

## **Application of Electrical Engineering Knowledge in the Work Considering Litigation of Electricity**

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### **Introduction**

Electrical energy to be produced, sold, delivered, supplied, maintained and consumed has to be properly managed and precise accounts have to be kept. At present, the requirement for solving accurate and correct accounting of electricity consumption problems is considered one of the major problems to be analyzed and studied in countries with developing economies, in other words, they are related to the issues of damage caused and income lost.

Generally speaking, Lithuania exhibits a tendency to have legal cases on illegal supply of electric energy as well as cases dealing with forgery of the accounts on electricity bills. Provided a supplier and consumer are unable to settle a dispute in between they have to be judged in courts of corresponding instances.

But in practice, the number of such already decided cases in Lithuanian Courts, namely cases of illegitimate consumption of electrical energy and false accounting between electricity producers, operators of transmission and distribution is not qualified in abundance and from the point of view of jurisdiction are not relevant.

The other situation concerns disputes held between electrical energy suppliers on the one hand and consumers on the other hand. Disputes on energy issues are rather frequent in the jurisdiction institution of Lithuania. Most often these disputes are related to unlawful electrical energy consumption or counterfeiting certain amounts of electricity used. During the process when operators supply electrical energy and consumers reimburse for that supply, the most significant fact is the reliable, proper and accurate keeping of accounts.

Therefore, the specific knowledge of electrical engineering is a vital issue in solving the mentioned above type of legal disputes.

The court practice proves that the knowledge of electrical engineering and its application in solving disputable legal cases distinguishes itself by unusual

peculiarities, which are presented in this article.

### **Some legal aspects**

The Law on Electrical Energy of Lithuania regulates the electrical energy supply and consumption in Lithuania. Based on the law the Minister of Economy of Lithuania approved the regulations on Electrical Energy Supply and Consumption. The regulations govern the order of supply, delivery and accounting of the consumed amount of power supply.

The Supreme Court of Lithuania highlights the requirements of regulations to be mandatory both for the suppliers and consumers of electricity.

In accordance with the regulated order for energy suppliers and consumers the parties in charge are obliged to follow binding regulations by signing the agreement 'On Energy Supply-Consumption'. They have to honor their commitments following the agreement and in case of violating the negotiated agreement they are liable for infringement of contractual liability.

The court rules, there is liability to cover the damage caused by incorrect and deceitful accounting of electrical energy. The Civil Code of the Republic of Lithuania defines the situation in article 6.249, part 1, in a detailed way. The monetary aspect of damage is considered to be the loss.

The Supreme Court of Lithuania regulates that the principle of applying any liability is to enter a plea of guilty. Therefore, the court is able to find a legal person or a person in kind guilty by submitting a claim for damages due to forgery in accounting and unlawful consumption of electrical energy. Because this malicious act committed is related to punitive actions in the field of engineering, the qualified knowledge of an electrical engineer is required to be able to investigate and state the case in court. Technical norms and standards are eligible for passing a sentence or giving a decision on a case. Technical norms and standards are approved to be legitimated and have to be observed in

legal procedures [1–3].

### Peculiarities of electrical energy accounting

As court practices indicate, the damage to electrical energy supplier is most frequently caused by a consumer who consumes energy without possessing the required energy accounting or measuring devices and by false keeping of accounting, by presenting incorrect readings of meters.

To account the consumption of electrical energy the electric meters have to be applied. A consumer covers the costs to a supplier strictly following the readings on the meters. False accounting is mostly committed by falsifying the readings on the meters.

To forge the readings means modify the principal of operation of a meter by destroying its regular operational process. To determine the measures and tools applied for false accounting as well as determining the disturbance of operation is capable to execute only an electrical engineer because it is considered to be the objective of an electrical engineering. The knowledge of applying of electrical engineering is favorable in legal procedures.

