STUDIJŲ KOKYBĖS VERTINIMO CENTRAS

Vilniaus Gedimino technikos universiteto

SAULĖS ELEMENTŲ IR MODULIŲ INŽINERIJOS STUDIJŲ PROGRAMOS (621J91001) VERTINIMO IŠVADOS

EVALUATION REPORT OF *SOLLAR CELLS AND MODULES ENGINEERING* (621J91001) STUDY PROGRAMME

at Vilnius Gediminas Technical University

Grupės vadovas:
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Išvados parengtos anglų kalba
Report language - English

Vilnius
2013

DUOMENYS APIE ĮVERTINTĄ PROGRAMĄ

Studijų programos pavadinimas	***Saulės elementų ir modulių inžinerija***
Valstybinis kodas	621J91001
Studijų sritis	Technologijos mokslų studijų sritis
Studijų kryptis	Technologijos
Studijų programos rūšis	Universitetinės studijos
Studijų pakopa	Antroji
Studijų forma (trukmė metais)	Nuolatinė (2)
Studijų programos apimtis kreditais	120
Suteikiamas laipsnis ir (ar) profesinė kvalifikacija	Energijos technologijos magistras
Studijų programos įregistravimo data	2011 birželio 22 d.

INFORMATION ON EVALUATED STUDY PROGRAMME

Title of the study programme	***Solar Cells and Modules Engineering***
State code	621J91001
Study area	Technology Sciences
Study field	Technologies
Kind of the study programme	University studies
Study Cycle	Second
Study mode (length in years)	Full-time (2)
Volume of the study programme in credits	120
Degree and (or) professional qualifications awarded	Master of Energy Technologies
Date of registration of the study programme	22 June 2011

CONTENTS

I. INTRODUCTION

The procedures of the external evaluation of Vilnius Gediminas Technical University (hereafter – VGTU) Master‘s study programme in *Solar Cells and Modules Engineering* (hereafter – *SCME)* were initiated by the Centre for Quality Assessment in Higher Education of Lithuania nominating the external evaluation peer group formed by the head, professor Sven Anders Flodström, professor Bernard Remaud, professor Adam Kiss, dr. Artūras Acus, dr. Irmantas Kašalynas, and Paulius Simanavičius, students' representative.

For the evaluation the following documents have been considered:

1. Law on Higher Education and Research of Republic of Lithuania;
2. Procedure of the External Evaluation and Accreditation of Study Programmes;
3. General Requirements of the Second Degree Study Programmes;
4. Methodology for Evaluation of Higher Education Study Programmes.

The basis for the evaluation of the study programme was the Self-Evaluation Report (hereafter – SER), its annexes and the site visit of the expert's team to VGTU on 23 of May 2013. The visit incorporated all required meetings with different groups: the administrative staff, staff responsible for preparing the self-evaluation documents, teaching staff, students of all years of study and employers. The experts' team evaluated various support services (classrooms, laboratories, library, and computer facilities). After the expert's team discussions and additional preparations of conclusions and remarks, introductory general conclusions of the site visit were presented. After the visit, the team met to discuss and agree the content of the report, which represents the experts' team consensual views.

The external evaluation of the experts' team is a considerable scientific expertise in Lithuania on semiconductor and material physics and chemistry. In a historical perspective it originates from the Soviet time, when Lithuania was a science and industrial centre for electronics. Nowadays it is pushed by Lithuania and also European Union structural funds to create new energy production in Lithuania. One of the initiatives in industry, research and higher education is related to solar cells elements and modules engineering. The Master's study programme in *SCME* is an offspring from this national development and as such is welcomed by Lithuanian companies in the energy sector. An important part of this study programme is not only the focus

on the actual mechanism for energy production, but to look for possible system solutions within different societal sectors as the building and transport.

II. PROGRAMME ANALYSIS

1. Programme aims and learning outcomes

The main aim of the study programme in *SCME* is to educate experts in the production and technological development of solar elements and modules which generate electricity. That is to say, study programme aims to provide highly skilled and rather narrow scoped professionals to the energy industry. It is necessary to highlight, that this trend is actively promoted and supported by European Union.

Looking closer to and analysing the aim definition in a detailed way, two strands distinguishes: one deals with the science and technology of the solar cells and relies on a strong basis in physics within solid state and semiconductor, also to a lower degree in chemistry within surface and thin film treatments. While the other – addresses the question of the production of solar modules and their integration in different systems, especially within the building and transport sectors. This is clearly a system engineering aspect on the use of solar cells.

