Appendix 2
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METHODOLOGIES

On Electricity Calculation used for Internal Needs of 0.38-35 kV Electricity Network

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YEREVAN

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Methodologies on Calculation of Consumed Electricity for Internal needs of 0.38-35 kV Electricity Networks

1.General Provisions

1. The amount of electricity used for internal needs of distribution companies serves as a guidance of control and planning of that actual consumption, as well for improving operation mode of consumers of internal needs.

2. Calculations shall be carried out by applying analytical method and by studying operational method for each consumer of internal needs separately. Electricity calculation used for internal needs shall be implemented within each settlement period (month, year).

3. Within the framework of these Methodologies, operation modes of consumers of internal needs shall be selected in the electricity calculation used for internal needs of distribution companies to meet the following conditions:

   a) Provision of normal technical condition of all devices installed in the buildings by normal implementation of operation;

   b) Provision of operation of all devices installed in the buildings by applying outstanding methods;

   c) Implementation of organizational-technical activities targeted to the economic consumption of electricity.

2. Composition of Electric Consumption Appliances for Internal Needs of Distribution Networks

1. The list of internal needs consumers in distribution networks comprises the following:

- Oil shop, motor-vehicle park, mechanization bases;
- Educational and testing centers;
- Equipment and material storages;
- Administrative buildings, library, medical center, residential buildings, rest rooms for construction personnel, specialized lab buildings;
- Shelters, fire-fighting and military protection buildings;

- Mantling, calibration and testing operations executed by electric networks and power system personnel;

- Service and residential premises for substation operative personnel.

2. The following is not included in the electricity consumption for internal needs in distribution networks:

   - Electricity consumed by the organizations having separate balance under administrative subordination of distribution networks (repairing-mechanical, ferro-concrete structures, wood-working and testing factories, specialized constriction and mantling organizations, specialized constructive and design organizations);

   - Electricity consumed for heat, water supply and lighting for workers' towns, personnel involved in repairing and operation activities, separate residential buildings, canteens, dormitories, hotels, clubs, hospitals, kinder gardens, resting areas and other premises.

The Consumed electricity for each of the listed consumers shall be recorded as energy of the outsider consumers and is included in the statements in compliance with the corresponding articles of delivered useful energy.

3. Electricity Calculation Used for Internal Networks of Distribution Electric Networks

1. Electricity calculation used for internal needs shall be conducted for each month or a year, including the following:

   - Energy consumption necessary for heating of the installed buildings (areas);
   - Electricity consumption for lighting;
   - Energy consumption for power facilities.

2. It is necessary to take into consideration environmental conditions in determining electricity consumption necessary for heat supply of the buildings. Calculation introduced in the Methodologies is provided on annual basis and for "mild, warm" climatic zone. This climatic zone is considered as basic for Armenia.

   Within the framework of these Methodologies territory of Armenia is dived into 4 climatic zones in compliance with the climatic conditions based on the altitude of the sea level:

   I zone - 1800m and higher

   2 zone - 1700-1800m

3 zone - 1100-1700m

4 zone- up to 1100m

Power system subdivisions are divided in compliance with four climatic zones (see table 1), where their environmental conditions are taken into account in compliance with the data of the corresponding nearest meteorological stations.

The amount of necessary heat:

$$(1)\ Q=\left[(F_w + F_c)K_w + F_l K_l\right](t_n - t_{est}) \quad (W), \tag{1}$$

where:

F_w - is total area of external walls of the construction (m^2),

F_c - is total area of ceiling (m^2),

$F_{ťáôë}$ - is total surface of windows (m^2),

K_w - is heat conductivity factor of the construction wall (is selected from reference books [1]) (W/Ù^2·K),

K_l - is heat conductivity factor of construction windows (is selected from reference books [1]) (W/Ù^2·K),

t_n - is required standard/normative temperature inside of the construction (18^0 C),

t_{est} - is average temperature of heating season within the RoA territory, estimated by meteorological service.

The amount of electricity in case of electricity usage for heat purposes during the heat season is the following:

$$(2)\quad W^h(I) = QT(I)\cdot 10^{-3} \text{ (kVh)},$$

where: T(1) - duration of the heat season for the given climatic zone.

The amount of electricity necessary during the heat season is divided based on months by the following formula:

$$(3)\quad W^h_{month} = K2(I,J)W^h(I) \text{ (kVh)},$$

Where: K 2 (1,J) - factor-relative unit (r.u.), which takes into consideration the portion of electricity used for heating based on months and climatic zones

I- number of the climatic zone;
J- name of the months of the year.

