STPIS Proposal
2014-2019 Regulatory Control Period

Endeavour Energy

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1.0 Overview

1.1 Introduction

The Australian Energy Regulator's (AER) distribution Service Target Performance Incentive Scheme (STPIS) provides a financial incentive for Endeavour Energy to maintain and improve its reliability and customer service performance over time. The purpose of this document is to detail Endeavour Energy's proposal on how the STPIS should apply for the 2014-19 regulatory period.

1.2 Relevant Rule requirements

The Rules set out a process on how the AER is to make a constituent decision on how an applicable STPIS is to apply to a DNSP for a regulatory control period. In the sections below, we set out the process prescribed under the Rules, including a reference to relevant documents that the AER has already published prior to our regulatory proposal:

- Under 6.6.2 of the Rules, the AER must publish a STPIS for DNSPs to maintain and improve performance. Clause 6.6.2 states: The most recent amended version of the STPIS to apply to DNSPs is that published by the AER on 24 November 2009 (version 1.2).

- The Rules require that the AER to set out its proposed approach to applying the current version of the STPIS in the Framework and Approach paper process. Under the Transitional Rules that applied to NSW DNSPs for the 2014-19 period, the AER was required to publish 2 Framework and Approach papers. The Stage 2 Framework and Approach paper published on 31 January 2014 included a description of how the AER proposes to apply the STPIS to the 2014-15 transitional year and the subsequent regulatory control period of 2015-16 to 2018-19.

- Importantly, the Rules require that a DNSP's regulatory proposal provide a description, including relevant explanatory material, of how the Distribution Network Service Provider proposes any service target performance incentive scheme that has been specified in a framework and approach paper that applies in respect of the forthcoming distribution determination should apply to it.

- Clause 6.12.1(9) of the Rules states that the AER must make a decision on how any applicable service target performance incentive scheme is to apply to the Distribution Network Service Provider.

1.3 Application of the STPIS to the 2014-19 Regulatory Control Period

In accordance with clause 11.56.4(l)(2) of the transitional rules, on 31 January 2014 the AER published a 'Stage 2' framework and approach (F&A) paper in respect of Endeavour Energy's 2014-19 distribution determination. This F&A paper addressed a number of matters including the application of the STPIS to the subsequent regulatory control period; 1 July 2015 to 30 June 2019.

The STPIS is to apply financial rewards and penalties to Endeavour Energy for the subsequent regulatory control period (2014-19) and continue current performance reporting obligations. This follows data gathering during the current period (2009-14) and transitional year (2014-15). Specifically, the AER's proposed approach to applying the STPIS in the subsequent period will be to:

- Set revenue at risk for each distributor within the range of +/- 5%
- Segment the network according to their interpretation of the the Standing Committee on National Regulatory Reporting Requirements feeder categories (CBD, urban, short rural and long rural) in the NSW jurisdictional distribution licence conditions.
- Set applicable paramters to be:
    - For the reliability of supply component: the SAIDI and SAIFI

- For the customer service component: telephone answering

- Set performance targets based on our average performance over the past five regulatory years
- Apply the methodology indicated in the national STPIS for excluding specific events from the calculation of annual performance and performance targets
- Apply the methodology and value of customer reliability (VCR) values as indicated in the national STPIS to the calculation of incentive rates.

We largely accept the application of the STPIS to the subsequent regulatory control period and the AER's proposed approach. In the following sections we outline our proposed targets, revenue at risk and detail any proposed amendments to the AER's approach in accordance with clause 2.2 of the STPIS.

2.0 Parameters and Targets

2.1 Reliability of Supply Component

There are three reliability of supply parameters that may be applied under the scheme including unplanned System Average Interruption Duration Index (SAIDI), unplanned System Average Interruption Frequency Index (SAIFI); and Momentary Average Interruption Frequency Index (MAIFI).

As per the Stage 2 F&A paper, only unplanned SAIDI and SAIFI will be subject to revenue at risk when applying the scheme to the 2015-16 to 2018-19 regulatory control period. We consider that our proposed approach to excluded MAIFI/MAIFIe is consistent with the criteria and objectives of the STPIS as we have previously demonstrated to the AER that we are unable to reliably measure MAIFI for the purposes of revenue incentives.

More information on our proposed reliability performance targets, incentive rates and exclusions are set out below.

2.1.1 SAIDI and SAIFI Targets

Unplanned SAIDI is defined as the sum of the duration of each unplanned sustained customer interruption (in minutes) divided by the total number of distribution customers. Unplanned SAIDI excludes momentray interruptions (one minute or less).

Unplanned SAIFI is defined as the total number of unplanned sustained customer interruptions divided by the total number of distribution customers. Unplanned SAIFI excludes monentary interruptions (one minute or less). SAIFI is expressed per 0.01 interruptions.

The scheme requires that to calculate revenue incentives, the electricity distribution network should be divided into segments by network type. When applying unplanned SAIDI and unplanned SAIFI we propose that the network area be divided into the following segments by network type as defined in the NSW jurisdictional Licence Conditions.[1] These definitions are not significantly different from those contained within Appendix A of the STPIS:

- CBD
- Urban
- Short Rural
- Long Rural

Stage 2 of the AER's F&A paper indicated the AER's preferred approach to base performance targets on average performance over the past five regulatory years. We have adopted this approach for establishing reliability targets, which are given in Table 1 and Table 2.

Year	2014-15	2015-16	2016-17	2017-18	2018-19
CBD	N/A	N/A	N/A	N/A	N/A
Urban	63.4	63.4	63.4	63.4	63.4
Short Rural	206.0	206.0	206.0	206.0	206.0
Long Rural	N/A	N/A	N/A	N/A	N/A
Total Unplanned SAIDI	89.4	89.4	89.4	89.4	89.4

[1] Reliability and performance licence conditions for electricity distributors (effective 1 July 2014)

Table 1 – SAIDI targets (Minus Excluded Events)

Year	2014-15	2015-16	2016-17	2017-18	2018-19
CBD	N/A	N/A	N/A	N/A	N/A
Urban	0.825	0.825	0.825	0.825	0.825
Short Rural	1.945	1.945	1.945	1.945	1.945
Long Rural	N/A	N/A	N/A	N/A	N/A
Total Unplanned SAIFI	1.042	1.042	1.042	1.042	1.042

Table 2 – SAIFI targets (Minus Excluded Events)

There are no SAIDI and SAIFI CBD targets as Endeavour Energy has no feeders which are categorised as CBD feeders. Furthermore, Endeavour Energy only has one rural long feeder that supplies 292 customers. The performance of this rural long feeder, as shown in Figure 1, reflects the volatility in reporting against a single feeder in a category type. Previous Electricity Network Performance Reports identified this issue, noting that "The Minister has recognised this in not imposing a Rural Long target for Integral (Endeavour) Energy." Therefore, as Endeavour Energy has no Rural Long feeder category performance targets under the NSW Operating Licence, no Rural Long feeder category performance targets are proposed under the STPIS.

