Rule of Calculation of the Electricity Normative Losses

Article 1. Goals and Objectives of the Rule

1. Rule of Calculation Electricity Normative Losses (hereinafter the Rule) sets principles and rule of calculation of electricity energy normative losses in electrical networks for transmission and distribution licensees (hereinafter the Licensees).

2. Georgian National Energy and Water Supply Regulatory Commission (hereinafter the GNERC) approves electricity normative losses, which are calculated using this rule, separately for transmission and distribution licensees.

3. The terms used in this Rule has the same meaning as in Georgian Law on “Electricity and Natural Gas”, also in "Electricity (Capacity) Market Rules" approved by Ministry of Energy and in tariff methodology approved by Commission

Article 2. Electricity Normative Losses

1. Electricity normative losses shows allowed outlay of electricity, which appears during electricity transmission and distribution and calculated in accordance with Article 3

2. Compensation for normative losses appeared during transmission and distribution of electricity will be reimbursed by applicable law.

3. Electricity normative losses consists technical losses, own consumption of electricity by substation and commercial losses (set standard- no more than 5%).

4. Technical losses appears during transportation of electricity with wires and electrical devices. Technical losses are divided into two groups: no-load losses and load losses.

a) No-load losses include:

a. a) Losses in power transformers.

a. b) Losses of reactive power in compensating equipment.

a. c) Losses in potential transformers and in high frequency communication equipment.

a. d) Losses in cable lines isolation.

a. e) Electrical losses on crown.

a. f) Losses caused by electricity leakage on the surface of transmission lines insulator.

b) Load losses include:

b. a) Losses in overhead and cable lines.

b. b) Losses in power and booster transformers.

b. c) Losses in current transformers and potential transformers.

b. d) Losses in high frequency traps.

b. e) Losses in reactors.

b. f) Losses in convertor devices.

5. Electricity outlay for own consumption is required amount of electricity to ensure well-functioning of substation and operation staff working conditions and used for the following purposes:

a.) Cooling of transformers.

b.) Substation building lighting, heating, ventilation - air conditioning and provision showers with hot water.

c.) Lighting of substations' territory.

d.) To provide accumulator charging-discharge machines functioning.

e.) Operative circuit and control circuit supply in substations.

f.) Breaker reservoirs and gear heating.

g.) Heating of voltage distribution devices (with relay protection and automatics, meters and switches) and outdoor relay boxes;

h.) Divider and short circuit switcher heating.

i.) Heating of transformer on-load tap changer devices motors and oil reservoirs;

j.) Heating of motor operated breakers.

k.) Meter heating in unheated buildings.

l.) Heating of aggregate cases and air-switchers control cases.

m.) Supply of compressor.

n.) Heating of air-collectors.

o.) Electricity outlay in synchronous compensators or in ancillary devices.

p.) Electric power supply of communication and telemechanics apparatus.

q.) Small repair work during operation process.

r.) electricity lost in different pumps, distillers, small machines and devices.

6. Commercial losses of electricity are:

a.) electricity losses that are caused by technical characteristics of metering system elements (potential and current transformers, meters, etc.) and operational regimes.

b.) Electricity losses caused by improper organization of electricity metering process.

Article 3. Rules for setting electricity normative losses

1. Internationally approved principles of incentive regulations are used for determination of electricity normative losses, which:

a) Is based on the principle, that distribution and transmission licensees must reflect actual outlay of electricity in electricity normative losses for next regulated period.
b) Gives motivation to licensees to reduce the actual outlay.

2. Electricity normative losses are determined for each regulated period and defined individually for distribution and transmission licensees by GNERC. Electricity normative losses are determined for previous year of the regulation period – in tariff calculation (t). The normative loss for regulated period is set on the basis of the test year (t-1), by the following rule:

a) Average percentage (l^f_{aver}) of the electricity actual losses for previous three years $\left(l^f_{t-2}, l^f_{t-3}, l^f_{t-4}\right)$ of the test year (t-1) is defined according to the following formula:

$$l^f_{aver} = \frac{1}{3}\left(l^f_{t-2} + l^f_{t-3} + l^f_{t-4}\right) \qquad (1);$$

