



**REGULATORY
AUTHORITY
OF BERMUDA**

Fairness • Innovation • Integrity

Service Standards Indicators for Electricity Licensees

Final Report
Final Decision and Order
Date: 4 April 2019

TABLE OF CONTENTS

I. INTRODUCTION.....	3
II. BACKGROUND AND PROCEDURAL HISTORY	5
III. LEGISLATIVE CONTEXT	6
IV. SUMMARY AND DISCUSSION OF RESPONSE TO THE INITIAL CONSULTATION DOCUMENT	8
V. SUMMARY AND DISCUSSION OF RESPONSE TO PRELIMINARY REPORT, PRELIMINARY DECISION AND ORDER.....	12
VI. CONCLUSION	14
APPENDIX A: ORDER.....	15
APPENDIX B: GENERAL DETERMINATION	18

I. INTRODUCTION

1. The purpose of this Final Report, Final Decision and Order (the “Final Report”) is for the Regulatory Authority of Bermuda (the “Authority”) to: (i) present the Authority’s assessment of the responses to the Service Standards for Generation and Transmission, Distribution & Retail Licensees Consultation Document (the “Consultation Document”) and Preliminary Report, Preliminary Decision and Order for the Indicators for Generation and Transmission, Distribution & Retail Licensee Service Standards (the “Preliminary Report”); and (ii) issue the General Determination (“GD”) to present the service standards (the “Standards”) which measure the performance of electricity sector licensees.
2. The Authority is responsible for regulating the electricity sector, including the issuing of licences, regulating new market entrants, tariffs, and monitoring the quality of service provisions to end-users by service providers within the sector.
3. In the conduct of its regulatory functions/activities, the Authority is guided by the legislative and regulatory framework set out in the Electricity Act 2016 (the “EA”) and the Regulatory Authority Act 2011 (“RAA”), as well as the general policy set forth in the National Electricity Sector Policy (the “Policy”).
4. Section 34(1) of the EA requires the Authority to set standards for reliability, power quality and customer service for the supply of electricity that are in line with industry best practice.
5. Section 34(1) of the EA, read along with sections 61-62 of the RAA, mandate that the Authority consult with the public through a general determination process in the creation of the Standards. It is in this context that the Standards are being established.
6. There is a requirement to establish performance indicators under the Standards that enable the system operator (the Transmission, Distribution & Retail (“TD&R”) Licensee) and others (regulators, government, public, independent agencies, etc) to effectively evaluate the performance of the licensees. These performance indicators measure reliability of the electric power service and should reflect operational effectiveness. Indicators can also be used to benchmark the power system performance among like utilities and generation plants.
7. On 30th August 2018, the Authority issued the Consultation Document to consult on the Standards. The Authority received one response to the Consultation Document.
8. On 15th January 2019, the Authority issued the Preliminary Report for the public to review the proposed Standards. The Authority received one response to the Preliminary Report.
9. Therefore, in this Final Report, the Authority summarises the responses received to the Consultation Document and Preliminary Report and presents a GD setting forth the Standards, in light of the responses to the Consultation Document and the Preliminary Report. The GD on the Standards is set out in Appendix B.
10. This Final Report is structured as follows:
 - a) section II outlines the background and procedural history;
 - b) section III sets out the legislative context and framework;
 - c) section IV summarises the responses to the Consultation Document;

- d) section V summarises the responses to the Preliminary Report;
- e) section VI provides the conclusion;
- f) Appendix A sets forth the Final Order; and
- g) Appendix B sets forth the GD.

II. BACKGROUND AND PROCEDURAL HISTORY

II.A. Background

11. The Authority initiated the consultation by publishing a Consultation Document on 30th August 2018 that invited responses from members of the public, including electricity sectoral participants and sectoral providers, as well as other interested parties.
12. The purpose of the Authority's Consultation Document was to set out the Authority's process to create service standards. It aimed to both identify and provide an overview of the key performance indicators that the Authority proposed to use in assessing the quality of customer service and the technical performance of the electricity network and generation plants.
13. The Consultation Document asked the following questions:
 - i) Do you agree with the categories of performance and service standards that are being considered?
 - ii) Do you agree with the Authority's proposed performance and service standards? If not, please set out your suggested modifications, additions or deletions.
 - iii) What information and benchmarks should the Authority use in developing the performance and service standards?
14. Responses to the Consultation Document were solicited from the public electronically through the Authority's website at www.rab.bm.
15. The response period commenced on 30 August 2018 and concluded on 18 September 2018.
16. The Authority received 1 written response to the Consultation Document from BELCO.
17. On 6 December 2018, the Authority issued the Preliminary Report. The Authority invited responses from members of the public, including sectoral participants and sectoral providers, as well as other interested parties.
18. Public comments on the Preliminary Report were to be submitted by 15 January 2019.
19. The Authority received one written response to the Preliminary Report from BELCO.

II.B. Final Decision and Order

20. The Authority hereby adopts the Order in Appendix A and make the General Determination set out in Appendix B to this Final Report.

III. LEGISLATIVE CONTEXT

21. The core legal framework relevant to the development of the Standards is based on the RAA, EA and the Policy.
22. The RAA established a cross-sectoral independent and accountable regulatory body “to protect the rights of consumers, encourage the deployment of innovative and affordable services, promote sustainable competition, foster investment, promote Bermudian ownership and employment and enhance Bermuda’s position in the global market”.
23. The EA received Royal Assent on 27 February 2016 and came into operation on 28 October 2016, pursuant to the Electricity Act 2016 Commencement Day Notice 2016 (BR 101/2016). The EA repealed the Energy Act 2009.
24. In June 2015, the Ministry of Economic Development of Bermuda published the Policy. The Policy set out the groundwork for the establishment of the subsequent Electricity Act 2016 and the desired structure of the electricity sector of Bermuda, and it also outlined four broad policy objectives for the sector. These policy objectives encourage the pursuit of an electricity service that is (i) least cost and high quality, (ii) environmentally sustainable, (iii) secure and (iv) affordable.¹
25. Sections 17-19 of the EA provide that no person shall engage in the following regulated activities unless authorised by a licence granted by the Authority: the transmission and distribution of electricity, generation of electricity (unless generation is below the specified licence threshold), large scale self-supply of electricity, retail of electricity, sale of electricity and wholesale purchase of electricity.
26. Section 34 of the EA requires the Authority to set standards for reliability, power quality and customer service for the supply of electricity that are in line with industry best practice by general determination.
27. The Authority’s roles and responsibilities within the Bermuda electricity sector are laid out in broad terms in the Policy and in more detail in the EA.
28. In relation to the Standards for the generation, transmission, distribution & retailing of electricity, section 5.2 of the Policy stipulates that the Authority has responsibility for oversight of the Bermuda Electric Light Company (“BELCO”) regarding “regulating tariffs and service quality” among other things.
29. The EA elaborates on the aspect of service quality in section 34(1), stating that the Authority “shall, by general determination, set standards for reliability, power quality and customer service for the supply of electricity that are in line with industry best practice.” Furthermore, section 6 of the EA specifies that it was enacted with the express purposes, among others, of ensuring “the adequacy, safety, sustainability and reliability of electricity supply in Bermuda” and “to protect the interests of end-users with respect to prices and affordability, and the adequacy, reliability and quality of electricity service”.
30. In addition, condition 14.1 of the TD&R Licence requires the TD&R Licensee “to comply with any applicable service standards including standards relating to power reliability, power quality and customer service standards set out in any General Determinations made pursuant to section 34” of the EA.

¹ Ministry of Economic Development (2015), “The National Electricity Sector Policy of Bermuda”, Bermuda, p. 4.