Despite a great variety of energy meters available for accounting of electrical energy, at present there are two major groups if their principle of operation and electrical circuit is taken into account, namely they are energy meters of induction and electronic types. Due to the essential divergence regarding their mode of operation and electric circuits, the methods, means and ways of falsifying their readings vary greatly. Therefore, the two types of meters have to be analyzed separately. Due to the limited space in the article, the author presents only the induction types of meters to be applied for electrical energy accounting.

From the point of view of jurisdiction and electrical engineering they are obliged to satisfy the general requirement, because energy measuring means in addition to their diverge electronic and inductive characteristics have to comply to the standards regulated by the Law on Metrology of the Republic of Lithuania. To ensure these requirements is one of the most justifiable and allowed ways of accounting of electrical energy within the determined limits of accuracy. The issues of civic liability are interrelated with the regulations of Law on Metrology.

### Possible ways of induction meter falsifying and measures taken to detect them

The principle of induction energy meter operation is based on voltage  $U$  and currents  $I$  of magnetic flows  $\Phi_I$  and  $\Phi_U$  generated by coils and on the interaction of Foucault currents  $I_{sI}$  and  $I_{sU}$  induced by electromotive forces  $E_{\Phi I}$  and  $E_{\Phi U}$  in the rotating disk. A disk movement of a meter is caused under the influence of torque moment  $M_s$  and summarized resistance moment  $M_p$ . The mentioned above is presented in the schemes in Fig. 1 and in vector diagrams.

In accordance with the established operational mode of the torque of a disk it is determined by the equation

$$M_s - M_p = 0, \quad (1)$$

where  $M_s$  – the torque moment of a disk;

$M_p$  – is a summarized braking torque moment to a disk torque.

Then the regular operation of an induction meter could be disturbed exercising influence on  $M_s$  or  $M_p$ .

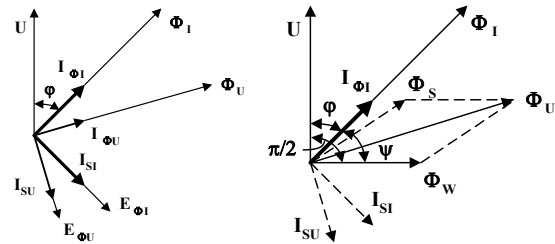


Fig. 1. Vector diagrams

It is known that the torque moment is equal to

$$M_s = k_1 \Phi_I \Phi_U \sin \psi, \quad (2)$$

$$\Phi_I = k_I I, \quad (3)$$

$$\Phi_U = k_U U, \quad (4)$$

where  $k_1, k_I, k_U$  – are the coefficients of proportionality;  $\psi$  – the phase angle between the fluxes.

As it is known from the theory of inductive type of devices, in order  $M_s$  to be proportional to value  $P$  of the load power, the equation has to be the following

$$M_s = kP = kUI \cos \varphi. \quad (5)$$

To satisfy the condition of equation (5), it is required to ensure that the structure of induction-type measuring instrument of a meter could satisfy the condition of  $\psi = \pi/2 - \varphi$ . Then it is  $\sin \psi = \cos \varphi$ . When some wires for short cut are put on the induction-type measuring instrument then it is possible to achieve that.

From equations (2), (3), (4) and (5) it is clear that to affect the torque movement of a disk through  $M_s$ , and at the same time to affect the reading of the meter it is possible via the electric values  $k_1, k_I, k_U, I, U$  and  $\varphi$ .

From equation (1) comes the following. To affect the rotation of a disk it is possible via the braking moment  $M_p$ . The moment consists of two components – moment  $M_{p1}$  generated by permanent magnet and moment  $M_{p2}$  generated by friction forces.

Besides that, in induction meters under the interaction of permanent magnet flow  $\Phi_{N-S}$  with Foucault current  $I_{S-N-S}$  there is generated the braking moment

$$M_{p1} = k_{N-S} I_{N-S} \Phi_{N-S}. \quad (6)$$

To compensate the force moment  $M_{p2}$  of disk friction both to air and friction forces in the supports of induction meters there are also applied special measures so called friction compensators.