b) Average trend (T_{aver}) of electricity actual outlay for previous three years $\left(l^f_{t-2}, l^f_{t-3}, l^f_{t-4}\right)$ of the test year (t-1) is defined according to the following formula:

$$T_{aver} = \frac{1}{2}\left[\frac{l^f_{t-4} - l^f_{t-3}}{l^f_{t-4}} + \frac{l^f_{t-3} - l^f_{t-2}}{l^f_{t-3}}\right], \qquad (2);$$

c) Expected percentage result (l^{ex}_{t-1}) of electricity actual outlay for the test year (t-1) is defined according to the average annual trend:

$$l^{ex}_{t-1} = (1 - T_{aver}) * l^f_{aver} \qquad (3);$$

d) Expected result of electricity actual outlay (l^{ex}_{t-1}) is compared to actual electricity loss (l^f_{t-1}) of the same year and the smallest between them is chosen as normative loss (target value) for the next regulatory period:

$$l^n_{rp} = MIN(l^{ex}_{t-1}, l^f_{t-1}) , \qquad (4).$$

3. If test year (t-1) trend is uprise or avarage index of the trend equals to zero, or network company does not have previous three years history, or network structure or/and loads has been significantly changed, following rule is used for calculation of normative losses for the next year:

a) Expected result of actual outlay (l^{ex}_{t-1}) for testing year is determined by using comparative analysis (benchmarking) method (using historical data of similar or same company) in accordance with paragraph 2, subparagraph c of this article.

b) Electricity technical losses and own consumption (l^{t+oc}_{t-1}) are calculated by standardize methodology or certified software product.

c) Normative losses of regulated period are determined as a minimum value between expected result of actual outlay as per paragraph “a” and electricity technical losses increased by 5% as per paragraph “b”:

$$l_{rp}^{n} = MIN[l_{t-1}^{ex}, (l_{t-1}^{t+oc} * 1{,}05)] \qquad (5).$$

Article 4. Actual outlay of electricity

1.) Electricity actual losses is the sum of electricity actual losses and own consumptions of electricity. Electricity actual losses is calculated as a difference between electricity supplied and received in transmission and distribution network (without electricity outlay for own consumption) calculated according to metering devices.
2.) Electricity actual outlay includes electricity technical and commercial losses
3.) Actual losses of transmission and distribution network is calculated by metering devices, totally and according to the different voltage levels.
4.) In exceptional cases, when metering system is not fully complete and only sum of electricity actual losses is known, electricity losses in different voltage level will be allocated according to the principles in article 6.

Article 5. The principles for determining electricity actual losses

1. During calculation of electricity actual losses Licensee shall use values and formulas described in this article.

2. Total amount of electricity received in transmission or distribution network by transmission or distribution licensees equal to the sum of the electricity amount received on the each voltage levels of the transmission or distribution network and calculated according to the following formula:

$$E_{r.\Sigma} = \sum E_{r.i} \ , \qquad (6),$$

where:

$E_{r.\Sigma}$ – Total amount of electricity received in transmission or distribution network by transmission or distribution licensees (kWh)

$E_{r.i}$ – amount of electricity received on the i-voltage levels (500, 400, 330, 220, 110, 35, 10, 6, 3,3 and 0.4 kV) of transmission or distribution network by transmission or distribution licensees (kWh)

3. Total amount of electricity which was delivered and billed (in case of fault of metering system amount of billed electricity is calculated according to the current legislation) from the

transmission or distribution network by the transmission or distribution licensees equals to the sum of the electricity delivered and metered from each voltage levels of transmission or distribution network and calculated according to the following formula:

$$E_{d.\Sigma} = \sum E_{d.i}\ , \quad (7),$$

where:

$E_{d.\Sigma}$ – Total amount of electricity which was delivered and billed from the transmission or distribution network by the transmission or distribution licensees (kWh);

$E_{d.i}$, – amount of electricity delivered or billed from the i-voltage levels (500, 400, 330, 220, 110, 35, 10, 6, 3,3 and 0,4 kV) of transmission or distribution network by transmission or distribution licensees (kWh)

4. Total actual losses of electricity in the transmission or distribution network of the transmission or distribution licensees is calculated according to the following formula:

$$\Delta E_{\Sigma} = E_{r\Sigma} - E_{d.\Sigma} - E_{oc.\Sigma} = \sum \Delta E_i \quad ,(8)$$

where,

ΔE_{Σ} – Total actual losses of electricity in the transmission or distribution network of the transmission or distribution licensees (kWh);

ΔE_i – Total actual losses of electricity in the i-voltage levels (500, 400, 330, 220, 110, 35, 10, 6, 3,3 and 0,4 kV) of transmission or distribution network of transmission or distribution licensees (kWh)

$E_{oc.\Sigma}$ – Total own consumption of electricity in the substations of the transmission or distribution licensees (kWh).