31. Similarly, condition 14.1 of the Bulk Generation Licence requires the Bulk Generation Licensee “to comply with any applicable service standards including standards relating to power reliability and power quality applicable to it and other standards set out in any General Determination made pursuant to section 34” of the EA.
32. The selection of the Standards is guided by objectives that align with the Authority’s roles and responsibilities laid out in the foundational regulatory documents discussed above. The objective of the Standards is to measure the Licensees’ performance against industry best practice in the following areas:
 - a) Customer service levels;
 - b) Reliability of electricity supply to end users;
 - c) Quality of electricity supplied to end users;
 - d) Efficiency of electricity supply to end users;
 - e) Environmental impact (sustainability); and
 - f) Safety.
33. The areas of customer service, reliability, quality, sustainability and safety are mentioned explicitly in the foundational documents discussed above, but the area of efficiency has been added to specifically address the concerns associated with “prices and affordability.”
34. The Authority’s role in the protection of consumer interests, specifically with regards to electricity prices and affordability, is executed in part through the regulation of tariffs. The Regulatory Authority (Retail Tariff Methodology) General Determination, issued on 19th October 2018, describes the Authority’s intention to retain the fuel adjustment rate mechanism in the retail tariff structure, with the implication that fuel costs will continue to be directly passed to consumers through the tariff. In this context, the performance parameters include measures for the efficiency of converting the energy within fuel to electricity for end-users.
35. Although some indicators are included for gaseous emissions and chemical spills, environmental sustainability is also addressed by the generation planning function of the TD&R Licensee through integrated resource planning, which is described in Part 8 of the EA.

IV. SUMMARY AND DISCUSSION OF RESPONSE TO THE INITIAL CONSULTATION DOCUMENT

IV.A. Response Method

36. The Consultation Document allowed the public to submit responses commenting on Service Standards for Generation and Transmission, Distribution & Retail Licensees and to respond to the consultation questions. One written response to the Consultation Document was received from BELCO.

IV.B. Summary of Response

37. This section provides an overview of the key themes from the response to the Consultation Document and the related decisions that the Authority made, taking into consideration the public response.
38. The response was carefully considered and is summarised below.
39. The Authority welcomes BELCO's view that it broadly agrees that the Standards are appropriate for Bermuda. The Authority noted the following key points raised by BELCO in its response to the Consultation Document:
- a) Care should be taken to ensure that no conflict arises between the service standards imposed by the Authority and those service standards that will ultimately be set out in power purchase agreements ("PPAs");
 - b) Recommendation of additional bulk generation production metrics;
 - c) Recommendation of additional bulk generation environmental metrics;
 - d) Recommendation of an additional Transmission, Distribution & Retail environmental metric;
 - e) Recommendation of additional occupational safety and health metrics; and
 - f) Information and benchmarks should reference the:
 - (i) the Occupational Safety and Health Act 1982 ("OSHA");
 - (ii) the Clean Air Act 1991 ("CAA");
 - (iii) the Clean Air Regulations 1993 ("CAR"); and
 - (iv) the Canadian Electricity Association Incident Reporting Standard ("CEA A-2-2008").
40. The Authority responded as follows to the points raised by BELCO:
- a) The TD&R Licensee is responsible for negotiating the terms of PPAs with prospective Bulk Generators, which are then subject to review and approval by the Authority. Therefore, it will be the responsibility of the TD&R Licensee to ensure that draft PPAs do not conflict with the Standards.
 - b) Each additional parameter recommended by BELCO under the heading "bulk generation production metrics" is addressed in turn below:

- (i) **Gross Generation (MWh):** The Authority did not include this parameter for the following reasons: (i) Gross generation is not controlled by the generator because it is dependent on electricity demand; and (ii) the dispatch instructions are given by the system operator, which is a function of the TD&R Licensee pursuant to clause 14.3 of its licence. It would not be fair to measure the performance of generators using a metric that is outside of their direct control. For reliability of supply, generators will be measured against the Availability Factor and Unavailable Generation parameters, which are under their control.
- (ii) **Net Generation (MWh):** The Authority did not include this parameter for the reasons described in (i) above.
- (iii) **Fuel Efficiency (kWh/bbl):** The Authority did not include this parameter for the following reasons:
 - A. The Standards include heat rate, which is the inverse of fuel efficiency and adequately addresses efficiency of supply by generators;
 - B. The inclusion of Fuel Efficiency as an additional parameter would not add any value;
 - C. The proposed units refer to barrels of fuel oil consumed, which is not a precise measurement of efficiency because the heat content of a barrel of oil depends on the chemical composition and changes depending on the source of the fuel; and
 - D. The units proposed for Fuel Efficiency are specific to fuel oil and would not be applicable to generators using other types of fuel; whereas the units for Heat Rate are not specific to a fuel type.
- (iv) **Heat Rate (Btu/kWh):** This parameter is already included in the Standards, but with different units of measurement (kJ/kWh). The Authority did not see any value added by expressing Heat Rate as a combination of imperial and metric units.
- (v) **Forced Outage Rate (Forced Outage Factor) (%):** This is included in the Standards as Forced Outage Factor.
- (vi) **Total Plant Availability (Availability Factor) (%):** This is included in the Standards as Availability Factor. Formulae are included for single units and groups of units (i.e. a total generating plant).
- (vii) **Generation Initiated Load Sheds:** The Authority did not include this parameter for the following reasons:
 - A. System stability (maintaining the frequency of electricity supply within an acceptable range) is the responsibility of the system operator;
 - B. The system operator should manage the system such that the failure of one generation unit does not lead to disruptions in supply to end-users (i.e. load-shedding);

- C. The system operator will be measured against the Frequency Excursions parameter within the Standards, which has the aim of avoiding load shedding. Therefore, Generation initiated load sheds are not within the Generator's direct control; and
 - D. The failure of individual units is within the Generator's control and is addressed by the Generator Unit Trips parameter contained within the Standards.
- c) Each additional parameter recommended by BELCO under the heading "bulk generation environmental metrics" is addressed in turn below:
- (i) **Opacity Exceedances:** The Authority incorporated this parameter in the Proposed Decision and the Standards have been revised accordingly. It is a useful method for measuring opacity levels (the degree to which smoke blocks light), especially considering that it is a requirement for the company's operating licence granted pursuant to the CAA.
 - (ii) **Ambient Air Quality Monitoring Station Exceedances:** The Authority incorporated this parameter in the Proposed Decision and the Standards have been revised accordingly:
 - A. oxides of nitrogen;
 - B. oxides of sulphur;
 - C. total suspended particulates (TSP-six-day cycle); and
 - D. inhalable particulate matter (PM, o-continuous).

Considering that these indicators are a requirement for an operating licence granted pursuant to the CAA and the CAR, this is a useful method for measuring ambient air quality standards.

- (iii) **Stack Emissions Testing:** The Authority incorporated seven of the eighteen parameters recommended by BELCO within the Proposed Decision. The seven parameters accepted were:
 - A. Carbon monoxide and carbon dioxide volumes;
 - B. Concentration of sulphur oxides in gaseous emissions;
 - C. Concentration of nitrogen oxides in gaseous emissions;
 - D. Concentration of total suspended particles in gaseous emissions;
 - E. Concentration of inhalable particulate matter (PM10) in gaseous emissions;
 - F. Concentration of mercury in gaseous emissions; and
 - G. Concentration of volatile organic compounds in gaseous emissions.

The Authority considers that it would not be necessary to include all eighteen parameters in the Standards because the volumes of emissions of arsenic, cadmium, chromium, copper, lead, nickel, vanadium, selenium, zinc, hydrogen chloride and poly aromatic hydrocarbons are generally low for conventional generation plants. This is because most fuels do not naturally contain significant amounts of these constituents due to their natural composition or pre-processing. Waste-to-energy plants could be an exception because the fuel for waste-to-energy plants can have higher volumes of these elements due to its heterogenous nature, depending on the sorting and processing methods used.