Concerning the intended learning outcomes, they are defined and set along 4 axes: knowledge and application, abilities in the specific domain, personal and social abilities. The attention should be paid, that the intended learning outcomes appear more as a description of the curriculum, than operative approach to design the courses, improve and assess studies quality. A clearer assessment system based on the quality of the achievement of the intended learning outcomes should be implemented with participation of social partners, particularly for the "soft" skills (abilities described in the intended learning outcomes: *ability to choose effective research and development techniques and equipment for investigation of solar cells/modules; ability to examine the efficiency, reliability and wear of solar cells/modules, create and implement new technologies; ability to interpret theoretical and experimental results, classify in respect of their importance and reliability of the theories explaining them (SER SG1-SG4)* lack clear assessment methods).

Moreover regardless of the described links between study programme and study subjects intended learning outcomes (in the SER), the assessment procedures if students meet all expectations, particularly linked to the personal and social abilities, are also missing (*ability to properly and independently organise his/her work and take the decisions; ability to think critically and constructively, evaluate the qualitative and quantitative information, analyze it, and formulate conclusions; ability to communicate and collaborate, work in team; ability, through life-long learning, to apply professional knowledge in solution of energy technology*

problems; ability to convey information orally and in writing in a clear and proper manner (BG1 – BG5)). The experts‘ team also highly recommends to the Study Programme Committee review study programme aim and intended learning outcomes, seeking to clarify the relative weight between the engineering and the R&D competences, that students must acquire.

The experts‘ team has no doubts, that this recommendation will be perceived positively by the Study Programme Committee, because as is indicated in the SER and the interviews confirmed, that the intended learning outcomes are reviewed on annual basis, with the social stakeholders contribution.

The study programme aim and the intended learning outcomes are published on VGTU information system Alma Informatica, website of the Department of Physics, also Open Information, Counselling and Guidance System. However the experts‘ team noted, that exist significant differences between the intended learning outcomes stated in SER and the website version. This should be fixed.

2. Curriculum design

The experts’ team did not find anything that was against the legal acts requirements at the evaluation of the curriculum of *Solar Cells and Modules Engineering* study programme: duration of the study programme is 2 years for full-time study mode. The scope of the study programme is 120 ECTS credits. Curriculum consists of study field subjects (70 ECTS credits), optional subjects (13 ECTS credits), obligatory subjects, which are general at University level (6 ECTS credits), preparation and defence of final theses (39 ECTS credits). Professional activity practise (3 ECTS credits) is not included in the study programme grid, taking into account regulations of VGTU.

From the analyses of study subjects descriptions provided in SER annexes and the discussions with the students became clear, that study subjects are evenly distributed in the curriculum. Students approved that the curriculum does not have any repetitions or non-understandable parts. However, during the site visit experts’ team received information, that on the first year of studies, teaching staff of the study programme has to adjust the level of the lectures to the knowledge level of the admitted students. Bluntly one could state that the curriculum on solar cells electricity production mechanisms demands knowledge in semiconductor physics, which Bachelors in engineering fields lacks. In experts’ team opinion, it is necessary some curriculum space to dedicate for a preparatory semiconductor physics course. A less but still significant problem exists with chemistry knowledge needed for the teaching process technology. That is

why experts' team suggests the core subjects distribute to physics, chemistry and engineering fields of interest.

In general, not taking into account the fact, that some courses are adjusted or must be adjusted to the students knowledge, the rest of the study subjects content is on appropriate (second cycle study programme) level. Moreover the content and methodology of teaching those courses are appropriate for achieving the specific technical intended learning outcomes.

In conclusion, if the attention will be paid to the mentioned weaknesses, the scope of the Master's study programme in *SCME* will be completely reasonable to ensure the achievement of the study programme intended learning outcomes.

3. Staff

Staff of Master's study programme in *SCME* consists of 14 members, 36% of which are teachers from the Department of Physics and 36% teachers from other VGTU departments. Remaining staff members (28%) are from VGTU external research institutes. The number of the teaching staff is quite large in relation to the number of students in the study programme (in a period 2011-2013 – 20 students) and it is more than adequate to ensure that students will achieve the intended learning outcomes.

All teachers of the study programme hold a PhD degree and at least 60% of them teach study subjects related to their research. The teaching staff is actively involved in applied physics, semiconductors physics and building engineering research fields, which obviously are directly related to the study programme. However the experts' team did not receive clear evidence that VGTU creates conditions for the professional development of the teaching staff. It seems, that many teachers are active in their individual interest areas through participation in scientific conferences and research projects but the staff's professional development at VGTU is left to the individual teacher's responsibility and therefore, there is a risk for the long-term development of the study programme.

