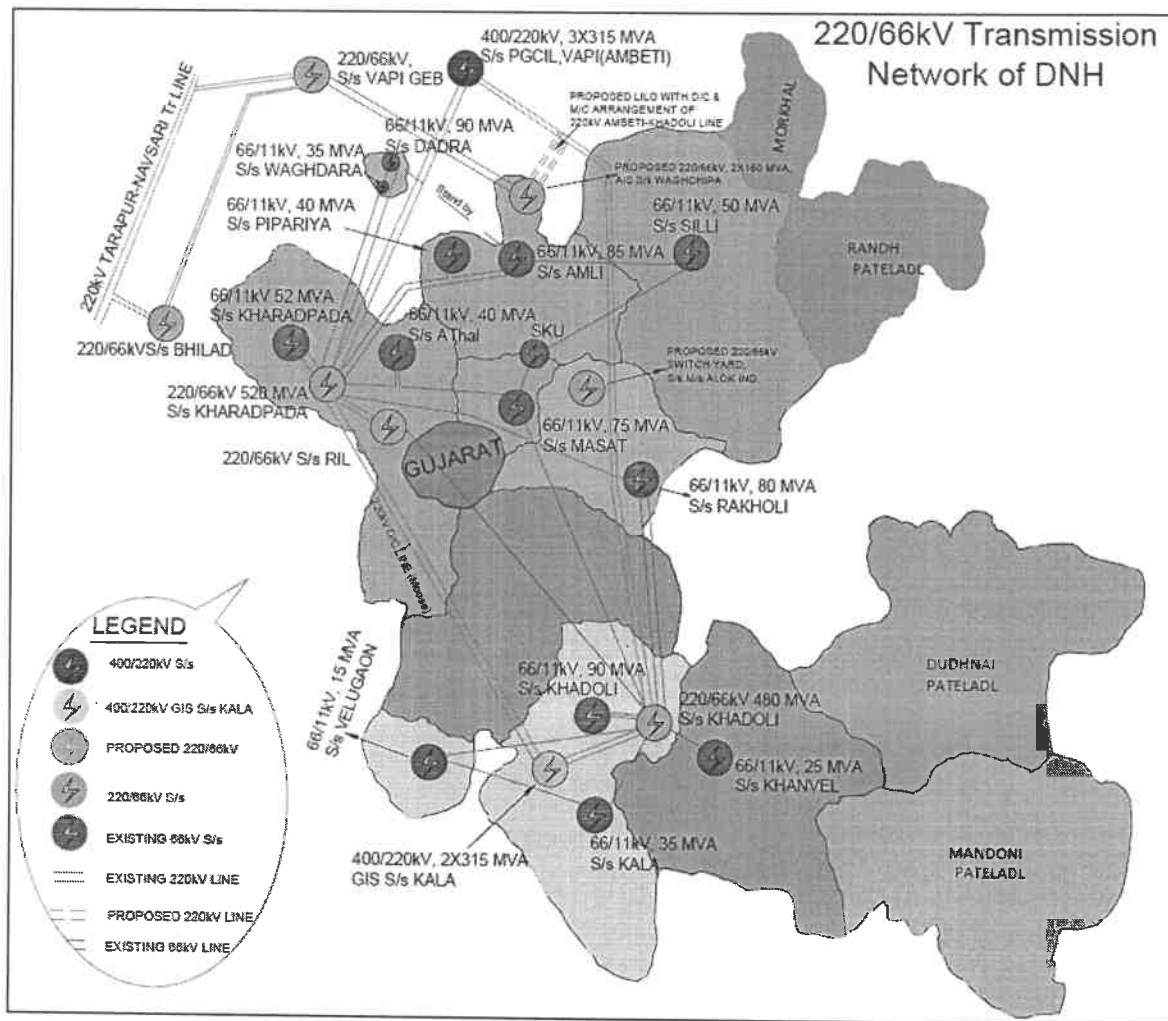


Figure 1: Power Map of Dadra and Nagar Haveli.

Chapter 2. Approach and Methodology

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2.1 Summary of the Chapter

This chapter presents methodology adopted for data preparation for calculating Reliability Indices (RI). Necessary data preparation is highly important as the analysis will be solely based on the data being used for the analysis. The major observations in this chapter are data collection and its methodology followed by thorough verification. The methodology presented here is developed based on best practices implementing in the utilities and based on our experience it is customized with practical limitations on data availability.