5. Total own consumption of electricity in the substations of the transmission or distribution licensees is equal to the sum of the own consumptions on each voltage levels of the transmission or distribution network and calculated according to the following formula:

$$E_{oc.\Sigma} = \sum E_{oc.i}, \quad (10)$$

where:

$E_{oc.i}$ – Own consumption of electricity in i-voltage level (500, 220, 110, 35, 10 and 6 kV) substations of the transmission or distribution licensee's network (kWh).

6. Total actual outlay in the transmission or distribution network of the transmission or distribution licensees includes sum of the electricity losses in the transmission or distribution network and total own consumption of electricity in the substations of the transmission or distribution licensees and calculated according to the following formula:

$$E_{\Sigma} = \Delta E_{\Sigma} + E_{oc.\Sigma} = \sum E_i, \quad (11),$$

where:

E_{Σ} – Total actual outlay in the transmission or distribution network of the transmission or distribution licensees (kWh);

E_i – Total actual outlay of electricity on the i-voltage level of the transmission or distribution network of the transmission or distribution licensee (kWh).

7. Percentage ($l_i^f\,\%$) of the total actual outlay of electricity by voltage levels is set according to the following formula:

$$l_i^f\,\% = \frac{E_i}{E_{r\Sigma}} \times 100\% \quad (12).$$

8. Sum of the percentages of the total actual outlay of electricity is set according to the following formula:

$$l_{\Sigma}^{f}\,\% = \sum l_{i}^{f}\,\%$$, (13)

9. In case of electricity is transmitted from distribution network in transmission network

a) For calculation of the actual electricity losses in corresponding distribution network, amount of electricity delivered to transmission network is subtracted to the amount of electricity received in the network ($\sum E_{d.i}^{tr}$):

$$E_{r\Sigma}^{\prime} = \sum E_{r.i} - \sum E_{d.i}^{tr}$$ (14);

b) Percentage of actual outlay in distribution network is determined by dividing total actual outlay calculated in accordance with paragraph 6 of this article by electricity amount received in distribution network calculated in accordance with subparagraph a of this paragraph ($E_{r\Sigma}^{\prime}$):

$$l_{i}^{f}\,\% = \frac{E_{i}}{E_{r\Sigma}^{\prime}} \times 100\%$$, (15).

10. In case if electricity transit, carried out through electricity transmission network, the network owner is obliged to:

a) Submit information about transit route, amounts and transit losses in the Electricity Loss Report separately;

b) Electricity losses from transit is not included in the normative losses of the transmission licensee.

Article 6. Allocation principles of electricity actual losses and outlay

1. Allocation of electricity technical outlay by voltage levels shall be based on metering data.

2. In case of metering system is not fully complete and only actual total losses is known, allocation of electricity losses shall be done according to different voltage levels based on the following principles:

a) Actual total loss is comprised of two enlarged empirical components:

a.a) no-load losses in transformers is taken within 15% range, according to expert evaluation;

a.b) load losses in overheads and cable lines is taken within 85% range, according to expert evaluation;

a.c) No-load losses on i-voltage level is allocated proportional to transformer capacities on the given level. Load losses is allocated proportional to energy received on given level and disproportional to the square of equivalent voltage relative indicator.

b) The first (upper) voltage level electricity losses is determined as part of total losses and calculated according to the following formula (kWh):

$$\Delta W_1 = \Delta W_\Sigma \left[0.15 \frac{S_1}{S_\Sigma} + 0.85 \frac{W_{r.1}}{W_{r.\Sigma}} \left(\frac{U'_{eq}}{U_{eq.1}} \right)^2 \right], \qquad (16),$$

where:

ΔE_Σ – actual total losses of electricity (kWh);

$E_{отп.1}$ – total amount of electricity received on the first voltage level (kWh);

$E_{r.\Sigma}$ – total amount of electricity received in the network (kWh);

S_Σ – total capacities of transformers (kVA);

S_1 – total capacity of transformers on the first level (kVA);

u'_{eq} – voltage equivalent amount of losses in the moment of receiving electricity.