K 2 (1,J) – the value of the factor is taken from Table 2.

The annual amount of electricity necessary for heating:

(4) $$W_{\text{year}}^{\text{h}} = \sum_{i=1}^{n} W_{\text{month}}^{\text{h}} \text{ (kVh)},$$

Where: n – number of months in a year.

3. For calculation of electric energy consumption necessary for artificial lighting of ancillary and internal needs of buildings and structures, the amount of luminous flux of lamp (lamps) is determined:

$$\Phi = \frac{100 E_1 k_s S Z}{N h} \quad \text{(Lumen)}, \qquad (5)$$

where:
E_1 - the lowest provided light (Lux),
S - lighting area (m^2),
N - number of lamps,
η- use factor (%),
k_s - safety factor, which takes into account the fact of decrease of the luminous flux increases during operation
Z - direction factor.

Amount E_1 is equal to [2]

$$El = \begin{cases} 50 \text{ l}ux, & for\ corridors, \\ 50 \div 200 \text{ l}ux, & for\ production \text{ buildings}, \\ 300 \text{ l}ux, & for \text{ work - rooms.} \end{cases}$$

Direction factor. [2]

$$Z = \begin{matrix} 1{,}15 & for \text{ incandescent lamps,} \\ 1{,}1 & for \text{ fluorescent and mercury lamps} \end{matrix}$$

Safety factor. [3]

$$k_{\text{å}} = \begin{cases} 1.3, & \text{for incandescent lamps,} \\ 1.5, & \text{for fluorescent and mercury lamps} \end{cases}$$

The use factor relating the size of the building is taken into account by –i- indice of the premises:

(6) $$\text{i} = \frac{\text{AB}}{\text{h}(\text{A}+\text{B})},$$

Where: A, B, h - corresponding length, weight and height of premises (m).

If i>5, then i =5. If A:B $\geq$ 10, then i =B/h.

For different types of lamps based on –i-, η-the values of the usage factor are determined in compliance with the walls, ceiling, as well as reflection factors of the floor area and reference book.

In accordence with Φ value, nearest standard lamp form the tables provided in the reference book is selected, the limen-lux can be differentiated from the calculated value in the amount of –10 ÷+20%.

The amount of designed load for artificial lighting for the buildings is the following:

(7) $$P_{\text{est}} = P_{\text{in}} K_{\text{d}} \text{ (kWh);}$$

Where:

$P_{in} = \sum P_i$ - Total designed capacity of lamps

K_d - Demand factor

P_i - Nominal capacity of the selected lamps.

Demand factor. [2]

$$K_d = \begin{cases} 1, & for\ emergency\ and\ \text{external lighting}, \\ 0.95, & for\ propduction\ buildings, \\ 0.9, & for\ admin\ istrative\ \text{buildings}, \\ 0.6, & in\ \text{storages}. \end{cases}$$

To calculate annual average consumption of electricity the number of the work hours of artificial lighting should be determined.

Number of working hours with artificial lighting:

$$T = t(A - a) \quad \text{(h)}, \tag{8}$$

where: t - number of daily working hours with artificial lighting ,

A - total number of days in a year,

a - number of non-working days.

Annual amount of electricity consumption for artificial lighting:

$$W_{year}^{l} = P_{est} T \quad \text{(kWh):} \tag{9}$$

4. For calculation of annual amount of electric energy consumption, necessary for ancillary and internal needs of power equipment, we will have to calculate the average capacity of electric consumption appliances during the shift with the highest load:

$$Pav = K_u P_{nom} \quad \text{(kWh)}, \tag{10}$$

where: K_u - use factor (is selected from reference books) [4]),

P_{nom}- nominal capacity of consumers.

Monthly amount of electric energy consumption is calculated by this formula:

$$W_{month}^{\text{áðÅ}} = P_{av} t_{month} \quad \text{(kWh)}, \tag{11}$$

where: t_{month} – number of working days of given consumer:

Annual amount of electric energy consumption:

$$W_{year}^{\text{áðÅ}} = \sum_{i=1}^{n} W_{month}^{\text{áðÅ}} \quad \text{(kWh):} \tag{12}$$

Table 1

Altitude From the Sea Level of Meteorological stations of the RoA Territory, Average Calculated Temperature and Duration in Winter Season