2.2 Definitions

- 2.2.1 **“Consumer”** means any person who is supplied with electricity for his own use by a licensee or the Government or by any other person engaged in the business of supplying electricity to the public under this Act or any other law for the time being in force and includes any person whose premises are for the time being connected for the purpose of receiving electricity with the works of a licensee, the Government or such other person, as the case may be;
- 2.2.2 **“Consumer count”** means the number of consumers is the preferred item to count if the counting system.
- 2.2.3 **“Interruption”** means the loss of service to one or more consumers.
- 2.2.4 **“Duration of interruption”** means the period measured in minutes from the initiation of an interruption to a consumer or other facility until service has been restored to that consumer or facility. It is essential to record the duration of each interruption.
- 2.2.5 **“Forced interruption”** means an interruption caused by a forced outage.
- 2.2.6 **“Interruptions caused by events outside of distribution”** means an interruption due to the cause of outside influences such as transmission line, of generating plant failure or outages.
- 2.2.7 **“Outage (electric power system)”** means the state of a component when it is not available to perform its intended function due to some event directly associated with that component.

Notes: 1. An outage may or may not cause an interruption of service to consumers, depending on system configuration.

2. This definition derives from transmission and distribution applications and does not apply to generation outages.

- 2.2.8 **“Scheduled interruption (electric power systems)”** means a loss of electric power that results when a component is deliberately taken out of service at a selected time, usually for the purposes of construction, preventative maintenance, or repair.

Notes:

1. This derives from transmission and distribution applications and does not apply to generation interruptions.

2. The key test to determine if an interruption should be classified as a forced or scheduled interruption is as follows. If it is possible to defer the interruption when such deferment is desirable, the interruption is a scheduled interruption; otherwise, the interruption is a forced interruption. Deferring an interruption may be desirable, for example, to prevent overload of facilities or interruption of service to consumers.

2.2.9 **“Total number of consumers served”** means the total number of consumers served on the last day of the reporting period. If a different consumer total is used, it must be clearly defined within the report.

2.2.10 **“Reporting period”** means a period assumed to be one month unless otherwise stated.

2.3 Assumptions

- a) Unique list of feeders in a substation are considered as total number of feeders in that substation.
- b) If both feeder IN and OUT times are not available then the feeder entry is counted in the calculation.
- c) If either IN time or OUT time any one of the entry data is not available then the default 5 minutes outage time is considered.

2.4 Reliability Indices (RI)

Reliability can be defined as the ability of the power system components to deliver electricity to all points of consumption, in the quantity & with the quality demanded by the consumer. Reliability is often measured by the outage indices defined in one international standard called IEEE 1366. (IEEE is the Institution of Electrical & Electronics Engineers, the biggest professional body of Electrical & Electronics Engineers. IEEE has its head office in the USA & has presence in most countries). These outage indices are based on the duration of each power supply interruption & the frequency of interruption. It is clear that all three major functional components of the power system – generation, transmission & distribution contribute to reliability. As far as the consumer is concerned, transmission & distribution outages are important. In fact, surveys (in developed countries) show that 80-90% of the outages experienced by consumers are caused by distribution outages.

A power supply outage is an planned or unplanned event & can be described in terms of the frequency, duration & amount of load (or consumers) affected. A momentary outage is defined as an outage lasting less than 5 minutes, corresponding to the time taken by automatic re-closure schemes to restore temporary faults; a sustained outage lasts longer than 5 minutes. IEEE standard 1366 gives the definition for outage indices. These indices are calculated using details of consumer interruptions collected from past year data. Definitions of few of the indices are given in Section 2.4.1.

2.4.1 Sustained interruption indices

- SAIFI - *System average interruption frequency index*
- SAIDI - *System average interruption duration index*
- CAIDI - *Consumer average interruption duration index*

❖ **SAIFI:** This index is designed to give information about the average frequency of sustained interruptions per consumer over a predefined area.

$$SAIFI = \frac{\text{Total number of consumer interruptions}}{\text{Total number of consumers served}}$$

(Or)

$$SAIFI = \frac{\text{Total number of interruptions}}{\text{Total no. of feeders}}$$

(Or)

$$SAIFI = \frac{\sum Ni}{NT}$$

Where,

- Ni Number of interrupted consumers for each interruption event during reporting period
- NT Total number of consumers served for the area being indexed

❖ **SAIDI:** This index is commonly referred to as consumer minutes of interruption and is designed to provide information about the average time the consumers are interrupted.

$$SAIDI = \frac{\text{Total consumer interruption durations}}{\text{Total number of consumers served}}$$

(Or)

$$SAIDI = \frac{\text{Total duration in minutes of interruptions}}{\text{Total no. of feeders}}$$

(Or)

$$SAIDI = \frac{\sum Ri * Ni}{NT}$$

Where

- Ri Restoration time for each interruption event
- i An interruption event
- T Total

CAIDI: CAIDI represents the average time required to restore service to the average consumer per sustained interruption.