Measuring and recording these additional eleven parameters could introduce unnecessary costs for Licensees. The Authority suggested that it would not be fair to require all Bulk Generation Licensees to report on these eleven parameters when they are not expected to occur at levels that could pose a risk to public health or the environment. If a Bulk Generation Licensee proposes to use a fuel that could produce emissions that pose a risk to public health or the environment, increased monitoring and reporting could be implemented through environmental regulations or operating licenses issued pursuant to the CAA.

As stated in paragraph 42 of the Preliminary Report, the Authority wished to select parameters that are appropriate and proportionate, without placing an unnecessary burden on licensees when there is limited justification for selecting the parameters.

- (iv) **Total Number of Spill Incidents:** The Authority incorporated a spill incident parameter within the Proposed Decision and the Standards have been revised accordingly.
- d) An additional parameter recommended by BELCO under the heading “Transmission, Distribution & Retail environmental metric” was:
- (i) **Total number of Spill Incidents:** The Authority incorporated this parameter within the Proposed Decision and the Standards have been revised accordingly.
- e) BELCO recommended additional parameters under the heading “occupational safety and health metrics”. The Authority did not include BELCO’s recommendations. The Standards currently refer to the Occupational Safety and Health Regulations of Bermuda and the Authority considered these to be adequate for measuring the performance of licensees in this area.
- f) References to the OSHA, the CAA and the CAR have been included in the Standards within the relevant sections. The Authority did not see any basis for including the CEA A-2-2008 within the Standards.

V. SUMMARY AND DISCUSSION OF RESPONSE TO PRELIMINARY REPORT, PRELIMINARY DECISION AND ORDER

V.I Response Method

The Authority received one written response to the Preliminary Report from BELCO.

41. The response has been carefully considered and is summarised and addressed below.

V.II Summary of Responses

42. This section provides an overview of the key themes from the responses to the Preliminary Report and summarizes some of the main decisions that the Authority has made, taking into consideration the public responses.

43. BELCO acknowledged that the Authority had considered its responses to the first round of consultation and that the Authority had implemented some of BELCO's suggestions in the Preliminary Report.

44. The comments received from BELCO all relate to the section within Annex 1.1 of the Standards entitled "Bulk Generation Licensee Performance Indicators - Environmental Impact".

45. The Authority notes the following key points raised by BELCO in its response to the Consultation Document, with responses given in paragraph 46 below:

a) In a number of occasions in its response, BELCO stated that "the Updated Standard, which is intended to address ambient air quality, does not in fact refer to ambient air quality." BELCO seems to thereby imply that indicators related to ambient air quality should be included in the Standards.

b) Opacity exceedances: BELCO suggested that exceedances allowed under operating licences granted under the CCA should be taken into account. In addition, BELCO advised that continuous emissions monitoring would be required to report strictly in accordance with the Standards.

c) Gaseous sulphur oxide exceedances: BELCO noted that only sulphur dioxide (SO₂) is regulated under the CCA rather than all oxides of sulphur as implied by the term "SO_x" in the Standards.

d) Gaseous nitrogen oxide exceedances: BELCO noted that only nitrogen dioxide (NO₂) is regulated under the CCA rather than all oxides of nitrogen as implied by the term "NO_x" in the Standards.

e) Volumes of carbon monoxide and carbon dioxide and concentrations of other pollutants in gaseous emissions: BELCO noted that measuring and reporting data for these indicators would require the use of continuous emissions monitoring systems. BELCO suggested that the measurement and reporting regime should be adjusted to align with the current methodology pursuant to operating licences granted under the CCA.

46. The Authority responds as follows to the points raised by BELCO:

a) Ambient air exceedances: The performance indicators for environmental impact are intended to assist in ensuring that electricity is supplied in a sustainable manner, which is one of the purposes of the EA. Ambient air quality is not specifically mentioned in the EA, the National Electricity Sector

Policy or in the Bulk Generation Licenses. Nevertheless, there are difficulties associated with precisely identifying how ambient air quality is directly affected by a generator. The majority of indicators listed in the section of Annex 1.1 entitled "Bulk Generation Licensee Performance Indicators - Environmental Impact" relate to gaseous emissions from generators, which all influence ambient air quality. The parameters listed in the Standards are those over which the licensee has control and – when measured collectively – give a reasonable indication of the Generator's impact on ambient air quality.

- b) Opacity exceedances: The Standards have been revised so that reporting acknowledges the requirements for reporting for licences granted under the CCA. Please see paragraph (e) below for the Authority's response concerning continuous monitoring of gaseous emissions.
- c) Gaseous sulphur oxide exceedances: The Standards have been revised so that reporting aligns with the requirements for reporting for licences granted under the CCA.
- d) Gaseous nitrogen oxide exceedances: The Standards have been revised so that reporting aligns with the requirements for reporting for licences granted under the CCA.
- e) Volumes of carbon monoxide and carbon dioxide and concentrations of other pollutants in gaseous emissions: The Authority acknowledges that continuous emissions monitoring systems would be required to measure and report on these parameters. The Authority does not see any reason for modifying the definitions of the indicators since continuous emissions monitoring systems are widely available and commonly used by generators in other jurisdictions.

VI. CONCLUSION

47. In furtherance of the proposals set forth above, the Authority hereby adopts the Order set forth in Appendix A to this Final Report, and makes the General Determination set forth in Appendix B.

APPENDIX A: ORDER



BERMUDA
**REGULATORY
AUTHORITY**

**Order:
Indicators for Generation and Transmission,
Distribution & Retail Licensee Service Standards**

Order
Date: 4 April 2019

1.1 The Regulatory Authority, pursuant to Sections 12, 13 and 62 of the Regulatory Authority Act 2011 and Sections 6, 14, 17 and 34 of the Electricity Act 2016, hereby:

- a) Adopts the General Determination attached hereto, setting forth the Indicators for Generation and Transmission, Distribution & Retail Licensee Service Standards for the Bermuda Electricity Network;
- b) Directs the Chief Executive of the Regulatory Authority to forward the General Determination to the Cabinet Secretary; and
- c) Authorises the General Determination to be effected on the date of its publication in the Official Gazette.

1.2 So Ordered this 4th day of April 2019

APPENDIX B: GENERAL DETERMINATION

BERMUDA

**REGULATORY AUTHORITY (SERVICE STANDARDS INDICATORS FOR
ELECTRICITY LICENSEES) GENERAL DETERMINATION 2019**

BR / 2019

TABLE OF CONTENTS

1	Citation
2	Interpretation
3	General purpose
4	Determination
5	Terms and conditions of General Determination
6	Effective Date of General Determination

The Regulatory Authority, in the exercise of the power conferred by section 62 of the Regulatory Authority Act 2011, as read with sections 12 and 13 of that Act and sections 6, 14, 17 and 34 of the Electricity Act 2016, makes the following General Determination:

Citation

1 This General Determination may be cited as the Regulatory Authority (Service Standards Indicators for Electricity Licensees) General Determination 2019.

Interpretation

2 In this General Determination, unless the context otherwise requires, terms shall have the meaning given in the Regulatory Authority Act 2011, the Electricity Act 2016, and the Schedule to this General Determination.

General purpose

3 This General Determination establishes service standards indicators for reliability, power quality, safety, environmental impact and customer service for the supply of electricity.