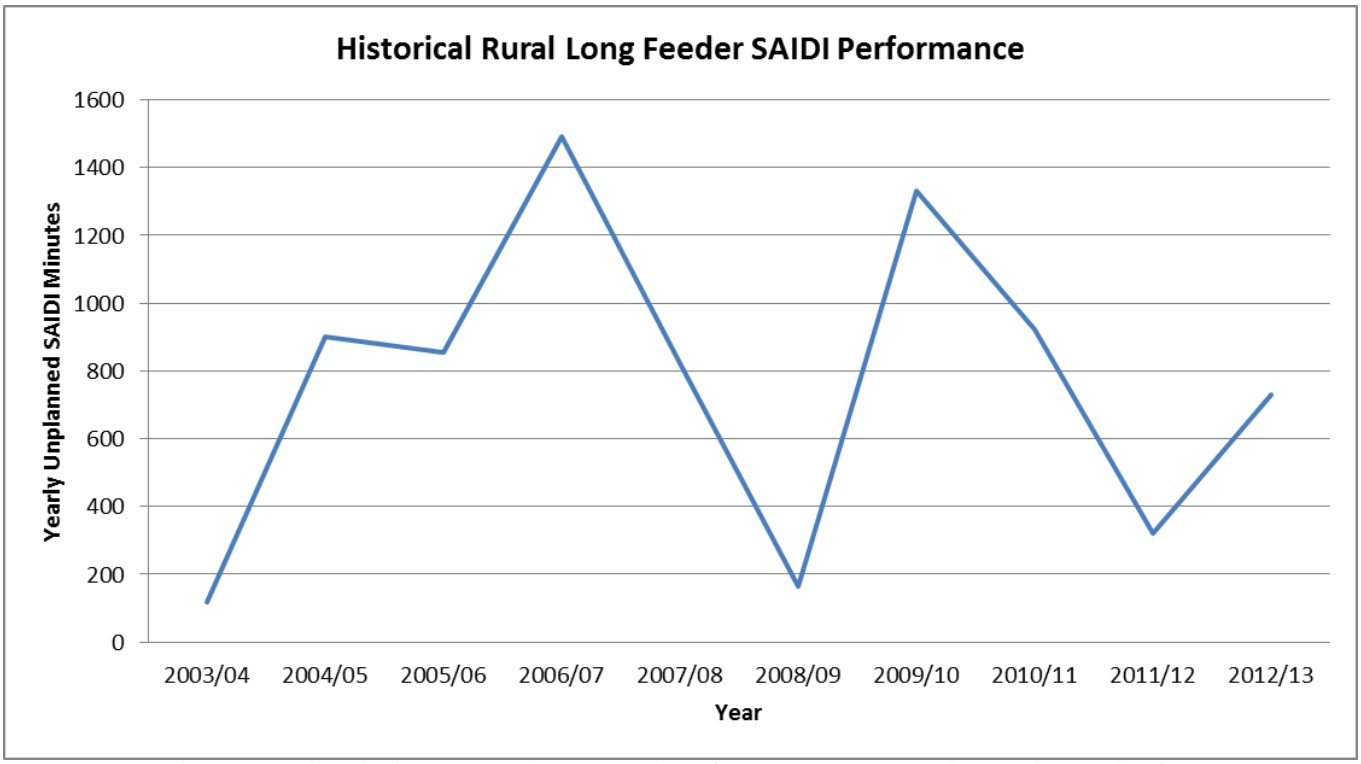

Figure 1 – Historical SAIDI performance of Endeavour Energy's only Rural Long feeder.

2.1.2 Revenue at Risk

Clause 2.5(b) of the STPIS document allows for a DNSP to "propose in accordance with clause 2.2 a different revenue at risk to apply where this would satisfy the objectives of the scheme described in clause 1.5."

During framework and approach consulation the NSW DNSPs submitted the position that the revenue at risk should be ±2.5%. As such, Endeavour Energy proposes that its revenue at risk under the STPIS scheme be limited to ±2.5%.

This proposed variation is consistent with clause 1.5, providing a balance between a signifant financial incentive to maintain stable service levels to customers while seeking to minimise the cost burden of the

scheme, wether penalty or reward, to the customer. A higher powered incentive will require additional reliability investment that, based on our research, customers are unwilling to fund.

2.1.3 Value of customer reliability

The Value of Customer Reliability (VCR) proposed in the scheme is $95 700/MWh for the CBD network type and $47 850/MWh for the urban, short rural and long rural network types. These values are to be adjusted for CPI from the September quarter 2008 to 1/7/2014. These amounts may change for subsequent regulatory control periods once the national VCR review is completed by AEMO and the ENA.

2.1.4 Incentive rates

Endeavour Energy proposes that the incentive rates for unplanned SAIDI and unplanned SAIFI are calculated in accordance with clause 3.2.2 of the STPIS for each network type utilising the formulae provided in Appendix B of the STPIS. These rates will be calculated once the input parameters are finalised, in particular the average of the smoothed annual revenue requirement for the 2014-19 regulatory control period as determined by the AER.

2.1.5 Exclusions - Major Event Day Threshold

In accordance with Appendix D of the STPIS document, an alternative daily unplanned SAIDI data normalisation method has been proposed to improve the validity and application of the Major Event Day (MED) 2.5β methodology.

A detailed discussion of this proposal is given in section 3 of this document.

2.2 Quality of supply

The current scheme does not include any quality of service parameters, and accordingly Endeavour Energy has not proposed any parameters to apply to the STPIS for the 2015-16 to 2018-19 period.

2.3 Customer Service Component

The Stage 2 F&A specifies that the applicable customer service parameter for the next regulatory control period is telephone answering.

2.3.1 Customer Service Targets

The AER proposes that the STPIS targets be set using the simple average of our performance over the past five regulatory years, this simple method would produce a target of 88%. In a broadly static environment Endeavour Energy would propose a similar target setting method. However, it is our view that the 2008-09 to 2012-13 averaging period does not necessarily reflect our current performance, proposed operating expenditure allowances or operating circumstances and consequently produces an inflated targeted reflective of scale efficiencies that no longer exist following the sale of the retail business and ceassation of retail activities, as part of the Transition Services Agreement.

There is both a recent and a material change to our short term performance levels that must be considered when transitioning to the STPIS due to fundamental changes in our organisational structure post retail separation and, therefore, a lack of consistent data over multiple years from which to draw reasonable medium term infrances. Retail separation means that we are likely to see a comparative decline in performance over the 2014-19 period. We therefore consider a lower target is consistent with clause 1.5(b)(3) of the scheme which relates to past performance, and is best interpreted to mean that higher targets should only be set when there is a clear link between past and future performance.

The STPIS objectives, specifically 1.5(b)(6), of the STPIS also require the AER to take into account:

the willingness of the customer or end user to pay for improved performance in the delivery of services

Our customer research indicates that customers are satisfied with current service levels and would prefer to maintain these levels rather than fund improvements. Refer to attachment xx for further details of this customer research. At the time of conducting this research (2013-14 year) our forecast telephone answering performance was 74% as per template 6.2.5 of the Reset RIN. In light of this, we have developed our operating expenditure forecast to maintain this current level of service.

Additionally, clause 1.5 of the STPIS refers to the revenue and pricing principles under the National Electricity Law (NEL). It is our view that modification is required to the AER's method when considering section 7A(6) of the NEL which states:

> *Regard should be had to the economic costs and risks of the potential for under and over investment by a regulated network service provider in, as the case requires, a distribution system or transmission system with which the operator provides direct control network services.*

As aforementioned, a target calculated in accordance with clause 5.3.1(a) of the STPIS reflects our previous operating model inclusive of a Retail business. Achieving this level of service would require significant investment that customers are unwilling to fund.