CAIDI for consumer=

$$\frac{\text{Total of (Duration in minutes of interruptin of feeder * Total no. of connected consumers to feeder)}}{\text{Total number of consumers}}$$

$$CAIDI = \frac{(\sum Ri * Ni)}{(\sum Ni)} = \frac{SAIDI}{SAIFI}$$

$$* RI \text{ for Feeder} = \left(1 - \frac{SAIDI \text{ for feeder}}{\text{Total no. of days in given period} * 24 * 60}\right) * 100$$

$$* RI \text{ for consumer} = \left(1 - \frac{CAIDI \text{ for Consumer}}{\text{Total no. of days in given period} * 24 * 60}\right) * 100$$

2.4.1.1 Exclusions

While calculation the values of Reliability Indices i.e. SAIFI, SAIDI & CAIDI; the interruptions due to Load Shedding, EHV Openings (Distress load shedding), Forced interruption, Interruptions caused by events outside of distribution & Interruptions due to natural calamities are to be excluded.

2.5 List of Team Members

List of Team members for Data Collection, Data Entry in software and report preparation are mentioned in below table,

Table 2: List of Team Members

Sr. No	Name	Role
1	Mr. Kalpesh	Data Collection
2	Mr. Jigar	Data Collection
3	Mr. Deven	Data Entry
4	Mr. Hardik	Data Entry
5	Mr. Nagarjuna	Report Preparation
6	Mr. Naresh	Project Coordinator
7	Mr. Chandresh	Team Leader

Chapter 3. RI for FY 2016-17

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This chapter summarizes the Reliability Indices (RI) Monthly, Quarterly and Yearly for Financial Year 2016-17 along with graphical representations for DNH and its subdivisions NZ, NZ-II and SZ.

3.1 RI Monthly Report for FY 2016-17

Table 3: Monthly RI for FY 2016-17

Sr.No.	Month	SAIFI	SAIDI	RI for Feeder	CAIDI	RI for Consumer
DNH						
1	Apr-16	2.65	180.57	99.58	337.49	99.22
2	May-16	3.18	315.04	99.29	579.4	98.7
3	Jun-16	4.3	278.24	99.36	427.42	99.01
4	Jul-16	5.13	199.36	99.55	365.5	99.18
5	Aug-16	4.63	300.23	99.33	631.2	98.59
6	Sep-16	3.68	251.11	99.42	177.94	99.59
7	Oct-16	3.37	155.29	99.65	146.69	99.67
8	Nov-16	3.07	264.12	99.39	276.01	99.36
9	Dec-16	2.94	245.3	99.45	438.19	99.02
10	Jan-17	2.82	197.97	99.56	149.62	99.66
11	Feb-17	2.2	112.53	99.72	80.32	99.8
12	Mar-17	2.83	153.84	99.66	246.12	99.45
Total		40.79	2653.6	99.5	3855.9	99.27
Sub Division of DNH						
NZ						
Sr.No.	Month	SAIFI	SAIDI	RI for Feeder	CAIDI	RI for Consumer
1	Apr-16	2.85	281.16	99.35	357.8	99.17
2	May-16	3.37	485.51	98.91	606.24	98.64
3	Jun-16	3.92	290.43	99.33	412.43	99.05
4	Jul-16	4.77	218.18	99.51	336.56	99.25
5	Aug-16	4.53	398.15	99.11	627.05	98.6
6	Sep-16	3.11	216.38	99.5	148.34	99.66
7	Oct-16	2.9	131.47	99.71	122.04	99.73
8	Nov-16	3.15	223.12	99.48	258.22	99.4
9	Dec-16	2.16	372.96	99.16	460.05	98.97
10	Jan-17	1.88	178.31	99.6	125.74	99.72
11	Feb-17	1.81	130.18	99.68	67.65	99.83
12	Mar-17	2.02	141.38	99.68	227.05	99.49
Total		36.47	3067.24	99.42	3749.17	99.29
NZ-II						
Sr.No.	Month	SAIFI	SAIDI	RI for Feeder	CAIDI	RI for Consumer
1	Apr-16	2.67	127.54	99.7	227.71	99.47
2	May-16	3.61	302.96	99.32	455.94	98.98
3	Jun-16	3.92	236.28	99.45	314.21	99.27
4	Jul-16	4.5	160.32	99.64	417.27	99.07
5	Aug-16	4.21	188.28	99.58	341.4	99.24