For instance:

$$u'_{eq} = \sqrt{\frac{U_{110}^2 * l_{110} + \cdots + U_{0,4}^2 * l_{0,4}}{l_{110} + \cdots + l_{0,4}}} \qquad (17);$$

$u_{eq.1}$ – voltage equivalent amount of given voltage levels. For instance:

$$u_{eq.1} = \sqrt{\frac{U_{110}^2 * l_{110} + U_{35}^2 * l_{35}}{l_{110} + l_{35}}} \qquad (18);$$

$U_{110}, U_{35,\dots} U_{0.4}$ – voltage levels (110, 35, 10, 6, 3.3 , 0.4) (kV)

$l_{110}, l_{35}, \dots l_{0.4}$ – overhead and cable line length of given voltage levels (kM)

C) Amount of transmitted electricity from the first level to the second level shall be equal:

$$E_{1,2} = E_{r.1} - \Delta E_1 - E_{d.1} - E_{oc.1}, \quad (19),$$

where:

ΔE_1 – Electricity losses in the first level grid (kWh);

$E_{d.1}$ – Total amount of electricity delivered and billed from the first voltage level of the network (kWh);

$E_{oc.1}$ – Own consumption of electricity in the first voltage level substations (kWh).

D) Energy received on the second voltage level network shall be equal to the energy received from another network to this level $E_{r.2}$ plus energy received from upper level to the given level ($E_{1,2}$) (kWh). Adequately, network losses in the second voltage level will be equal (kWh):

$$\Delta W_2 = (\Delta W_\Sigma - \Delta W_1)\left[0.15\frac{S_2}{S_\Sigma} + 0.85\frac{W_{r.2} + W_{1,2}}{W_{r.\Sigma}}\left(\frac{U''_{eq.}}{U_{eq.2}}\right)^2\right] \quad (20),$$

where:

u''_{eq} - voltage equivalent amount of losses in the moment of receiving electricity on the second voltage level. For instance:

$$u''_{eq} = \sqrt{\frac{U_{10}^2 * l_{10} + \dots + U_{0,4}^2 * l_{0,4}}{l_{10} + \dots + l_{0,4}}}, \quad (21);$$

$u_{eq.2}$ - voltage equivalent amount on the second voltage level. For instance:

$$u_{eq.2} = \sqrt{\frac{U_{10}^2 * l_{10} + U_6^2 * l_6 + U_{3,3}^2 * l_{3,3}}{l_{10} + l_6 + l_{3.3}}} \quad (22).$$

e) Losses on the next levels will be calculated similarly by same logic as in subparagraphs c and d of this paragraph.

f) Electricity losses in the network of the last voltage level will be equal to:

$$\Delta E_3 = \Delta E_\Sigma - \Delta E_1 - \Delta E_2 , \qquad (23).$$

3. This article can be used for the allocation of actual electricity outlay in electricity distribution network only (110; 35; 10; 6; 3.3; 0.4 kV voltage levels) with the consent of the Commission.

Article 7. Approval and reporting of normative losses

1. Transmission and distribution licensees should submit information about actual technical losses to the Commission within applicable time periods pursuant to the current legislation

2. If significant changes in the network structure and/or loads in the short term are not envisaged in the electricity network of transmission and distribution licensees, normative losses will be set according to the regulatory period.3. If significant changes in the network structure and/or loads occurred in the electricity network of transmission and distribution licensees during the regulatory period and led to more than ±10% change of actual losses in the network of the licensee in respect to normative losses approved by the Commission in the electricity network of transmission and distribution licensees the Commission is authorized to recalculate normative losses after submission of the proper justification and actual data by the Licensee to the Commission.

4. In case of justified claim provided by the Licensee correction of normative losses' structure is allowed (reallocation between voltage levels)