For this reason, the target would be inconsistent with the objectives outlined under clause 1.5 of the STPIS. A more appropriate target can be set based on our historical performance, but limited to the post-retail separation from February 2013. Our proposed target and methodology is explained in further detail below.

2.3.2 Proposed target

As required by the clause 2.2 of the STPIS and Schedule 1 of the Reset RIN, in this section we set out our proposed target; the reasons for the variation and the methodology.

a) the reasons for the change;

The reason that Endeavour Energy has not applied the average of the last 5 years as a target for '% calls answered in 30 sec', is that our current business model is materially different now, compared to previous years. Prior to 'Retail Separation' in February 2013, the Endeavour Energy Call Centre's had significantly more staff, (as a result of the significantly higher volume of activity) that were multi skilled, taking both retail and network related calls. The target suggested by Endeavour Energy reflects the post retail separation model, and Endeavour's focus on reducing costs for the customer while continuing to maintain a sustainable level of service.

b) the quantum of the adjustment, and the effect of the adjustment on the targets for each of the supply reliability areas; and

The average % of calls answered in 30 seconds over the past five years from FY08/09 to FY12/13 is 88%. Endeavour Energy submits an adjustment to the target that would see it reduced to 75%. There is no anticipated impact to supply reliability in lieu of this target adjustment.

c) the method, basis and empirical data used as justification for the adjustment.

The method that Endeavour Energy has used to adjust the target for calls answered in 30 seconds, is to calculate the average 'calls answered in 30 seconds', based on the monthly call answering data from the period February 2013 to March 2014.

The basis for choosing February 2013 to March 2014 as the data range for calculating the '% calls answered in 30 seconds', is that Endeavour Energy ceased supporting a Retail business (Transitional Services Agreement) at the end of January 2013, and became a 'Network only' call centre from February 2013. For the period 2008/09 to end Jan 2013, Endeavour Energy had significantly greater call centre work force and operated in a true multi skilled environment, where priority was placed on handling

network calls. As such, network calls were answered in a shorterr time frame due to the economies of scope.

All data used for this calculation comes from Endeavour Energy's call centre reporting application (CC6), and is consistent with the methods and approach applied to all prior year reporting to the AER.

Month/Year	Calls offered to agents	Calls answered	% GOS (threshold 30 secs)	Calls answered in 30 seconds
Feb-13	20,948	19,038	55%	11521
Mar-13	18,034	17,279	85%	15329
Apr-13	16,391	15,550	88%	14424
May-13	19,093	18,249	84%	16038
Jun-13	17,847	16,975	82%	14635
Jul-13	21,780	19,963	66%	14375
Aug-13	18,588	17,600	73%	13529
Sep-13	19,900	18,870	75%	14925
Oct-13	21,283	20,131	73%	15567
Nov-13	21,302	19,984	73%	15550
Dec-13	17,501	16,494	78%	13651
Jan-14	18,646	17,529	76%	14171
Feb-14	17,917	16,971	76%	13691
Mar-14	22,889	20,282	71%	16204
Total	**272,119**	**n/a**	**75%**	**203610**
Monthly Average	19,437	n/a	75%	14,544
Annual Avg	**233,245**		**75%**	**174,523**

Table 3 – Telephone answering data range for target calculation

2.3.3 Revenue at Risk

The scheme notes that the maximum revenue increment or decrement (the revenue at risk) for an individual customer service parameter for each regulatory year of the regulatory control period shall be 0.5%, that is, the s-factor associated with an individual customer service parameter must lie between +0.5% (the upper limit) and –0.5% (the lower limit). A DNSP may propose a different revenue at risk from that referred to in clauses 5.2(a) and/or 5.2(b) to apply where this would satisfy the objectives of the scheme described in clause 1.5.

We propose that the revenue at risk for telephone answering is ±0.25 per cent for each year of the 2015-16 to 2018-19 regulatory period. We consider this best meets the objectives under 1.5 of the scheme as follows:

- As aforementioned, there is considerable uncertainty on medium term performance levels when transitioning to the STPIS due to recent and fundamental changes in our organisational structure post-retail separation. We therefore consider a lower target is consistent with clause 1.5(b)(3) of the scheme which relates to past performance, and could be interpreted to mean that higher targets should only be set when there is a clear link between past and future performance.

- Our customer engagement initiatives have not indicated that customers have concerns on the current levels of telephone answering, or would be willing to pay more for improved service

levels. We therefore consider a lower target is consistent with clause 1.5(b)(6) of the scheme which relates to the willingness of customers to pay more for improved services.

2.3.4 Incentive rates

We propose to use the AER's incentive rate for the 'telephone answering' parameter of -0.040% per unit of the 'telephone answering' parameter. This is consistent with clause 5.3.2 of the scheme.

2.3.5 Exclusions

Endeavour Energy proposes that where a reliability exclusion occurs, this should also be excluded from the calculation of telephone answering performance. This is consistent with the scheme which states that where the impact of an event is to be excluded from the calculation of a revenue increment or decrement under the 'reliability of supply' component as provided for in clause 3.3, the impact of that event may be excluded from the calculation of a revenue increment or decrement for the 'telephone answering' parameter as appropriate. Endeavour Energy proposes to apply the reliability exclusion as set out below for the purposes of the measurement of telephone answering performance.

3.0 Major Event Day Normalisation Methodology Proposal

3.1 General

This section details the reasoning and justification for Endeavour Energy to use an alternative daily unplanned SAIDI normalisation method for calculating the Major Event Day (MED) exclusion threshold based on the five year regulatory reporting period of 2008/09 to 2012/13.

The key issue of relevance is that the scheme should be designed to exclude uncontrollable events that have a material impact on the reported reliability and that the method should ensure that events are distributed normally around the exclusion threshold. In other words, the exclusion threshold should result in a consistent exclusion outcome.

3.2 AER STPIS Major Event Day Exclusion Methodology

The AER STPIS major event day exclusion methodology implements the IEEE 1366-2003 2.5β method and is detailed in Appendix D of the STPIS document. The methodology involves assembling five years daily unplanned SAIDI data, excluding days where the unplanned SAIDI is zero. This data is then normalised by taking the natural logarithm of each daily SAIDI value and determining the mean (α) and standard deviation (β). These are then applied to the following equation to determine the threshold for major event days.

$$T_{MED} = e^{\alpha + 2.5\beta}$$

Days in each year of the subsequent five year regulatory reporting period with a daily SAIDI above T_{MED} are excluded from the calculation of yearly network unplanned SAIDI.

3.3 Provision for Alternative Data Normalisation

Appendix D of the STPIS document makes allowance for the testing of the log-normality assumption inherent in the IEEE 1366-2003 2.5β method. The requirements in this regard are given in clause 4 and clause 6 of Appendix D, as follows:

> *4. Apply a commonly accepted statistical test to the data set and where application of the statistical test indicates:*
>
> *(a) the logarithms of the data set are not normally distributed:*
>
> *(1) Propose an alternative data transformation method which results in a more normally distributed data set in accordance with clause 2.2 of this scheme.*
>
> *6. Where 4(a) applies a DNSP must, in addition to the requirements of clause 2.2 of this scheme:*
>
> *(a) Demonstrate that the natural logarithm of the data set of each unplanned SAIDI value is not normally distributed.*
> *(b) Explain the proposed alternative data transformation method.*
> *(c) Provide the calculations that demonstrate the application of the alternative data transformation method to the unplanned SAIDI values.*
> *(d) Provide the data set resulting from applying the proposed alternative transformation method.*
> *(e) Demonstrate that the resulting data set is normally distributed or that the normality of the data set is improved.*

3.4 Key Assumptions of IEEE1366-2003 Major Event Day Methodology

The IEEE 1366-2003 major event day methodology was developed on the basis that daily SAIDI data is asserted to be log-normal. Assuming daily SAIDI is log-normal, then one can calculate the probability of exceeding a major event day threshold. It can be shown that this probability is dependant only on the β multiplier (k) and independent of the value of the mean mean (α) and standard deviation (β).