Sr.No.	Month	SAIFI	SAIDI	RI for Feeder	CAIDI	RI for Consumer
6	Sep-16	3.57	317.87	99.26	247.22	99.43
7	Oct-16	3.15	169.73	99.62	199.07	99.55
8	Nov-16	3.75	460.61	98.93	509.48	98.82
9	Dec-16	3.16	222.08	99.5	349.51	99.22
10	Jan-17	3.12	233.94	99.48	260.03	99.42
11	Feb-17	1.45	50.43	99.87	106.93	99.73
12	Mar-17	2.89	156.26	99.65	407.9	99.09
Total		40.01	2626.3	99.5	3836.67	99.27
SZ						
Sr.No.	Month	SAIFI	SAIDI	RI for Feeder	CAIDI	RI for Consumer
1	Apr-16	2.38	120.49	99.72	178.57	99.59
2	May-16	2.37	113.57	99.75	325.05	99.27
3	Jun-16	5.28	316.46	99.27	944.04	97.81
4	Jul-16	6.4	225.42	99.5	806.95	98.19
5	Aug-16	5.29	319.03	99.29	1305.74	97.07
6	Sep-16	4.56	209.78	99.51	595.85	98.62
7	Oct-16	4.22	167.09	99.63	505.59	98.87
8	Nov-16	2.08	64.59	99.85	132.86	99.69
9	Dec-16	3.64	112.56	99.75	206.71	99.54
10	Jan-17	3.63	176.9	99.6	374.73	99.16
11	Feb-17	3.64	169.61	99.58	265.55	99.34
12	Mar-17	3.8	166.6	99.63	274.63	99.38
Total		47.3	2162.11	99.59	5916.25	98.87

Graphical representations of monthly RI of DNH and its subdivisions NZ, NZ-II and SZ for FY 2016-17 are as follows.

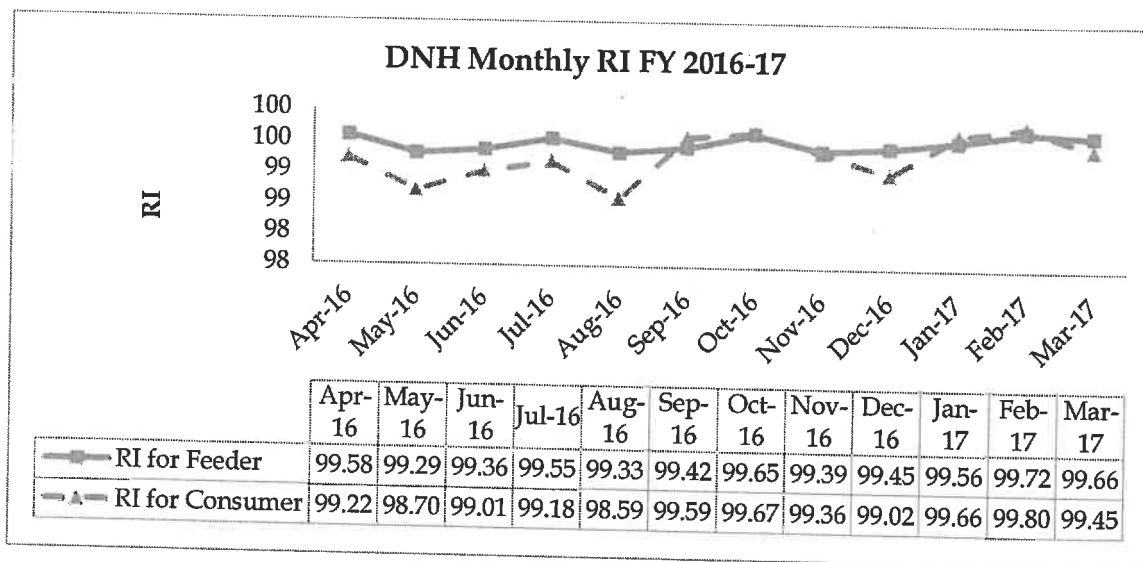


Figure 2: Graphical representation of DNH Monthly RI for FY 2016-17.