In order the disk of the induction meter without the load under the influence of a compensator moment (disk

self-action mode) could produce no rotation, the adequate measures have to be applied in the induction meters.

The force moments acting on the disk of the induction meter could be expressed by the product of force  $F$  and geometric radius  $r$ , i.e.

$$M = F \cdot r. \quad (7)$$

To affect the rotation of a disk is possible not only by changing  $F$  by means of electric parameters, but also by changing the geometric radius  $r$  of these forces.

There are two major ways how to affect these parameters: 1) by changing the scheme of connection indicated by the producer of a meter; 2) by changing the scheme of internal connections of a meter or the structural parameters of its induction mechanism.

In order to limit these illegal actions, the covers of the socket box of meters have to be sealed by the seals made by producers and the casing of induction mechanism has to be made by producers (its repair is carried by the enterprise) and by applying seals owned by the institutions approving metrological verification.

To change the scheme of connection one has to break the seal of the socket box cover, and when changing the scheme of internal connection of a meter or structural parameters of its induction mechanism one has to break the seals of the casing of the induction mechanism.

From the point of view of legislation the braking of seals without determining the facts of the effect on the readings of a meter bears seldom proved value and carries only influential value. The problem of determining the evidences is based on the theory of induction device. Determining of these indications is the subject of electro-technical engineering and electrical engineering. The issues of electro-technical engineering and electrical engineering as a subject of science are the issues to be applied as „specified knowledge“ in judicial practice and require certain competence. However, in developing countries the tendency is still vital to consider that the source of specific knowledge could be only a person having an extensive practical experience (electricians-practitioners in the field of electrical engineering). When tolerating the tendency there used to be a lot of deviations from scientific competence towards the arty-crafty professionals of „specified knowledge“, the latter phenomenon was registered in judicial practice. In legal practice the concept “expert” means a very qualified professional, but the concept „professional“ – is a person having university education.

When applying the knowledge electrical engineering for detecting the falsifying of induction meter readings, there is essential not only the professional competence, but logical analysis required in determining methodologically proved facts.

After analyzing and summarizing the court expertise available there is proposed the following sequence to be observed when investigating a meter: 1) investigation of a meter externally; 2) self-action research; 3) sensitivity research; 4) research regarding the operation of a meter; 5) analysis of the transfer number of the calculating mechanism and determining of the constant of a meter; 6) analysis of a relative error of a meter; 7) analysis of the

scheme of internal connections of a meter and analysis of structural parameters of an induction mechanism.

If these methodological recommendations are followed and if the basic knowledge of electrical engineering is available, there is possible to determine the essential features valuable for legal practice. To determine the main evidence of falsifying there is enough to determine the main parameters of an induction meter.

One of the major parameters describing the reading of a meter is the transmission number  $A$  of a calculating mechanism, which expresses the number of disk rotations corresponding to 1 kWh of electrical energy and which is present in the table of a data of a meter.

Actual number of transmission

$$A_f = N_f / W_f \quad (8)$$

where  $N_f$  – the actual measured number of disk rotations;  $W_f$  – the corresponding number  $N_f$  of the measured amount of electrical energy in kWh.

If number  $A$  is known, the actual constant of a meter is calculated

$$C_f = 3600 \times 1000 / A_f, \text{ W/r.} \quad (9)$$

After determining  $C_f$  and in accordance with the nominal number  $A_{nom}$  as indicated in a data table of a meter following the expression (9), the nominal constant of a meter is calculated

$$C_{nom} = 3600 \times 1000 / A_{nom}, \text{ W/r.} \quad (10)$$

Then there is calculated in percentage the actual value of the relative error of a calculation mechanism

$$\delta_f = (C_{nom} - C_f) / C_f \times 100, \%. \quad (11)$$

When the values of  $A_f$  and  $A_{nom}$ ,  $\delta_f$  and  $\delta_{nom}$  are compared, there is determined the correspondence of induction meter readings to the actual ones and as well as the exact accuracy of the calculation.