Determination

4 (1) This General Determination is made pursuant to the Consultation Document entitled "Service Standards for Generation and Transmission, Distribution and Retail Licensees" dated 30 August 2018, the Preliminary Report, Preliminary Decision and Order entitled "Indicators for Generation and Transmission, Distribution and Retail Licensee Service Standards" dated 6 December 2018 and the Regulatory Authority's Decision on them.

**REGULATORY AUTHORITY (SERVICE STANDARDS INDICATORS FOR
ELECTRICITY LICENSEES) GENERAL DETERMINATION 2019**

(2) Taking into account the received responses to the Consultation Document and the Preliminary Report, Preliminary Decision and Order, for the reasons given in the Decision, the Authority determines that service standards indicators set forth in the Schedule are consistent with the purposes of the Electricity Act 2016, including to ensure the efficient and secure functioning of the power system and network, appropriate quality of electricity supply and customer service.

Terms and conditions of General Determination

5 (1) The Schedule to this General Determination has effect.

(2) The Schedule is published on the Regulatory Authority's website (www.rab.bm), and is also available for inspection at the offices of the Authority (1st Floor, Craig Appin House, 8 Wesley Street, Hamilton HM 11) during ordinary business hours.

Effective Date of General Determination

6 This General Determination shall become effective on the day it is published in the Official Gazette.

Signed this 4th day of April 2019



Chairman, Regulatory Authority



REGULATORY
AUTHORITY

Bermuda

**Schedule to Regulatory Authority
(Service Standards Indicators for
Electricity Licensees) General
Determination**

General Determination

Date: 4 April 2019

Table of Contents

- 1 Definitions
- 2 Interpretation
- 3 Legislative and Procedural Background
4. Final Determination
5. Annex 1 – Service Standards Indicators for Electricity Licensees

This General Determination is made by the Regulatory Authority of Bermuda pursuant to section 62 of the Regulatory Authority Act 2011 (“**RAA**”) and in accordance with sections 6, 14, 17 and 34 of the Electricity Act 2016 (“**EA**”) and establishes the Service Standards Indicators for Electricity Licensees of the electricity sector.

1. DEFINITIONS

Administrative Determination: means a general determination, order, direction, decision, or other written determination by which the Authority establishes the legal rights and obligations of one or more sectoral participants but does not include an advisory guideline or an adjudicative decision and order.

The “**Authority**”: means the Regulatory Authority of Bermuda.

Bbl: means a Barrel (of oil).

BELCO: means the Bermuda Electric Light Company Limited.

Btu: means British thermal units.

Bulk Generation Licence: means a licence granted by the Authority under section 20(b) of the EA.

Bulk Generation Licensee: means a person that holds a Bulk Generation Licence.

Consultation Document: means the Service Standards for Generation and Transmission, Distribution & Retail Licensees Consultation Document.

Customer service: means the experience of end-users in relation to the service that is being provided (i.e. the supply of electricity).

EA: means the Electricity Act 2016.

Efficiency: means the degree to which the energy contained within the primary resources for electricity generation (e.g. fuel, solar radiation) is converted to electricity and supplied to end-users.

GD: means General Determination.

Grid Code: means the code for the operation of the transmission system developed by the TD&R Licensee and approved by the Authority. It covers all material technical aspects relating to (i) connections to and the operation and use of, the transmission and distribution system; and (ii) the operation of electrical installations required for the operation of the transmission and distribution system.

kWh: means Kilowatt-hours.

licence: means a valid licence granted by the Authority in accordance under the Electricity Act 2016.

licensee: means a person that holds a valid licence granted by the Authority in under the Electricity Act 2016.

MWh: means Megawatt-hours.

The “**Policy**”: means the National Electricity Sector Policy issued in June 2015.

Power Quality: means the extent to which the measurable properties (voltage, frequency, and waveform) of the electricity supplied to end-users fall within the design parameters of the equipment and appliances that consume the electricity as specified in the Grid Code.

RAA: means the Regulatory Authority Act 2011.

Reliability: means the degree to which electricity is supplied to end-users on a continuous basis (i.e. without interruption) and in sufficient volume to meet their consumption requirements.

Service Rules: mean the set of rules that state the types of services offered by the TD&R Licensee and detail the terms and conditions under which service is supplied by the TD&R Licensee to the customer.

The Standards: means the Service Standards Indicators for Electricity Licensees.

System operator: means the function of the TD&R Licensee pursuant to clause 14.3 of the TD&R Licence.

TD&R: means Transmission, Distribution & Retail.

TD&R Licence: means a licence granted by the Authority under section 20(a) of the Electricity Act 2016.

TD&R Licensee: means a person that holds a TD&R Licence.

2 INTERPRETATION

- (1) For purposes of interpreting this General Determination:
- a) unless the context otherwise requires, words or expressions shall have the meaning assigned to them by the RAA and the EA;
 - b) where there is any conflict between the provisions of this General Determination and the EA or RAA, the provisions of the EA or RAA, as the case may be and subject to sections 3(2) and 3(3) of the EA, shall prevail;
 - c) terms defined herein and, in the EA and RAA have been capitalised;
 - d) headings and titles used herein are for reference only and shall not affect the interpretation or construction of this General Determination;
 - e) references to any law or statutory instrument include any modification, re-enactment or legislative provisions substituted for the same;
 - f) a document referred to herein shall be incorporated into and form part of this General Determination and a reference to such document is to the document as modified from time to time;
 - g) expressions cognate with those used herein shall be construed accordingly;
 - h) use of the word "include" or "including" is to be construed as being without limitation; and
 - i) words importing the singular shall include the plural and vice versa, and words importing the whole shall be treated as including a reference to any part unless explicitly limited.

3 LEGISLATIVE AND PROCEDURAL BACKGROUND

- (1) This General Determination has been undertaken in accordance with section 62 of the RAA and the exercise by the Authority of its powers under sections 6, 14, 17 and 34 of the EA.
- (2) The Authority initiated the consultation by publishing a Consultation Document on 30 August 2018 that invited responses from members of the public, including electricity sectoral participants and sectoral providers, as well as other interested parties. The purpose of the Authority's Consultation Document was to consult on the identification of the key performance indicators that it proposed to use in assessing the quality of customer service and the technical performance of the electricity network and generation plants.
- (3) The Consultation Document asked questions on the following topics:
 - a) Do you agree with the categories of performance and service standards that are being considered?
 - b) Do you agree with the Authority's proposed performance and service standards? If not, please set out your suggested modifications, additions or deletions.
 - c) What information and benchmarks should the Authority use in developing the performance and service standards?
- (5) Responses to the Consultation Document were solicited from the public electronically through the Authority's website at www.rab.bm.
- (6) The response period commenced on 30 August 2018 and concluded on 18 September 2018.
- (7) The Authority received one response from the public.
- (8) The Authority issued a Preliminary Report, Preliminary Decision and Order on 6 December 2018 that invited responses from members of the public, including electricity sectoral participants and sectoral providers, as well as other interested parties.
- (9) The Authority received one response from the public to the Preliminary Report, Preliminary Decision and Order.

4 FINAL DETERMINATION

- (1) Pursuant to section 62 of the RAA and in accordance with sections 6, 14, 17 and 34 of the EA using the general powers granted to the Authority under section 13 of the RAA and in accordance with the procedures established for this purpose in section 62 of the RAA, the Authority hereby determines that:
- (2) The adoption and implementation of the Service Standards Indicators for Electricity Licensees as set forth in Annex 1 of this Schedule below is consistent with the purposes of the EA, including to seek to: (a) ensure the adequacy, safety, sustainability and reliability of electricity supply in Bermuda; (b) encourage electricity conservation and the efficient use of electricity; (c) promote the use of cleaner energy solutions and technologies; (d) provide sectoral participants and end-users with non-discriminatory interconnection to transmission and distribution systems; (e) protect the interests of end-users with respect to prices and affordability, and the adequacy, reliability and quality of electricity service; and (f) promote economic efficiency and sustainability in the generation, transmission, distribution and sale of electricity.