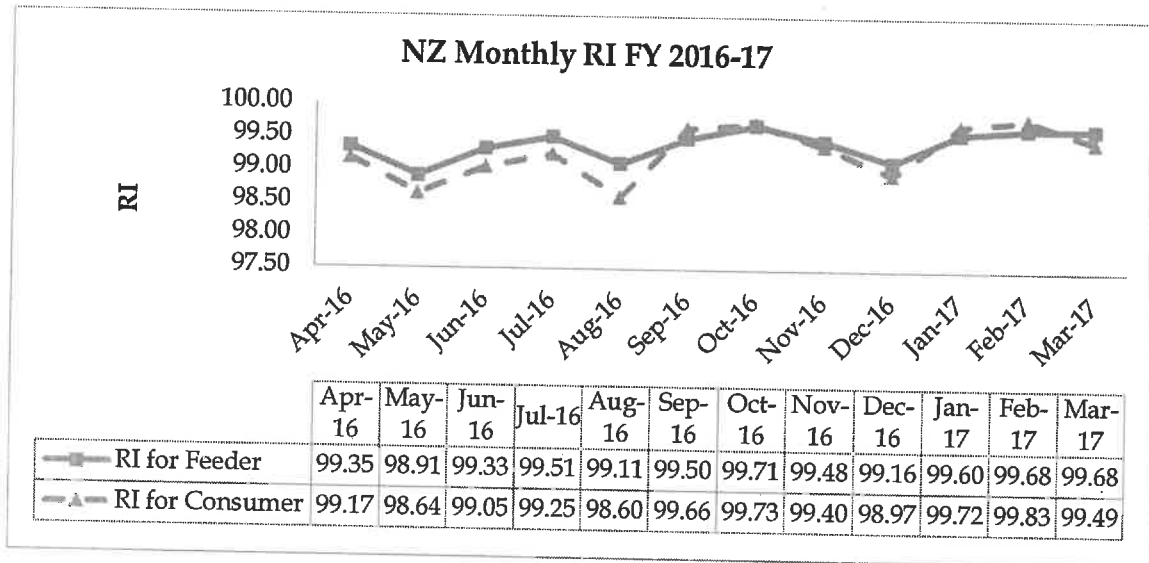


Figure 3: Graphical representation of NZ Monthly RI for FY 2016-17.

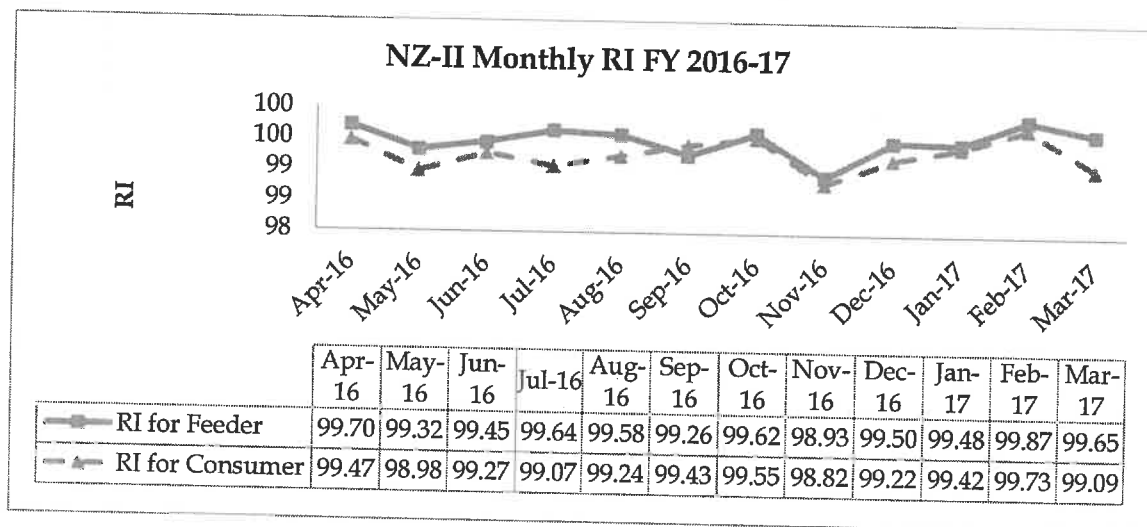


Figure 4: Graphical representation of NZ-II Monthly RI for FY 2016-17.