With k = 2.5, determined by the experience of the standard committee members, the probability of exceeding T_{MED} is 0.00621 or 2.3 days per year. In section B.6 of IEEE 1366-2003, there are some key statements around the fairness of this 2.5 β methodology:

" A fair MED classification method would classify, on average, the same number of MEDs per year for different utilities " "… using the mean and standard deviation of the logs of the data (α and β) to set the threshold makes the expected number of MEDs depend only on the multiplier, and thus should classify the same number of MEDs for large and small utilities, and for utilities with low and high average reliability "

The above statements are applicable only if the degree of log-normality between utilities daily SAIDI data is the same for all practical purposes. In reality this may not be the case, and therefore there can be great variation between the average number of event days classified between utilities.

The 2013-14 major event day threshold (based on 2008-09 to 2012-13 daily unplanned SAIDI) was calculated for all three NSW distributors. This threshold was then back applied to the daily 2008-09 to 2012-13 unplanned SAIDI data to compare the average number of MEDs per annum for the period. The results are shown in Table 4.

	Endeavour		Ausgrid		Essential	
Transformation	Tmed	Average MEDs/year	Tmed	Average MEDs/year	Tmed	Average MEDs/year
Log-Natural	4.64	1.2	2.61	2.8	5.89	4.0

Table 4 – NSW Distribution Businesses Average Major Event Days based on the application of a 08-09-12/13 calculated T_{MED} on the 08-09-12/13 daily SAIDI data.

This highlights a significant variation between the NSW distributors in the number of major event days that would be classified if this T_{MED} is back applied on the daily SAIDI data for 08/09-12-13. Notably Endeavour would classify far fewer event days with the average number of event days being half of the expected average of 2.3 days per year. Note, this is an exercise to compare the expected average number of excluded days in the next five year period assuming the reliability performance is similar. It should not be compared with distributers historical excluded days data in regulatory submissions.

3.5 Alternative Data Normalisation Methods

The natural logarithm is one method of normalising data. There are alternative methods, such as the power transformation. Power transforms take the general form of X^Y. A commonly used power transform appropriate for data normalisation is the Box-Cox transformation. It has the following form:

$$X_{norm} = \frac{X^{\lambda} - 1}{\lambda} \text{ for } X \neq 0, \quad X_{norm} = Log_e(X) \text{ for } X = 0$$

There are statistical methods to determine the value of lambda (λ), such as that which maximises the Log-Likelihood Function as shown in Figure 1. These methods are implemented in packages such as Matlab or R. For the 08/09-12/13 dataset the value of λ was determined to be 0.07, therefore the power transform becomes:

$$X_{norm} = \frac{X^{0.07} - 1}{0.07}$$

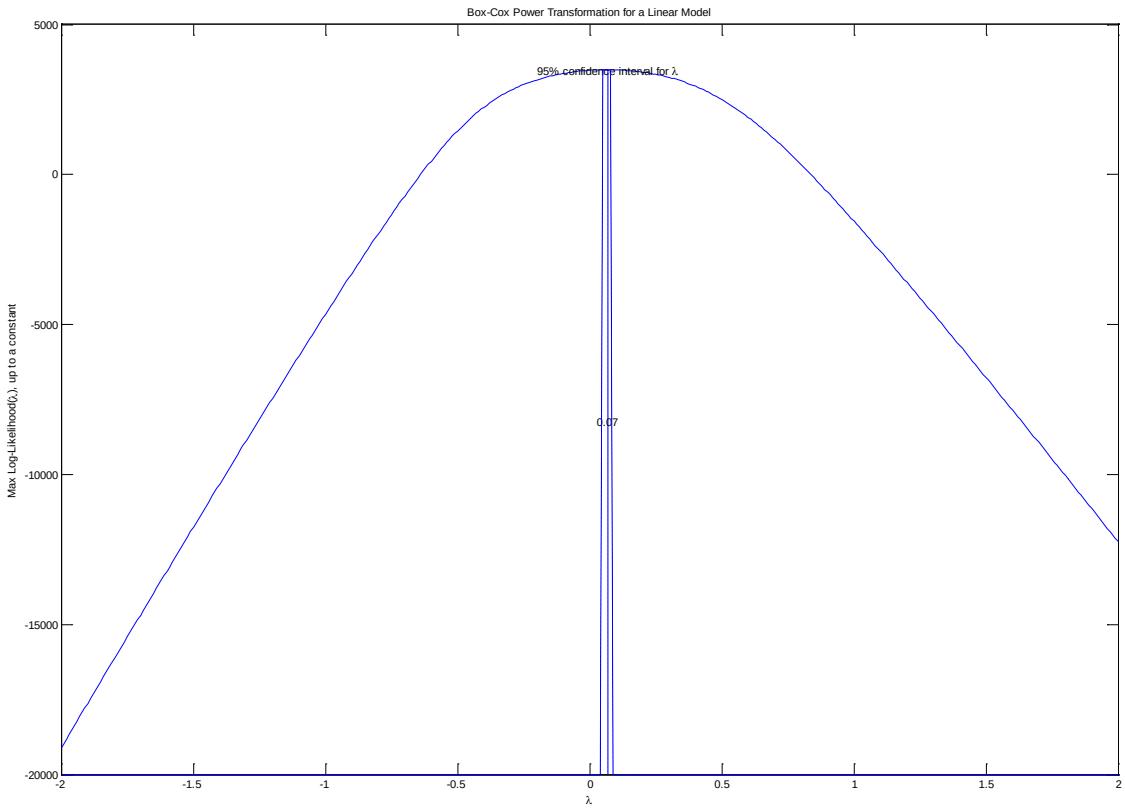

Figure 1 – Log Likelihood Function Plot

3.6 Evaluation Criteria

The testing and assessment of the normality of data can be done through various common methods. A description of these methods, which have utilised in this report, is given below:

- **Visual Inspection:**
  - Histogram plot overlayed with a fitted normal distribution.
  - Quantile-Quantile (Q-Q) plot – A normal distribution is a straight line on a quantile quantile plot and therefore it follows that the better the data overlays this straight line the better the normality of the data.

- **Inspection of Distribution properties:**

  A standard normal distribution has the following properties:

  - The ***Mean*** and ***Median*** are the same.
  - The ***Standard Deviation*** is equal to one.
  - The ***Skewness*** is equal to zero.
  - The ***Kurtosis*** or peakiness is equal to one.

- **Statistical Tests of Normality:**
  - Anderson Darling test where the assumption of normality is rejected with a 95% confidence level if the p value is less than 0.05.
  - Jarque-Bera test where the assumption of normality is rejected with a 95% confidence level if the p value is less than 0.05.

3.7 Comparison of Log_e and Power Transformation Results

In accordance with Section 4 of Appendix D section 4 of the AER STPIS document, the following tests have been applied to verify the normality of the transformed daily SAIDI data.