ANNEX 1 – SERVICE STANDARDS INDICATORS FOR ELECTRICITY LICENSEES

SERVICE STANDARDS INDICATORS FOR ELECTRICITY LICENSEES

I INTRODUCTION

1. The Authority is issuing this General Determination to set the standards for reliability, power quality and customer service for the supply of electricity that are in line with industry best practice (the “Service Standards”).
2. The Authority is responsible for regulating the electricity sector including the issuing of licences, regulating new market entrants, tariffs, and monitoring the quality of service provisions to end-users by service providers within the sector.
3. In the conduct of its regulatory functions and activities, the Authority is guided by the legislative and regulatory framework set out in the RAA and EA.
4. The EA was enacted with several purposes in section 6, including:
 - i. “to protect the interests of end-users with respect to prices and affordability, and the adequacy, reliability and quality of electricity service”; and
 - ii. “to ensure the adequacy, safety, sustainability and reliability of electricity supply in Bermuda.”
5. The EA specifies the approach to service quality in section 34(1), stating that the Authority “shall, by general determination, set standards for reliability, power quality and customer service for the supply of electricity that are in line with industry best practice.”
6. In accordance with the EA, a Transmission, Distribution & Retail (TD&R) licence has been granted to BELCO authorizing BELCO’s TD&R activities. Condition 14.1 of the TD&R Licence requires the TD&R licensee “to comply with any applicable service standards including standards relating to power reliability, power quality and customer service standards set out in any General Determinations made pursuant to section 34” of the EA.
7. Similarly, condition 14.1 of the Bulk Generation Licence require bulk generation licensees “to comply with any applicable service standards including standards relating to power reliability and power quality applicable to it and other standards set out in any General Determination made pursuant to section 34” of the EA.
8. The EA and RAA also mandate that the Authority consult with the public on the Standards as part of the general determination process.² It is in this context that the standards of performance, covering the provision of service to customers, are being established.
9. The Standards mandated by the EA are intended to ensure that customers receive good service from licensees and that the supply of electricity to customers is efficient, secure and of appropriate quality for their purposes. Therefore, there is a need for common indicators that enable stakeholders to evaluate the performance of licensees and hold them to account. These stakeholders include customers, the Authority, other regulators, government, the public, the media, independent agencies and the system operator (which is a function of the TD&R Licensee). These indicators measure the

² EA section 34(1); RAA section 62(2)(a)

reliability and quality of the services provided by licensees and reflect the effectiveness of operational management. They can also be used as a tool to compare or benchmark the power system performance, both against similar utilities and generation plants and to assess changes in performance over time.

10. Electricity customers are at the heart of the Standards. The customer mainly interacts with the network owner and operator (the TD&R Licensee), but the whole electricity value chain has a bearing on the quality of the electricity ultimately consumed by the customer, including generators of electricity, and on the overall level of service that is provided.
11. Suitable standards must therefore be applied to both the TD&R Licensee and Bulk Generation Licensees, to ensure that there is appropriate oversight of each part of the electricity value chain.

II. PURPOSE

12. This General Determination sets out the key performance indicators that make up the Standards. It both identifies and provides an overview of the key performance indicators that the Authority will use in assessing the quality of customer service and the technical performance of the TD&R and Bulk Generation Licensees. Specifically, this General Determination sets out the Authority's performance measures.
13. Pursuant to this General Determination, the Authority will undertake a benchmarking process for the performance indicators. Subsequently, the Authority will set the performance targets for the performance indicator by an Administrative Determination. An Administrative Determination includes a general determination, order, direction, decision, or other written determination by which the Authority establishes the legal rights and obligations of one or more sectoral participants but does not include an advisory guideline or an adjudicative decision and order.
14. The Authority will also set the mechanisms for reporting, submission and disclosure of relevant information to the Authority and the public via Administrative Determination.
15. The detailed definitions and formulae for the performance indicators which make up the Standards are presented by licence type in Annex 1.1.

III OBJECTIVES

16. The objectives of the Standards are to measure licensees' performance in the following areas:
 - i. Customer service levels: The experience of customers in relation to the services that are being provided (i.e. the supply of electricity and related services).
 - ii. Reliability of electricity supplied to customers: The degree to which electricity is supplied to customers on a continuous basis (i.e. without interruption) and in sufficient volume to meet their consumption requirements.

- Reliability, which can also be described as the availability of electricity supply to a customer, is an important measure of the level of service that is being provided. Failures in supply can result from a shortfall in generation or from problems with the transmission and distribution system.
- iii. Quality of electricity supplied to customers: The measurable technical characteristics of the electricity supplied to customers and verification that these fall within the design parameters of the equipment and appliances that consume the electricity, as laid out in the relevant national standards (e.g. Bermuda Building Code) and international standards.
 - This generally includes aspects such as the voltage at which electricity is delivered to customers and its frequency (measured in Hertz).
 - iv. Efficiency of electricity supplied to customers: This covers the efficiency of the electricity generation process and the efficiency of transmission and distribution to customers over the electricity network.
17. Other areas of performance measures are designed to meet safety and environmental goals.

IV QUALITY OF SERVICE REGULATION

18. The sections below set out the performance indicators that make up the Standards. These are grouped by indicators relating to customer service, transmission and distribution and generation.
19. Section 20(2) of the EA mandates that the Authority shall grant one TD&R Licence only. In a monopoly, customers have limited bargaining power and choice. These market characteristics, and associated lack of competition, prevent customers from switching suppliers if they are not satisfied with the quality of service being offered. In these circumstances there is a risk that monopolies may not be incentivised to maintain a high quality of service. Therefore, there is a need for regulation to provide a mechanism to ensure that standards of service provided are of an appropriate level.
20. Where there is a competitive market in generation, service levels are generally laid out in the power purchase agreement between the generator and the purchaser. The EA encourages competitive generation, however the competitive generation market in Bermuda is still emerging. Subsequently, there is a need for the Authority to establish performance levels for the generation sector as well as for transmission and distribution.
21. To implement a service quality scheme, quantifiable and verifiable performance indicators are required. These indicators should be related to the aspects of service that customers value (i.e. those that are important to customers). Additionally, licensees should be able to both accurately measure and affect the quality of performance against indicators.
22. Performance indicators have several uses, including, but not limited to, the following:
 - i. Comparing a licensee's performance over time with the aim of continual improvement;
 - ii. Comparing performance of generators with each other;
 - iii. Comparing Bermuda licensees with utilities in other jurisdictions to benchmark performance; and
 - iv. Establishing performance incentives in the rate-setting process.

IV.1 TD&R Licensee Customer Service Indicators

23. Customer service indicators relate to the timely provision of connection services, the timely repair of faults, call centre performance and complaint handling. The Standards shall set the following indicators for customer service:
 - i. Percentage of calls answered within 30 seconds, based on total calls received;
 - ii. Average waiting time before a call is answered;
 - iii. Percentage of calls abandoned;
 - iv. Number of complaints received and resolved by type;
 - v. Resolution time (average, minimum and maximum) by complaint type;

- vi. First call resolution (% remaining unresolved after the call);
- vii. Number of billing and metering queries;
- viii. Number and percent of meters not read in accordance with the Service Rules;
- ix. Average lead time to provide new connections;
- x. Average lead time to reconnect costumers upon payment following a disconnection;
- xi. Average lead time to investigate or replace meters following a complaint;
- xii. Number of disconnections due to non-payment;
- xiii. Response time to voltage complaints;
- xiv. Response time to emergency calls; and
- xv. Number of appointments cancelled or rescheduled by the licensee;

IV.1.1 Customer satisfaction survey

24. As well as the quantitative measures listed above, an important method for assessing customer satisfaction, with regards to the levels of service delivered, is by conducting an independent customer satisfaction survey. An independent customer satisfaction survey is particularly important in circumstances where customers are not able to select alternative service providers, as is the case in the electricity sector of Bermuda. Therefore, the TD&R licensee is required to develop a customer satisfaction survey, subject to the Authority's approval, which shall be conducted on an annual basis by an independent party. This will enable an effective assessment of opinions and concerns of customers, which can be tracked over time, as the survey is repeated.