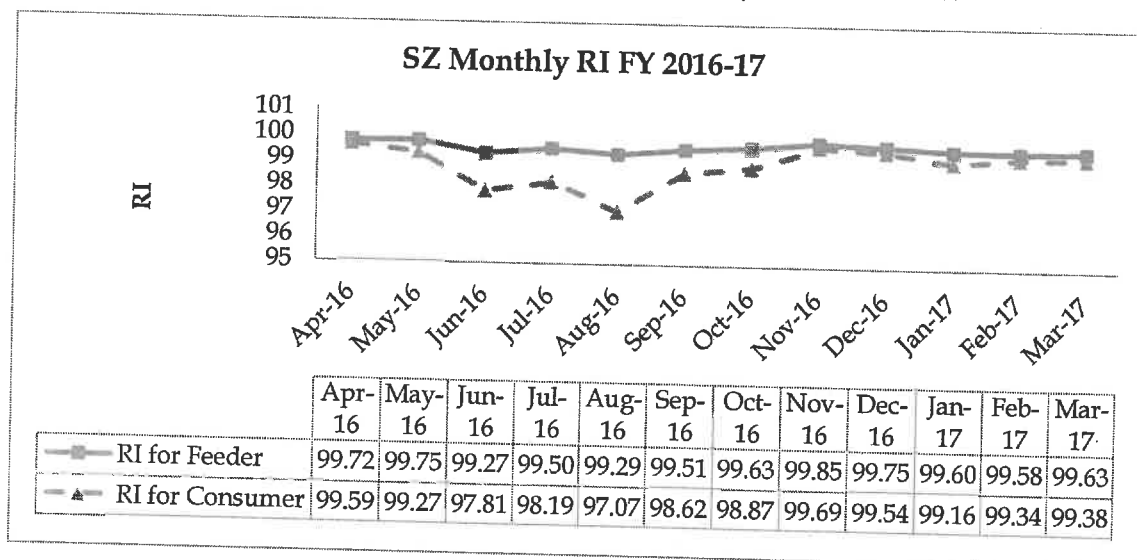


Figure 5: Graphical representation of SZ Monthly RI for FY 2016-17.

3.2 RI Quarterly Report for FY 2016-17

Table 4: Quarterly RI for FY 2016-17

DNH						
Sr.No.	Quarter	SAIFI	SAIDI	RI for Feeder	CAIDI	RI for Consumer
1	Q1	10.57	807.66	99.38	1344.33	98.97
2	Q2	14.03	783.5	99.41	1174.65	99.11
3	Q3	9.62	682.15	99.49	860.9	99.35
4	Q4	7.85	464.34	99.64	476.06	99.63
Sub Division of DNH						
NZ						
1	Q1	10.14	1057.1	99.19	1376.47	98.95
2	Q2	12.41	832.71	99.37	1111.95	99.16
3	Q3	8.21	727.56	99.45	840.31	99.37
4	Q4	5.71	449.88	99.65	420.44	99.68
NZ-II						
1	Q1	10.76	703.07	99.46	997.93	99.24
2	Q2	12.95	702.73	99.47	1005.96	99.24
3	Q3	10.41	880.83	99.34	1058.11	99.2
4	Q4	7.46	440.63	99.66	774.85	99.4
SZ						
1	Q1	10.94	600.12	99.54	1447.92	98.9
2	Q2	17.71	822.18	99.38	2709.04	97.96
3	Q3	10.46	362.2	99.73	845.24	99.36
4	Q4	11.07	513.12	99.6	914.9	99.29

Graphical representations of quarterly RI of DNH and its subdivisions NZ, NZ-II and SZ for FY 2016-17 are as follows.