- **Visual Inspection:**

The histogram plot of Log_e daily SAIDI with a fitted normal distribution is shown for the Log_e transformation in Figure 2 and the Power transformation in Figure 3.

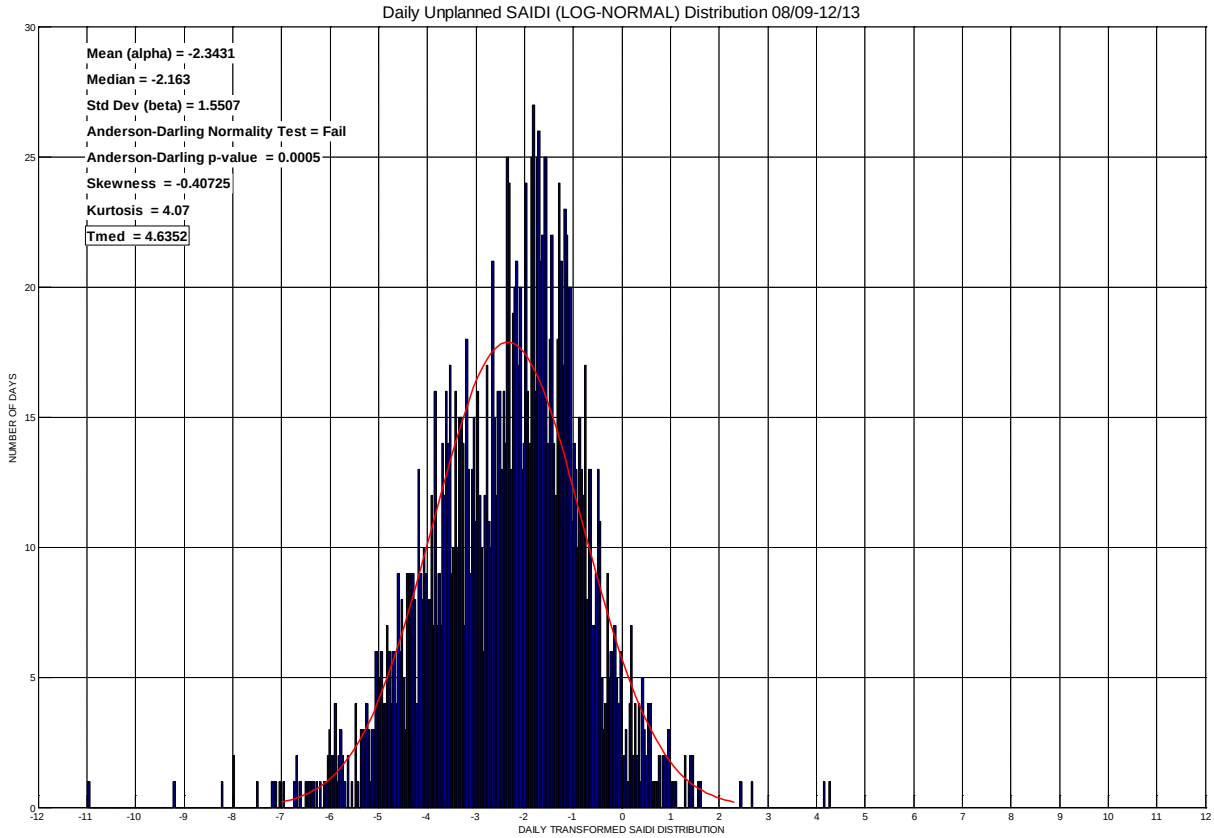

Figure 2 – Log_e Histogram Plot

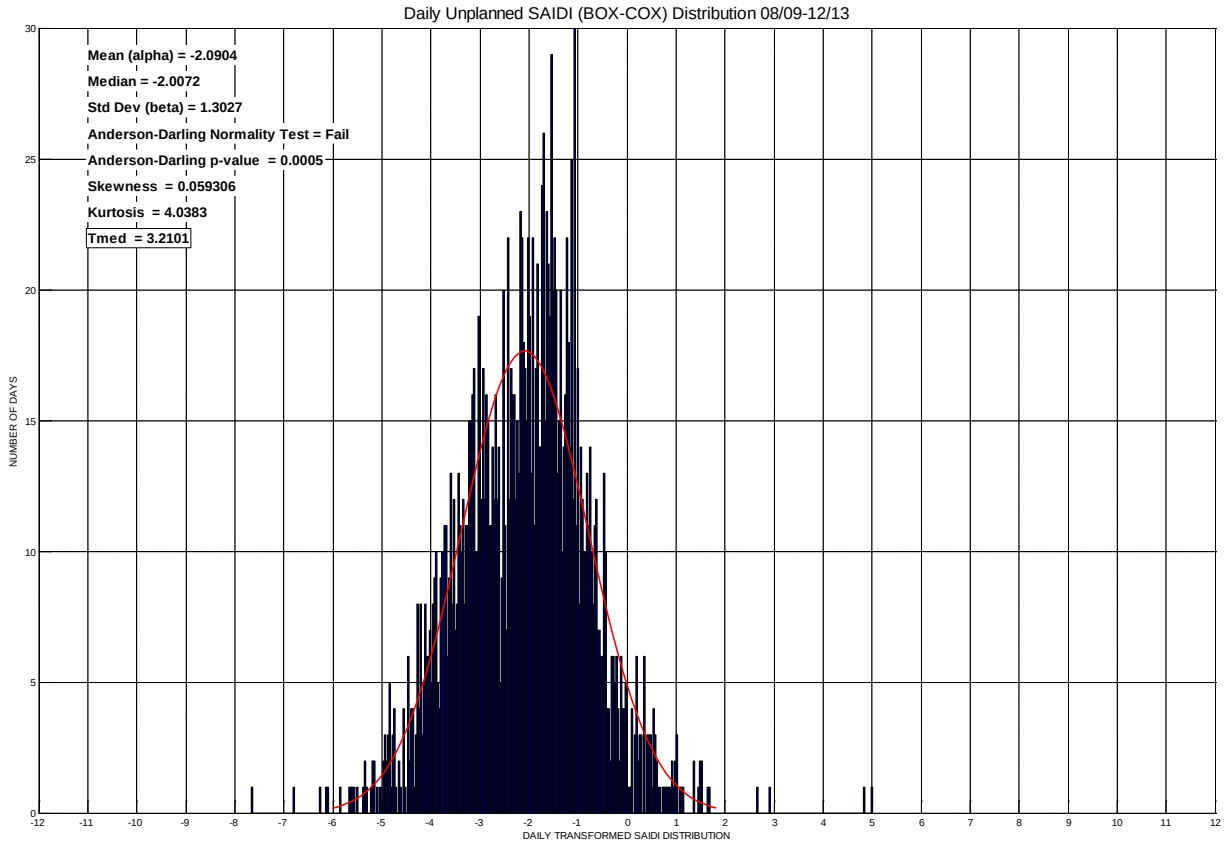

Figure 3 – Power Transform Histogram Plot

There is a general normal distribution like shape to both sets of transformed data when viewed as a histogram plot. It is evident that the Log_e transformed data is more skewed than the power transformed data. Both also have longer and more significant tails than a normal distribution, however the power transformed data less so.

The Q-Q plot in Figure 4 demonstrate that the natural logarithm transformed data generally fits the straight line, however with a tail that noticeably strays away from the straight line. This general fit of the straight line is an indicator of the data being somewhat normally distributed. As is evident from the Q-Q plot in Figure 5, the power transform provides a significantly better fit of the straight line, significantly improving the fit of the tails of the line.