N	Meteorological station		Altitude from the sea level,m	Hetaing Season			
	N based (1)-Ç	Name		Averege temperature, °C	Duration, day	Beginning	End
I Climatic zone							
1	82	Saravan	2031	-3.2	210	9.10	7.05
2	11	Ashotsk	2009	-3.2	210	9.10	7.05
3	49	Gavar	1961	-1.5	200	14.10	2.05
4	69	Martuni	1945	-0.6	200	14.10	2.05
5	59	Sotk	1940	-2.2	215	6.10	9.05
6	39	Sevan	1936	-2.2	215	6.10	9.05
7	61	Vardenis	1930	-1.8	208	10.10	6.05
8	43	Shorja	1914	-0.8	205	12.10	5.05
9	35	Aparan	1891	-2.7	210	9.10	7.05
10	16	Amasya	1876	-2.6	212	8.10	8.05
Average				-2.1	209	10.10	7.05
I I Climatic zone							
11	45	Fantan	1798	-2.0	190	19.10	27.04
12	19	Jajur	1792	-2.2	204	11.10	5.05
13	42	Hrazdan	1765	-2.2	204	11.10	5.05
14	34	Artik	1750	-2.0	190	19.10	27.04
15	37	Maralik	1706	-2.2	194	17.10	29.04
Average				-2.1	196	15.10	29.04
I I I Climatic zone							
16	47	Talin	1582	-0.8	177	28.10	23.04
17	85	Arpan	1580	-0.1	194	17.10	29.04
18	89	Geghy	1558	1.0	170	1.11	19.04
19	27	Gymri 2	1556	-2.7	191	19.10	28.04
20	23	Spitak	1552	0.5	186	21.10	25.04
21	5	Tashir	1507	0.1	196	16.10	30.04
22	64	Jrvej	1410	-1.7	181	23.10	22.04
23	87	Goris 2	1398	1.9	174	1.10	23.04
24	13	Stepanavan	1397	0.2	190	19.10	27.04
25	25	Vanadzor	1350	0.7	186	21.10	25.04
26	79	Yeghegnadzor	1267	0.2	150	10.11	10.04
27	52	Arzni	1262	-0.2	161	6.11	15.04
28	29	Dilijan	1256	1.6	180	23.10	21.04
29	50	Aragats c.	1254	1.8	170	1.11	19.04

N	Meteorological station		Altitude from the sea level,m	Hetaing Season			
	N based (1)-Ç	Name		Averege temperature, °C	Duration, day	Beginning	End
Average				0.0	179	24.10	21.04
IV Climatic zone							
30	53	Ashtarak	1090	0.1	148	17.11	14.04
31	57	Karakert	1085	-0.7	151	15.11	16.04
32	63	Yerevan sem.	1042	-0.4	145	18.11	12.04
33	81	Arpy	1009	-0.2	143	19.11	11.04
34	66	Yerevan s. gh.	951	-0.7	144	18.11	11.04
35	62	Yerevan agro	942	-1.0	145	18.11	12.04
36	68	Yerevan	910	0.2	138	22.11	9.04
37	72	Armavir village	875	0.9	145	18.11	12.04
38	67	Armavir	861	-0.2	145	18.11	12.04
39	65	Edjmiadzin	853	0.1	144	18.11	11.04
40	74	Artashat	829	0.1	142	20.11	11.04
41	78	Ararat	818	0.2	137	22.11	8.04
42	80	Yerasgh	802	-1.0	135	23.11	7.04
43	3	Koghb	743	1.8	148	17.11	14.04
44	22	Ijevan	732	2.8	151	15.11	16.04
45	6	Alaverdi	721	2.3	160	12.11	20.04
46	21	Berd	717	2.4	156	14.11	10.04
47	90	Kapan	705	2.8	143	20.11	12.04
Average				0.5	146	18.11	13.04

Table 2

Allocation of Annual Electricity Consumption of the Premises on monthly basis

r.u.

Name of the factor	Climatic zone	Months (J)												Year
		I	II	III	IV	V	VI	VII	VIII	IX	XI	XI	XII	
Heating of the premises K2(I,J)	1	0.148	0.134	0.148	0.144	0.033	0	0	0	-	0.101	0.144	0.148	1
	2	0.158	0.143	0.158	0.148	0	0	0	0	0	0.082	0.153	0.158	1
	3	0.173	0.156	0.173	0.118	0	0	0	0	0	0.039	0.168	0.173	1
	4	0.212	0.192	0.212	0.089	0	0	0	0	0	0	0.083	0.212	1

Note

Value of K2(I,J) shall be determined.

$$K2(I,J) = T(J) / T_1(I),$$

Where: $T(J)$ - Number of days in the heating month;

$T_1(I)$ - Number of the heated average annual days of a year.

The values of T(J), T_1(I) are taken form Table 1 for the corresponding climatic zones.