IV.2 Transmission and Distribution Network Performance Indicators

25. The Standards shall include the technical performance indicators of the transmission and distribution system, owned and operated by the TD&R Licensee, described in the paragraphs below. For the assurance that the Standards laid out in this section are achieved at all times, and that end-user tariffs are maintained at a reasonable level, the TD&R Licensee shall ensure that:
- i. there is sufficient, but not excessive, generation capacity connected to the network to meet electricity demand under all loading conditions as set by the Authority and as may be documented in any Integrated Resource Plan, among others;
 - ii. investment in transmission and distribution assets is prudently planned; and
 - iii. the transmission and distribution assets are maintained in accordance with good engineering practice, including any applicable manufacturer's requirements;
26. Further detail about the transmission and distribution performance indicators is provided in Annex 1.1, where applicable.

IV.2.1 Network Reliability (Availability) Measures

27. This section considers service failures that result from difficulties with the transmission and distribution system (generation reliability is considered in section IV.3.1). Such failures are a result of network circuit outages or interruptions and these can be evaluated using indicators that measure the number of outages and their duration.
28. It is important to measure the overall level of performance for each of the various availability measures. However, greater understanding of the underlying factors can be obtained by disaggregating these into their component parts. For example, the measures can be split between those resulting from scheduled or planned outages and those resulting from unplanned or forced outages. The interruptions could also be classified and reported as momentary interruptions (i.e. less than 5 minutes), sustained interruptions (i.e. more than 5 mins) and major interruptions (i.e. greater than 10% of customers affected for 24 hours or more).
29. There may also be benefits from examining performance at each voltage level and even at the level of an individual line or cable. The reliability of a network can be assessed through individual and overall performance indicators. Individual performance indicators are used to measure the network system availability of individual assets (e.g. transmission lines and substation transformers), while overall performance indicators apply to the network as a whole. However, publication of data at this level may be regarded as excessive.
30. There is also the potential that situations where extreme conditions (for example, hurricanes) may have the potential to distort reported performance and hence it may be appropriate for such periods to be reported separately.
31. Some of the indicators outlined below have been derived from the Institute of Electrical and Electronics Engineers ("IEEE") standard *IEEE 1366-2012: IEEE Guide for Electric Power Distribution Reliability Indices* ("IEEE 1366"), which is an international standard that is commonly applied to network performance measurement.

IV.2.1.1 Average interruption and availability indicators

32. The following five indicators shall provide measures of the average quantity and duration of supply interruptions experienced by customers:
- i. System Average Interruption Frequency Index (“SAIFI”);
 - ii. Customer Average Interruption Frequency Index (“CAIFI”);
 - iii. System Average Interruption Duration Index (“SAIDI”);
 - iv. Customer Average Interruption Duration Index (“CAIDI”); and
 - v. Average Service Availability Index (“ASAI”).
33. These indicators are described in detail in Annex 1.1 below, together with the method for calculating such indicators. The intention of these indicators is for the TD&R Licensee to aim to minimise the number and duration of supply interruptions.

IV.2.1.2 Quantity of worst-served customers

34. This is the number of customers who have experienced a certain number of interruptions in the previous three-year period. The TD&R Licensee will be measured based on the number of customers that meet the defined requirements of a worst-served customer (e.g. number of customers that experienced more than a certain number of interruptions in the previous three years).

IV.2.1.3 Maximum duration of planned interruptions

35. According to IEEE 1366, a planned interruption is defined as “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”. The TD&R Licensee will be required to report the number of planned interruptions that exceeded the stated maximum duration in each period.

IV.2.1.4 Maximum duration of unplanned interruptions

36. Unplanned interruptions are those that are not planned as per the definition given in IEEE 1366. The TD&R Licensee will be required to report the number of unplanned interruptions that exceeded the stated maximum duration in each period.

IV.2.2 Quality of Supply

37. To assess the performance of a transmission and distribution network, the quality of the electricity supplied must be considered. Networks are designed so that electricity should be delivered within the design parameters of the equipment and appliances that use it, as laid out in the relevant national and international standards. Quality indicators will show how the network parameters comply with these defined standards. These are defined below.

IV.2.2.1 Frequency excursions

38. Frequency variation is the deviation of frequency beyond a certain range from the nominal supply frequency. Any frequency excursions outside these limits for a defined duration or more (e.g. 60 seconds) must be recorded as frequency limit violations.

39. Under Bermuda industry norms, the standard system of supply is set at a frequency of 60 Hertz. Frequency deviation indices can be established to record the number of times the system frequency goes beyond the allowable range and the duration of the deviation.

IV.2.2.2 Voltage level

40. Based on international standards, the voltage of all transmission substations must be maintained within $\pm 6\%$ of the nominal declared. The number, magnitude and duration of occasions of deviations from these limits are required to be recorded each year by the TD&R Licensee. Relevant standards and industry best practice should be referenced for taking measurements.

IV.2.3 Efficiency of supply

IV.2.3.1 Network Losses

41. The transmission and distribution of electricity from generators to customers over the network involves unavoidable inefficiencies. Some of these losses are technical, including the energy lost as heat from cables and transformers, while other losses are due to non-technical reasons such as theft (illegal connections to the network that are not billed through a meter) or administrative failures. Technical and non-technical losses decrease the efficiency of the network and ultimately result in higher rates for customers, since more electricity must be generated to compensate for the losses. Therefore, the TD&R Licensee will be required to calculate and report these losses as set out below in Annex 1.1.

IV.2.4 Environmental impact

42. The transmission and distribution of electricity sometimes involves the handling, storage and consumption of chemicals that can be hazardous to health and the environment. Therefore, Annex 1.1 include a parameter to monitor the number of chemical spills caused by the TD&R Licensee.

IV.2.5 Safety

43. The Occupational Safety and Health Act 1982 and Occupational Safety and Health Regulations of Bermuda set industry standards for safety. Therefore, the TD&R Licensee will be required to report on the number of accidents, dangerous occurrences and minor injuries involving employees and contractors of the TD&R Licensee, as well as other persons, that occur in a given year:
- i. at the TD&R Licensee's place of employment and other premises;
 - ii. in the course of employment of the TD&R Licensee's employees; or
 - iii. in the course of work performed under a contract between the TD&R Licensee and an individual or company.

IV.3 BULK GENERATION PERFORMANCE INDICATORS

44. The EA mandates that there is only one TD&R Licensee in Bermuda. However, the EA permits multiple Bulk Generation Licensees to generate the electricity that will be sold by the TD&R Licensee to customers. Indicators can be used to compare the performance of generators with each other, and over time.

45. Therefore, the performance indicators for generators are related to the ability to supply electricity to the network when it is needed (reliability), monitoring the losses in the generation process (efficiency), and any environmental and safety impacts.
46. These categories of generation performance parameters are discussed in this section and details of the technical aspects can be found in Annex 1.1.