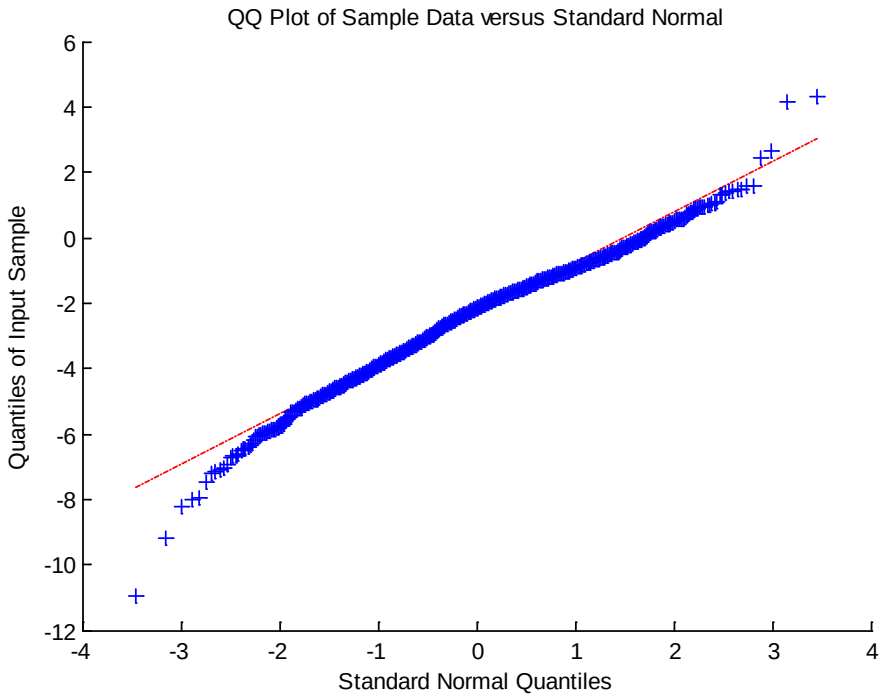

Figure 4 – Log_e QQ Plot

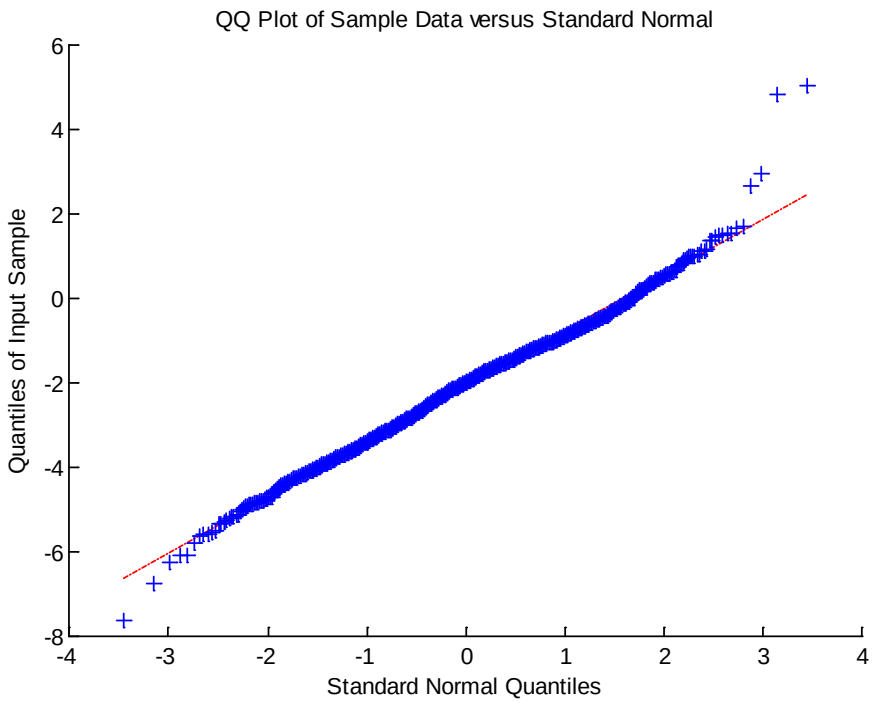

Figure 5 – Power Transform QQ Plot

- **Inspection of Distribution properties:**

A summary of the normalised distribution properties is given in Table 5.

	Mean	Median	Std Dev	Skewness	Kurtosis
Log	-2.343	-2.163	1.551	-0.407	4.070
Power	-2.090	-2.007	1.302	0.059	4.038

Table 5 – Distribution Properties Comparison

It is evident that for the Power normalisation compared to the Log normalisation the mean and median are far closer, the skewness much improved and the kurtosis slightly improved.

- **Statistical Tests of Normality:**

Two commonly applied statistical tests of normality have been applied, namely the Jarque-Bera and Anderson-Darling tests. A summary of the resultant p-values along with the pass/fail acceptance of the normality assumption is given in Table 6.

	Log		Power	
Year	Jarque-Bera	Anderson-Darling	Jarque-Bera	Anderson-Darling
08/09	p = 0.224 (Pass)	p = 0.0005 (Fail)	p = 0.500 (Pass)	p = 0.0066 (Fail)
09/10	p = 0.001 (Fail)	p = 0.0005 (Fail)	p = 0.055 (Pass)	p = 0.0048 (Fail)
10/11	p = 0.001 (Fail)	p = 0.0005 (Fail)	p = 0.001 (Fail)	p = 0.0016 (Fail)
11/12	p = 0.001 (Fail)	p = 0.0068 (Fail)	p = 0.001 (Fail)	p = 0.2058 (Pass)
12/13	p = 0.397 (Pass)	p = 0.0803 (Pass)	p = 0.045 (Fail)	p = 0.2335 (Pass)
08/09-12/13	p = 0.001 (Fail)	p = 0.0005 (Fail)	p = 0.001 (Fail)	p = 0.0005 (Fail)

Table 6 – Statistical Tests Results

Both transformation methods resulted in distributions with p-values well below 0.05 for the 08/09-12-13 period. That is, the assumption that the data is normally distributed is rejected based on a 95% confidence level. However, some individual years data is accepted to be normally distributed with p-values above 0.05. It was generally found that the Power transformation resulted in higher year by year p-values for these statistical tests.

It is important to be mindful that the power of these statistical tests to reject the normality assumption increases greatly with the size of the dataset. In other words, for large datasets, i.e. greater than a 1000 values, even minor imperfections can cause the tests to reject normality. The size of the dataset used in the major event day calculations is up to 365 * 5 or 1825 values.

3.8 Comparison of Tmed and Major Event Days

Using the T_{MED} derived through each normalisation method, the number of excluded days for the same five year period was compared as shown in Table 7. Evidently the power transformation method results in an average excluded days per year much closer to the 2.3 days intended with the 2.5β method.

Transformation	T_{MED}	Average MEDs/year
Log	4.64	1.2
Power	3.21	2.8

Table 7 – T_{MED} and average excluded days (08/09-12/13)

3.9 MED Calculation Proposal Summary

In accordance with Appendix D of the STPIS document, it has been demonstrated that:

- Endeavour's 2008/09 – 2012/13 daily SAIDI data transformed through the $\log_e$ transformation is not satisfactorily normally distributed and hence compromises the application and validity of the 2.5β method.
- The $\log_e$ normalisation method results in a major event day exclusion threshold which is expected to deliver half the excluded major event days on average for Endeavour's data than is the intent of the 2.5β method.
- The alternative power transformation (Box-Cox) method results in a significant improvement to the normality of the transformed daily SAIDI distribution based on visual inspection, distribution properties and statistical tests.
- Use of the alternative power transformation (Box-Cox) method significantly improves the validity of the application of the 2.5β methodology to determine the major event day exclusion threshold.