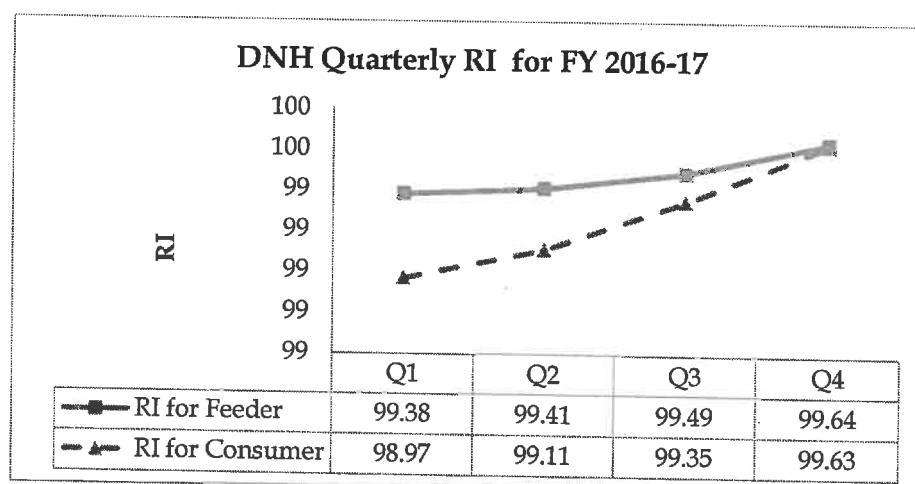


Figure 6: Graphical representation of DNH Quarterly RI for FY 2016-17

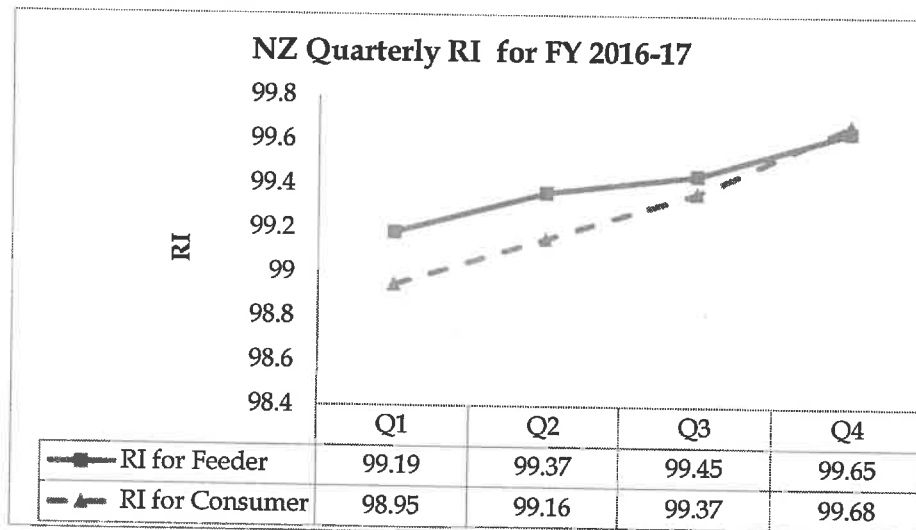


Figure 7: Graphical representation of NZ Quarterly RI for FY 2016-17

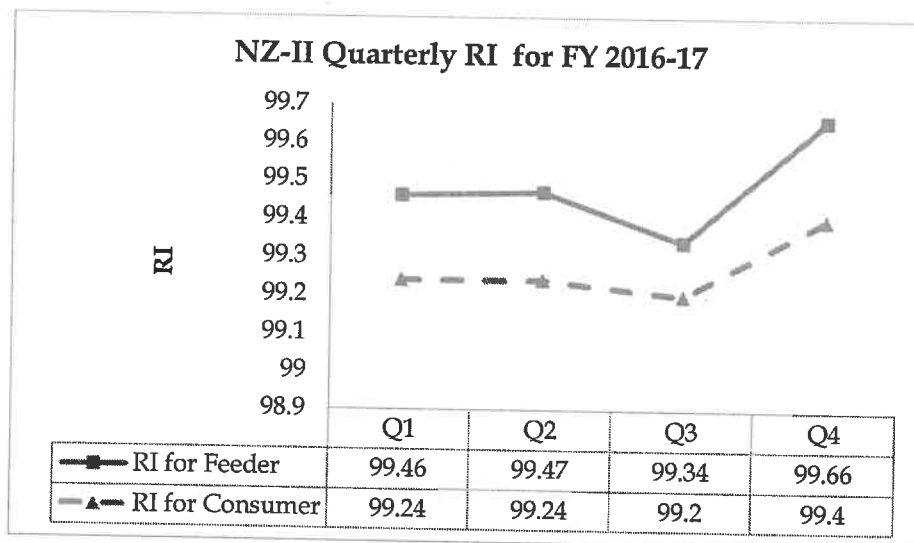


Figure 8: Graphical representation of NZ-II Quarterly RI for FY 2016-17

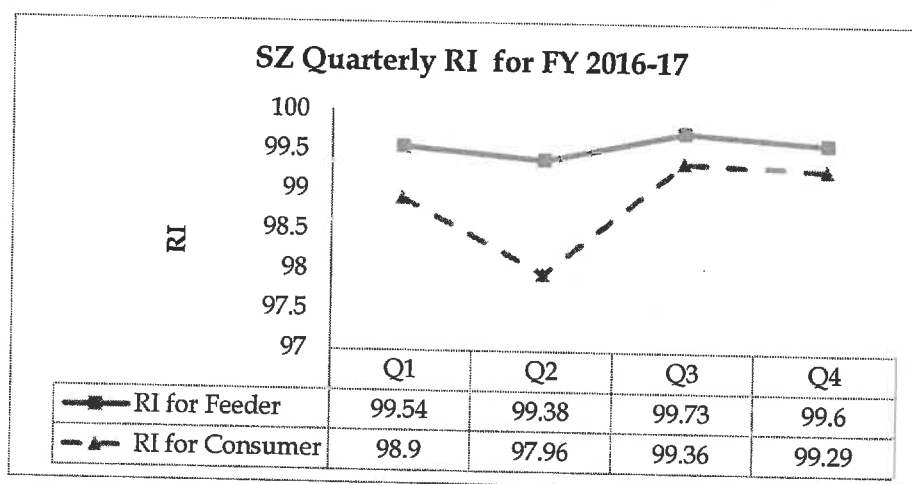


Figure 9: Graphical representation of SZ Quarterly RI for FY 2016-17

3.3 RI Yearly Report for FY 2016-17

RI Financial Year wise Report from 01-04-2016 to 31-03-2017,

Table 5: Financial Year wise RI from FY 2016-17

Financial Year	SAIFI	SAIDI	RI for Feeder	CAIDI	RI for Consumer
DNH					
FY 2016-17	40.79	2653.6	99.50	3855.90	99.27
Sub Divisions of DNH					
NZ					
FY 2016-17	36.47	3067.24	99.42	3749.17	99.29
NZ-II					
FY 2016-17	40.01	2626.3	99.50	3836.67	99.27
SZ					
FY 2016-17	47.30	2162.11	99.59	5916.25	98.87

Graphical representations of RI financial year wise for DNH and its subdivisions NZ, NZ-II and SZ for FY 2016-17 as follows.

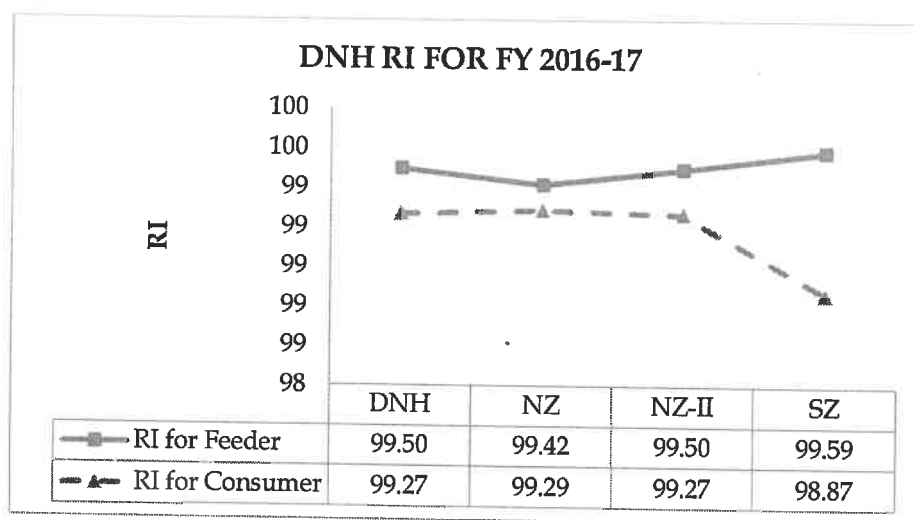