IV.3.1 Reliability of supply

47. Reliability of electricity supply is dependent on the ability of generators to supply all the electricity demanded by the TD&R under all demand scenarios (i.e. under planned and unplanned outage of generating units). This depends on generators:
 - i. having sufficient installed generation capacity to supply the electricity required under all demand scenarios (including peak demand, which is defined as the highest load demanded in a period); and
 - ii. having this capacity available when required to meet demand.

The selected parameters therefore account for the capacity and availability elements of electricity generation.

IV.3.2 Efficiency of supply

48. The amount of fuel consumed by generators has a direct impact on the rate paid by end-users in Bermuda. If the process of generating electricity is less efficient than it could be, rates may increase. Therefore, licensees will be required to monitor and be accountable for the efficiency of generation.

IV.3.3 Environmental impact

49. Some generators burn fuel in the process of generating electricity. The combustion process generates exhaust gases that are emitted into the atmosphere. Some of these gases are harmful to the environment and need to be monitored. Therefore, Annex 1.1 gives details of the aspects of the exhaust gases that will be monitored and reported by licensees.
50. The process of generating electricity sometimes requires the handling, storage and consumption of chemicals (including fuel) that can be hazardous to health and the environment. Hence, Annex 1.1 includes a parameter to monitor the number of chemical spills caused by the licensee.

IV.3.4 Safety

51. The Occupational Safety and Health Act 1982 and Occupational Safety and Health Regulations of Bermuda set industry standards for safety. Therefore, the licensee will be required to report on the number of accidents, dangerous occurrences and minor injuries involving employees and contractors of the licensee, as well as other persons, that occur in a given year:
 - i. at the licensee's place of employment and other premises;
 - ii. in the course of employment of the licensee's employees; or

- iii. in the course of work performed under a contract between the licensee and an individual or company.

V CONCLUSION

52. The key objective of implementing the performance indicators that make up the Standards is to measure the performance of the network or system: (i) so that the indicators can be compared with those of other similar networks or systems; and (ii) to assess the performance improvements attained. They can be used to indicate changes in performance over time, to set targets, and to facilitate incentive regimes to encourage performance improvements.
53. The transmission and distribution network in Bermuda is owned and operated by the TD&R Licensee and most of the data required to compute the listed transmission and distribution performance indicators is already recorded. Data logging and recording facilities should be implemented to obtain any data which is currently unavailable (particularly power quality measures) to measure the network performance.
54. Most of the data required to compute the generation performance measures of power generation plants in Bermuda is already available with the plant operators. Data logging and recording facilities should be implemented to obtain any data which is currently unavailable to measure generation performance
55. To determine the quantitative value of indicators, the Authority will work with the licensees to assess their historical data and will review data from similar jurisdictions. Further to this GD, the Authority will then set performance benchmarks by administrative determination.
56. The licensees will be obligated to comply with minimum standards set, to monitor the quality and reliability of the electricity supply and measure performance for each indicator. Historical trends of performance will thus be accumulated, with the aim of continual improvement.
57. Minimum filing requirements for reporting will subsequently be set by the Authority by administrative determination, pursuant to this GD.
58. These indicators will also be used as part of the retail tariff methodology to incentivise licensees to reasonably exceed specified targets, or to compensate customers for underperformance.

ANNEX 1.1 DEFINITIONS AND FORMULAE FOR THE SERVICE STANDARDS INDICATORS

DEFINITIONS AND FORMULAE FOR THE SERVICE STANDARDS INDICATORS

59. This Annex 1.1 sets out the detailed definitions and formulae for the performance indicators which make up the Standards, which are presented by licence type below. Annex 1 provides a general explanation of the rationale for the various categories of performance indicators, while Annex 1.1 is intended to provide details of how each indicator is to be calculated so that the basis and methodology are clear.

Basic Factors

60. The basic factors defined below specify the data needed to calculate the reliability indices.

NOTE—The subscript ‘i’ denotes an interruption event.

CI	Customers interrupted
CMI	Customer minutes of interruption
CN	Total number of distinct customers who have experienced a sustained interruption during the reporting period
N_i	Number of interrupted customers for each sustained interruption event during the reporting period
N_{mi}	Number of interrupted customers for each momentary interruption event during the reporting period
N_T	Total number of customers served for the area
r_i	Restoration time for each interruption event

TD&R Licensee Performance Indicators - Reliability

61. The reliability performance indicators for the TD&R Licensee have been derived from IEEE Standard 1366-2012: *IEEE Guide for Electric Power Distribution Reliability Indices*. The TD&R Licensee is required to report on the parameters described below.

System Average Interruption Frequency Index (“SAIFI”)

62. This measures the average number of interruptions (outages) that a customer experiences in a year. It is a ratio of the number of customer-interruptions in a year (“Cumulative”) to the total number of customers. Customer-interruptions are determined from estimates of the number of customers affected by each interruption.

$$SAIFI = \frac{\text{Cumulative no. of customers interrupted}}{\text{Total no. of customers served}}$$

To calculate the index,

$$SAIFI = \frac{\sum N_i}{N_T} = \frac{CI}{N_T}$$

Customer Average Interruption Frequency Index (“CAIFI”)

63. This measures the average number of interruptions per customer interrupted per year. It is calculated as the number of interruptions that occurred divided by the number of customers affected by the interruptions. For the denominator of this parameter, an end-user is counted once regardless of the number of interruptions experienced in the period.

$$CAIFI = \frac{\text{Cumulative no. of customers interrupted}}{\text{Total no. of customers interrupted}}$$

To calculate the index,

$$CAIFI = \frac{\sum N_i}{CN} = \frac{CI}{CN}$$

System Average Interruption Duration Index (“SAIDI”)

64. This measures the average duration of interruptions, as the sum of the durations of the customer interruptions used for SAIFI, divided by the total number of customers.

$$SAIDI = \frac{\text{Aggregate duration of supply interruptions}}{\text{Total no. of customers served}}$$

To calculate the index,

$$SAIDI = \frac{\sum r_i N_i}{N_T} = \frac{CMI}{N_T}$$

Customer Average Interruption Duration Index (“CAIDI”)

65. This measures the average amount of time in a year that a customer’s electricity service is interrupted, as the sum of the customer-interruption durations as in SAIDI, divided by the number of customer-interruptions as in SAIFI.

$$CAIDI = \frac{\text{Aggregate duration of supply interruptions}}{\text{Cumulative no. of end users interrupted}} = \frac{CMI}{CI}$$

To calculate the index,

$$CAIDI = \frac{\sum r_i N_i}{\sum N_i} = \frac{SAIDI}{SAIFI}$$

Average Service Availability Index (“ASAI”)

66. This measures the average amount of time that electricity service is available to customers.

67. ASAI is a measure of the average availability of the network to serve customers. It is the ratio of the total customer minutes that service was available to the total customer minutes demanded in a period. It is normally expressed as a percentage.

$$ASAI = 1 - \frac{\text{Time that service was available to customers}}{\text{Time that service was demanded by customers}}$$

To calculate the index,

$$ASAI = \frac{N_T \times (\text{Number of hours/yr}) - \sum r_i N_i}{N_T \times (\text{Number of hours/yr})}$$

Note— There are 8,760 hours in a non-leap year and 8,784 hours in a leap year.

TD&R Licensee Performance Indicators - Efficiency

Transmission and Distribution (Network) Losses

68. Network losses are calculated as the ratio between the total electrical energy received from the generating plants and the total energy billed to all customers, expressed as a percentage value. The losses are measured over a defined period.

$$\% \text{ Losses} = \left[1 - \left(\frac{\text{Energy Billed to Customers (MWh)}}{\text{Total Energy Generated (MWh)}} \right) \right] \times 100$$

TD&R Licensee Performance Indicators – Environmental Impact

Number of spill incidents

69. Total number of chemical spills (including fuel oil and lubricating oil) exceeding 1 US gallon in a year, regardless of location or containment measures.