Therefore, Endeavour seeks the approval of the AER for the application of the power (Box-Cox) transformation in place of the $\log_e$ transformation of the daily SAIDI data in the calculation of the major event day exclusion threshold.

APPENDIX A – DETAILS OF MED CALCULATIONS

The calculations to compare natural log normalisation and power (box-cox) normalisation were implemented in a Matlab script. The script reads in the five years of daily unplanned SAIDI (contained in an excel file with a worksheet for each year's daily SAIDI). The script reads in this data, performs both the normalisation methods, performs statistical tests and outputs these results as graphs and text result outputs.

```
%%  ENDEAVOUR ENERGY MAJOR EVENT DAY ANALYSIS ACCORDING TO AER STPIS METHODOLOGY
%   This script utilises the last 5 yearly daily SAIDI values as inputs
%   from an excel spreadsheet
%   A Comparison of normalisation methods is conducted and calculation of
%   Major event day thresholds for both transformation methods, with corresponding plots
%   of exclusions.

SAIDIS_YEAR_1 = zeros(1,1);
SAIDIS_YEAR_2 = zeros(1,1);
SAIDIS_YEAR_3 = zeros(1,1);
SAIDIS_YEAR_4 = zeros(1,1);
SAIDIS_YEAR_5 = zeros(1,1);
DATES_YEAR_1 = cell(1,1);
DATES_YEAR_2 = cell(1,1);
DATES_YEAR_3 = cell(1,1);
DATES_YEAR_4 = cell(1,1);
DATES_YEAR_5 = cell(1,1);

NETWORK = 'ENDEAVOUR';
DRIVE_LOC = 'H:\SPB\FILING\Reliability\STPIS Major Event Day Exclusion\';
YEAR_1 = '08-09';
YEAR_2 = '09-10';
YEAR_3 = '10-11';
YEAR_4 = '11-12';
YEAR_5 = '12-13';

DATA_YEAR_1 = ImportExcel([DRIVE_LOC,NETWORK,'\DATA.xls'],YEAR_1);
count = 1;
for i = 1:1:size(DATA_YEAR_1,1)
    if DATA_YEAR_1(i,2) > 0                                     % Only include if unplanned
SAIDI is greater than 0
        DATES_YEAR_1{count,1} = datestr(DATA_YEAR_1(i,1));      % Convert the imported date (a
number after import) into a date string
        SAIDIS_YEAR_1(count,1) = DATA_YEAR_1(i,2);              % Unplanned SAIDI
        count = count + 1;
    end
end

DATA_YEAR_2 = ImportExcel([DRIVE_LOC,NETWORK,'\DATA.xls'],YEAR_2);
count = 1;
for i = 1:1:size(DATA_YEAR_2,1)
    if DATA_YEAR_2(i,2) > 0                                     % Only include if unplanned
SAIDI is greater than 0
        DATES_YEAR_2{count,1} = datestr(DATA_YEAR_2(i,1));      % Convert the imported date (a
number after import) into a date string
        SAIDIS_YEAR_2(count,1) = DATA_YEAR_2(i,2);              % Unplanned SAIDI
        count = count + 1;
    end
end

DATA_YEAR_3 = ImportExcel([DRIVE_LOC,NETWORK,'\DATA.xls'],YEAR_3);
count = 1;
for i = 1:1:size(DATA_YEAR_3,1)
    if DATA_YEAR_3(i,2) > 0                                     % Only include if unplanned
SAIDI is greater than 0
        DATES_YEAR_3{count,1} = datestr(DATA_YEAR_3(i,1));      % Convert the imported date (a
number after import) into a date string
        SAIDIS_YEAR_3(count,1) = DATA_YEAR_3(i,2);              % Unplanned SAIDI
        count = count + 1;
    end
end

DATA_YEAR_4 = ImportExcel([DRIVE_LOC,NETWORK,'\DATA.xls'],YEAR_4);
```

```
count = 1;
for i = 1:1:size(DATA_YEAR_4,1)
    if DATA_YEAR_4(i,2) > 0                                     % Only include if unplanned
SAIDI is greater than 0
        DATES_YEAR_4{count,1} = datestr(DATA_YEAR_4(i,1));      % Convert the imported date (a
number after import) into a date string
        SAIDIS_YEAR_4(count,1) = DATA_YEAR_4(i,2);              % Unplanned SAIDI
        count = count + 1;
    end
end

DATA_YEAR_5 = ImportExcel([DRIVE_LOC,NETWORK,'\DATA.xls'],YEAR_5);
count = 1;
for i = 1:1:size(DATA_YEAR_5,1)
    if DATA_YEAR_5(i,2) > 0                                     % Only if unplanned SAIDI is
greater than 0
        DATES_YEAR_5{count,1} = datestr(DATA_YEAR_5(i,1));      % Convert the imported date (a
number after import) into a date string
        SAIDIS_YEAR_5(count,1) = DATA_YEAR_5(i,2);              % Unplanned SAIDI
        count = count + 1;
    end
end

%%  NORMALISATION AER STPIS METHODOLOGY (IEEE1366-2003)
%   LOG-NATURAL NORMALITY TRANSFORMATION

for i = 1:1:size(SAIDIS_YEAR_1,1)
    SAIDIS_YEAR_1(i,2) = log(SAIDIS_YEAR_1(i,1));     % LOG-NATURAL transform of Unplanned
Daily SAIDI
end
for i = 1:1:size(SAIDIS_YEAR_2,1)
    SAIDIS_YEAR_2(i,2) = log(SAIDIS_YEAR_2(i,1));     % LOG-NATURAL transform of Unplanned
Daily SAIDI
end
for i = 1:1:size(SAIDIS_YEAR_3,1)
    SAIDIS_YEAR_3(i,2) = log(SAIDIS_YEAR_3(i,1));     % LOG-NATURAL transform of Unplanned
Daily SAIDI
end
for i = 1:1:size(SAIDIS_YEAR_4,1)
    SAIDIS_YEAR_4(i,2) = log(SAIDIS_YEAR_4(i,1));     % LOG-NATURAL transform of Unplanned
Daily SAIDI
end
for i = 1:1:size(SAIDIS_YEAR_5,1)
    SAIDIS_YEAR_5(i,2) = log(SAIDIS_YEAR_5(i,1));     % LOG-NATURAL transform of Unplanned
Daily SAIDI
end
SAIDIS = [SAIDIS_YEAR_1; SAIDIS_YEAR_2; SAIDIS_YEAR_3; SAIDIS_YEAR_4; SAIDIS_YEAR_5]; %
Combine all years

% Perform statistical tests on each year and all years
disp('STATISTICAL TESTS ON LOG-NORMALISED SAIDI:');
[h, p] = jbtest(SAIDIS_YEAR_1(:,2));
disp([YEAR_1,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_1(:,2));
disp([YEAR_1,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = jbtest(SAIDIS_YEAR_2(:,2));
disp([YEAR_2,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_2(:,2));
disp([YEAR_2,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = jbtest(SAIDIS_YEAR_3(:,2));
disp([YEAR_3,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_3(:,2));