If these parameters are determined it is possible to answer the question significant for legal practice, whether the readings of a meter correspond to the actual ones and to what accuracy in average it corresponds.

When the data are available it is possible further to continue the research and determine the ways the meters have been affected (if any impact is determined) on to the rotation of a disk of a meter or measures have been taken (an induction mechanism of a meters is analyzed).

The above mentioned technique to justify the accounting kept with the help of induction meters comprises assistance in solving legal disputes without any extra expenses, allows to respond expeditiously to urgent issues of legal practice and to increase the objectivity and efficiency of the research.

## Conclusions

The following conclusions have been derived after summarizing the material presented:

1. The application of methodologically correct knowledge of electrical engineering in court practice together with the legislation available comprises great

significance in responding to the disputable issues of falsifying electrical energy accounting and allow to avoid extensive investigation into the matter as well as increase the objectivity and efficiency of legal examination.

2. In cases of electrical energy false accounting only the scientists from electro-technical engineering field shall have the right to participate in the expertise to be carried out as the object of "specified knowledge" in court procedures or shall have the right the professionals from electrical engineering field trained for that purpose.

3. The results of the investigation of induction type meters have to be validated by the theory on induction type of devises.

## References

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3. **Radzevičius L., Radzevičius E.** Modern conception and competence of electrical forensic examination // Proceedings of the XV International Conference on Electromagnetic Disturbances EMD 2005, ISSN 1822-3249. – Technologija. – 2005. – P. 289–291.

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**L. Radzevičius, E. Radzevičius. Application of Electrical Engineering Knowledge in the Work Considering Litigation of Electricity // Electronics and Electrical Engineering. – Kaunas: Technologija, 2009. – No. 4(92). – P. 79–82.**

The article presents the application of electrical engineering knowledge in legal practice as the issues are becoming relevant. The issues dealing with application of engineering knowledge are described on disputes between suppliers and consumers regarding induction type of meters used in energy accounting. The recommendations are submitted how to solve the indicated problems with the help of theoretical engineering and how to increase the efficiency in legal practice on the issues mentioned. Ill. 1, bibl. 3 (in English; summaries in English, Russian and Lithuanian).

**Л. Радзевичюс, Э. Радзевичюс. Применение знаний электроинженерии в судебной практике при рассмотрении споров связанных со снабжением и использованием электрической энергии // Электроника и электротехника. – Каунас: Технология, 2009. – № 4(92). – С. 79–82.**

Рассматриваются всё большую актуальность приобретающие проблемы применения электроинженерных знаний в юридической практике. Анализируются особенности использования электроинженерных знаний при рассмотривании споров между поставщиками и пользователями в случаях учета электрической энергии индукционными счетчиками. Предлагаются рекомендации по повышению эффективности электроинженерных знаний в правовой практике и способы решения этих проблем. Илл. 1, библи. 3 (на английском языке; рефераты на английском, русском и литовском яз.).

**L. Radzevičius, E. Radzevičius. Elektros inžinerijos žinių taikymas teismų praktikoje, nagrinėjant ginčus, kylančius dėl elektros energijos tiekimo ir vartojimo // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2009. – Nr. 4(92). – P. 79–82.**

Apžariamos aktualėjančios elektros inžinerijos žinių taikymo teisinėje praktikoje problemos. Analizuojami elektros inžinerijos žinių panaudojimo, nagrinėjant elektros energijos tiekėjų ir jos vartotojų ginčus apskaitos indukciniais prietaisais atvejais, ypatumai. Pateikiama rekomendacijų, kaip didinti elektros inžinerijos žinių taikymo teisinėje praktikoje efektyvumą, ir pasiūlymai, kaip spręsti nurodytas problemas. Il. 1, bibl. 3 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).

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