Bulk Generation Licensee Performance Indicators - Reliability

70. IEEE standard *IEEE 762-2006: Definitions for Use in Reporting Electric Generating Unit Reliability, Availability and Productivity* provides a structured approach to defining and selecting performance indicators for generation plants. Definitions are provided for individual units and for groups of units. The performance indicators listed below shall apply at the level of the generation fleet operated by an individual generation licensee.
71. Generators are required to report on the parameters described below.

Availability factor

72. IEEE 762 defines the availability factor (“AF”) of an individual unit as “the fraction of a given operating period in which a generating unit is available without any outages.” It is expressed in the following formula:

$$AF = \left(\frac{\text{Hours available}}{\text{Hours in period}} \right) \times 100$$

73. For a group of units, the formula given in IEEE 762 for the capacity-weighted availability factor (WAF) is:

$$WAF = \left(\frac{\sum(\text{Hours avail.} \times \text{unit net max. capacity})}{\sum(\text{Hours in period} \times \text{unit net max. capacity})} \right) \times 100$$

Forced outage factor

74. IEEE 762 defines the forced outage factor (“FOF”) of an individual unit as “the fraction of a given operating period in which a generating unit is not available due to forced outages.” A “forced outage” is defined as an outage that “cannot be deferred beyond the end of the next weekend.”

75. The FOF is expressed in the following formula:

$$FOF = \left(\frac{\text{Forced outage hours}}{\text{Hours in period}} \right) \times 100$$

76. For a group of units, the formula given in IEEE 762 for the capacity-weighted forced outage factor (“WFOF”) is:

$$WFOF = \left(\frac{\sum(\text{Forced outage hours} \times \text{unit net max. capacity})}{\sum(\text{Hours in period} \times \text{unit net max. capacity})} \right) \times 100$$

Planned outage factor

77. IEEE 762 defines the planned outage factor (“POF”) of an individual unit as “the fraction of a given operating period in which a generating unit is not available due to planned outages.” A “planned outage” is defined as an outage “where a unit is unavailable due to inspection, testing...or overhaul. A planned outage is scheduled well in advance.”

78. The POF is expressed in the following formula:

$$POF = \left(\frac{\text{Planned outage hours}}{\text{Hours in period}} \right) \times 100$$

79. For a group of units, the formula given in IEEE 762 for the capacity-weighted planned outage factor (“WPOF”) is:

$$WPOF = \left(\frac{\sum(\text{Planned outage hours} \times \text{unit net max. capacity})}{\sum(\text{Hours in period} \times \text{unit net max. capacity})} \right) \times 100$$

Unavailable generation

80. The unavailable generation (“UG”) indicator gives an indicator of the availability and capacity of a generation unit or group of units. IEEE 762 defines UG as “the energy that could not be generated by a unit due to planned and unplanned outages and unit deratings.”
81. The UG for a single unit is expressed in the following formula:

$$UG = (\text{planned outage hours} + \text{unplanned outage hours} + \text{derated hours}) \times \text{maximum capacity}$$

82. The de-rated hours factor is expressed as equivalent unit de-rated hours (“EUNDH”) in IEEE 762 and is intended to account for periods where units are available for generation, but their capacity is limited.
83. The UG for a group of units is calculated as follows:

$$UG_{Group} = \sum \{ (\text{planned outage hours} + \text{unplanned outage hours} + \text{derated hours}) \times \text{max. capacity} \}$$

Generator unit trips

84. This indicator measures the number of generator unit trips within a specified period. A generator trip occurs if a generator experiences an unplanned outage from an in-service state that required it to be removed from service immediately. This is termed by IEEE 762 as a “Class 1 unplanned outage”.

Bulk Generation Licensee Performance Indicators - Efficiency

Heat rate

85. Heat rate, expressed in kJ/kWh, is a measure of the efficiency of conversion of fuel to electricity, defined as follows:

$$\text{Heat Rate} = \frac{\text{Energy content of fuel consumed}}{\text{Energy delivered to the grid as active power}}$$

Bulk Generation Licensee Performance Indicators - Environmental Impact

86. Generators that rely on combustion of carbon-based fuels produce gaseous emissions that can be harmful to the environment. Generators are required to report on the parameters described below.

Opacity exceedances

87. This indicator measures the number of occasions in a calendar year that the gaseous emissions have exceeded an average opacity of 20 percent over a test period of six minutes, when measured according to the requirements of licenses granted under the Clean Air Act 1991. Generators should report the number of permitted exceedances and the number of non-permitted exceedances as defined pursuant to licenses granted under the Clean Air Act 1991.

Gaseous sulphur dioxide (SO₂) exceedances

88. Number of occasions in a calendar year that the gaseous sulphur dioxide (SO₂) emissions have exceeded the following values:
- 450 µg/m³ average over a 1-hour period;
 - 150 µg/m³ average over 24-hour period; and
 - 30 µg/m³ average over a 1-year period.
89. This parameter is based on requirements of licenses granted under the Clean Air Act 1991 and Clean Air Regulations 1993.

Gaseous nitrogen dioxide (NO₂) exceedances

90. Number of occasions in a calendar year that the gaseous nitrogen dioxide (NO₂) emissions have exceeded the following values:
- 400 µg/m³ average over a 1-hour period;
 - 200 µg/m³ average over 24-hour period; and
 - 60 µg/m³ average over a 1-year period.
91. This parameter is based on requirements of licenses granted under the Clean Air Act 1991 and Clean Air Regulations 1993.

Total suspended particles exceedances

92. Number of occasions in a calendar year that the total suspended particles in gaseous emissions have exceeded the following values:
- 100 µg/m³ average over 24-hour period; and

- 60 µg/m³ average over a 1-year period.

93. This parameter is based on requirements of licenses granted under the Clean Air Act 1991 and Clean Air Regulations 1993.

Inhalable particulate matter (PM₁₀) exceedances

94. Number of occasions in a calendar year that the Inhalable particulate matter (PM₁₀) in gaseous emissions have exceeded the following values:

- 50 µg/m³ average over 24-hour period; and
- 30 µg/m³ average over a 1-year period.

95. This parameter is based on requirements of licenses granted under the Clean Air Act 1991 and Clean Air Regulations 1993.

Carbon monoxide and carbon dioxide volumes

96. The average volumes of carbon monoxide (CO) and carbon dioxide (CO₂) produced per unit of electricity produced each month, measured in kg/MWh.

Concentration of sulphur oxides in gaseous emissions

97. The average concentration of sulphur oxides (SO_x) in gaseous emissions for each month, measured in µg/m³.

Concentration of nitrogen oxides in gaseous emissions

98. The average concentration of nitrogen oxides (NO_x) in gaseous emissions for each month, measured in µg/m³.

Concentration of total suspended particles in gaseous emissions

99. The average concentration of total suspended particles in gaseous emissions for each month, measured in µg/m³.

Concentration of inhalable particulate matter (PM₁₀) in gaseous emissions

100. The average concentration of inhalable particulate matter (PM₁₀) in gaseous emissions for each month, measured in µg/m³.

Concentration of mercury in gaseous emissions

101. The average concentration of mercury in gaseous emissions for each month, measured in µg/m³.

Concentration of volatile organic compounds in gaseous emissions

102. The average concentration of volatile organic compounds in gaseous emissions for each month, measured in $\mu\text{g}/\text{m}^3$.

Number of spill incidents

103. Total number of chemical spills (including fuel oil and lubricating oil) exceeding 1 US gallon in a year, regardless of location or containment measures.