disp([YEAR_3,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = jbtest(SAIDIS_YEAR_4(:,2));
disp([YEAR_4,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_4(:,2));
disp([YEAR_4,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = jbtest(SAIDIS_YEAR_5(:,2));
disp([YEAR_5,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_5(:,2));
disp([YEAR_5,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = jbtest(SAIDIS(:,2));
disp(['OVERALL Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
```

```
[h, p] = adtest(SAIDIS(:,2));
disp(['OVERALL Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);

alpha = mean(SAIDIS(:,2));
beta = std(SAIDIS(:,2));
Tmed = exp(alpha+2.5*beta);

PLOT_HISTOGRAM(SAIDIS,'AER_STIPIS_LN',(-10:0.05:10),'Daily Unplanned SAIDI (LOG-NORMAL)
Distribution 08/09-12/13',NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_1,DATES_YEAR_1,[YEAR_1,'_LN'],'Daily Unplanned SAIDI
distribution 08/09',Tmed,NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_2,DATES_YEAR_2,[YEAR_2,'_LN'],'Daily Unplanned SAIDI
distribution 09/10',Tmed,NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_3,DATES_YEAR_3,[YEAR_3,'_LN'],'Daily Unplanned SAIDI
distribution 10/11',Tmed,NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_4,DATES_YEAR_4,[YEAR_4,'_LN'],'Daily Unplanned SAIDI
distribution 11/12',Tmed,NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_5,DATES_YEAR_5,[YEAR_5,'_LN'],'Daily Unplanned SAIDI
distribution 12/13',Tmed,NETWORK,DRIVE_LOC)

x1 = SAIDIS(:,2); % for Q-Q plot down below

%%  NORMALISATION PROPOSED METHODOLOGY
%   POWER TRANSFORMATION FOR NORMALITY (BOX-COX METHOD)

SAIDIS = [SAIDIS_YEAR_1; SAIDIS_YEAR_2; SAIDIS_YEAR_3; SAIDIS_YEAR_4; SAIDIS_YEAR_5];
data = SAIDIS(:,1);
X = [ones(size(data,1),1) (1:size(data,1))'];
[Lambda,LambdaInterval] = boxcoxlm(data,X); % provides the Lambda value for the power
transform which maximises the log-liklihood function.
disp(['BOX-COX LAMBDA = ',num2str(Lambda)]);

for i = 1:1:size(SAIDIS_YEAR_1,1)
    SAIDIS_YEAR_1(i,2) = (SAIDIS_YEAR_1(i,1)^Lambda-1)/Lambda;  % power transform of Unplanned
Daily SAIDI
end
for i = 1:1:size(SAIDIS_YEAR_2,1)
    SAIDIS_YEAR_2(i,2) = (SAIDIS_YEAR_2(i,1)^Lambda-1)/Lambda;  % power transform of Unplanned
Daily SAIDI
end
for i = 1:1:size(SAIDIS_YEAR_3,1)
    SAIDIS_YEAR_3(i,2) = (SAIDIS_YEAR_3(i,1)^Lambda-1)/Lambda;  % power transform of Unplanned
Daily SAIDI
end
for i = 1:1:size(SAIDIS_YEAR_4,1)
    SAIDIS_YEAR_4(i,2) = (SAIDIS_YEAR_4(i,1)^Lambda-1)/Lambda;  % power transform of Unplanned
Daily SAIDI
end
for i = 1:1:size(SAIDIS_YEAR_5,1)
    SAIDIS_YEAR_5(i,2) = (SAIDIS_YEAR_5(i,1)^Lambda-1)/Lambda;  % power transform of Unplanned
Daily SAIDI
end
SAIDIS = [SAIDIS_YEAR_1; SAIDIS_YEAR_2; SAIDIS_YEAR_3; SAIDIS_YEAR_4; SAIDIS_YEAR_5]; %
Combine all years

% Perform statistical tests on each year and all years
disp('STATISTICAL TESTS ON POWER TRANSFORM NORMALISED SAIDI:');
[h, p] = jbtest(SAIDIS_YEAR_1(:,2));
disp([YEAR_1,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_1(:,2));
disp([YEAR_1,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = jbtest(SAIDIS_YEAR_2(:,2));
disp([YEAR_2,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_2(:,2));
disp([YEAR_2,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = jbtest(SAIDIS_YEAR_3(:,2));
disp([YEAR_3,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_3(:,2));
disp([YEAR_3,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = jbtest(SAIDIS_YEAR_4(:,2));
disp([YEAR_4,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_4(:,2));
disp([YEAR_4,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
```

```
[h, p] = jbtest(SAIDIS_YEAR_5(:,2));
disp([YEAR_5,' Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS_YEAR_5(:,2));
disp([YEAR_5,' Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = jbtest(SAIDIS(:,2));
disp(['OVERALL Jarque-Bera: result = ',num2str(h),' p = ',num2str(p)]);
[h, p] = adtest(SAIDIS(:,2));
disp(['OVERALL Anderson-Darling: result = ',num2str(h),' p = ',num2str(p)]);

alpha = mean(SAIDIS(:,2));
beta = std(SAIDIS(:,2));
Tmed = exp(alpha+2.5*beta);

PLOT_HISTOGRAM(SAIDIS,'AER_STIPIS_BOXCOX',(-10:0.05:10),'Daily Unplanned SAIDI (BOX-COX)
Distribution 08/09-12/13',NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_1,DATES_YEAR_1,[YEAR_1,'_BOXCOX'],'Daily Unplanned
SAIDI distribution 08/09',Tmed,NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_2,DATES_YEAR_2,[YEAR_2,'_BOXCOX'],'Daily Unplanned
SAIDI distribution 09/10',Tmed,NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_3,DATES_YEAR_3,[YEAR_3,'_BOXCOX'],'Daily Unplanned
SAIDI distribution 10/11',Tmed,NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_4,DATES_YEAR_4,[YEAR_4,'_BOXCOX'],'Daily Unplanned
SAIDI distribution 11/12',Tmed,NETWORK,DRIVE_LOC)
PLOT_HISTOGRAM_SAIDIS_TMED(SAIDIS_YEAR_5,DATES_YEAR_5,[YEAR_5,'_BOXCOX'],'Daily Unplanned
SAIDI distribution 12/13',Tmed,NETWORK,DRIVE_LOC)

x2 = SAIDIS(:,2); % for Q-Q plot down below

%% PRINT Q-Q PLOTS FOR BOTH NORMALISATION METHODS
% LOG-NORMAL NORMALISATION Q-Q PLOT
f = figure;
set(f, 'PaperType', 'A4');
subplot(1,1,1);
ax1 = subplot(1,1,1);
set(ax1,'Position',[0.1 0.1 0.8 0.8]);
grid on
qqplot(x1)
print(f,'-dmeta',[DRIVE_LOC,NETWORK,'\QQPLOT_LOG']);
close(f);

% BOX-COX POWER TRANSFORM NORMALISATION Q-Q PLOT
f = figure;
set(f, 'PaperType', 'A4');
subplot(1,1,1);
ax1 = subplot(1,1,1);
set(ax1,'Position',[0.1 0.1 0.8 0.8]);
grid on
qqplot(x2)
print(f,'-dmeta',[DRIVE_LOC,NETWORK,'\QQPLOT_BOXCOX']);
close(f);
```