Figure 10: Graphical representation of DNH RI for FY 2016-17.

Chapter 4. Conclusion

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4.1 Conclusion

4.1.1 Reliability Indices (RI)

Quarterly RI for DNH in zone wise is given below,

DNH						
Sr.No.	Quarter	SAIFI	SAIDI	RI for Feeder	CAIDI	RI for Consumer
1	Q1	10.57	807.66	99.38	1344.33	98.97
2	Q2	14.03	783.5	99.41	1174.65	99.11
3	Q3	9.62	682.15	99.49	860.9	99.35
4	Q4	7.85	464.34	99.64	476.06	99.63
Sub Division of DNH						
NZ						
1	Q1	10.14	1057.1	99.19	1376.47	98.95
2	Q2	12.41	832.71	99.37	1111.95	99.16
3	Q3	8.21	727.56	99.45	840.31	99.37
4	Q4	5.71	449.88	99.65	420.44	99.68
NZ-II						
1	Q1	10.76	703.07	99.46	997.93	99.24
2	Q2	12.95	702.73	99.47	1005.96	99.24
3	Q3	10.41	880.83	99.34	1058.11	99.2
4	Q4	7.46	440.63	99.66	774.85	99.4
SZ						
1	Q1	10.94	600.12	99.54	1447.92	98.9
2	Q2	17.71	822.18	99.38	2709.04	97.96
3	Q3	10.46	362.2	99.73	845.24	99.36
4	Q4	11.07	513.12	99.6	914.9	99.29

Q4, Q3, Q2 and Q1 of DNHPDCL for FY 2016-17 is the order of better reliability indices sequence. Among three zone of DNHPDCL, Zone-II has better reliability indices.