The mostly qualified teachers are responsible for delivering the parts of the study programme related to the physics of the *SCME*. The qualifications of the teaching staff in this field are adequate to ensure that the students will achieve the intended learning outcomes.

Teaching and practical experience of the staff varies from 9 to 46 years. The experts' team found quite hard to evaluate teaching staff turnover, when study programme implementation has started just 18 months ago. But taking into account the age structure of the teaching staff, the attention

should be paid, that 6 teachers are over 61 years and the recruitment of new staff members would be praiseworthy.

4. Facilities and learning resources

The premises for the study programme implementation are adequate both in their size and quality: lectures are delivered in 8 auditoriums, equipped with video projectors. There are also 2 computer rooms (equipped with 47 computers). Master's in *SCME* study programme students their laboratory works performs in the classroom with 12 working places, which belongs to the Faculty of Mechanics at VGTU. All material facilities are in compliance with occupational requirements for safety at work and hygiene.

Funds to develop the teaching and learning environment of the study programme are allocated both from the European Union structural funds (2011-2013) and from VGTU resources. However, there is a need to pay attention to the renewal of laboratory equipment, software acquisition, and other facilities with specific focus on the new technologies of a very dynamic *SCME* industry.

Laboratory works are related to two study courses "Origin of Light and Its Interaction With Material" and "Semiconductors and Semiconductor Technology". Available laboratory equipment: micro-ampere meter M906, voltmeter V4313, power supply devices VUP-2, VUP-2M, UIP-2, B5-46, PS280DC, heat block, NiCr-Ni temperature sensor, NiCr-Ni adapter, sensor-CASSY-lab, pyrometer P-107, micro-ammeter M226M, diffraction grating, laser HeNe, oscilloscope C1-114 is not up-to-date, but fully functioning and is suitable for using.

The managers of the study programme should pay more attention to the development of the laboratory resources related to the "Mathematical Modeling of Solar Cells" and "Renewable Energy Technologies" courses, because those are key courses of the study programme.

There are adequate arrangements for students' practice. Students' internships create conditions for integrating theoretical and practical knowledge. All students may undergo practical training during a period scheduled in the study timeline for each academic year. Students have opportunities for practical training by choosing the companies engaged in activities relevant to the study field and having employees with appropriate qualification competences. In compliance with legal provisions, a trilateral agreement of practical training is signed between VGTU, companies and students. According to the survey results, a majority (80%) of the students believed that the industrial R&D internships were useful for the preparation of their final Master's theses and even more important for their future career.

The Central Library of VGTU and the reading room of the Faculty of Fundamental Sciences contain sufficient number of literature necessary for the *SCME* study programme. It is worth to mention, that on the initiative of the Department of Physics, the library collects the newest scientific literature in English language intended for the *SCME* study programme (34 copies of 12 publications were bought from European Union structural funds). The library and reading rooms provide online access to full-text international and local databases. Textbooks and learning materials are fully available for almost all study subjects (70%) of the *SCME* study programme. Lecture notes (compendiums) are prepared for individual courses. Students are allowed to take textbooks or other literature from the library for a certain period of time. If one copy of a publication is available in the library, the students can take it for reading in the reading rooms only. The reading rooms of Central Library are open each day 24 hours per day. Teachers of the study programme prepare and place learning material on the VGTU intranet virtual learning environment MOODLE.

5. Study process and student assessment

The admission requirements to the Master's study programme in *SCME* are based on the prerequisite of holding Bachelor degree in electronics, environment engineering, energy engineering, civil engineering, transport engineering and/or mechanical engineering, and having completed courses in mathematics, physics and special programme courses (e.g., electronics and electrical engineering, renewable energy resources, industrial technologies, technology management, etc.). It is a competitive admission due to more students than available places. Up to now, there have been only two years of admittance. In both cases the numbers of applicants on the first place were at least twice higher than the number of state financed places (15 and 11, respectively). As though, there is a real competition for the places and only high quality students could be accepted. The number of applicants has so far been fuelled by the labour market demand.

The problem with the admission requirements to the study programme is that it does not take into account that deep knowledge in physics and in chemistry is seemingly needed to these studies. This appeared as the problem during the discussion with both the students and the teachers. However, nobody of the graduates in physics and chemistry study programmes could for formal reasons apply.

According to the experience of the first two years of study programme implementation, the majority of the accepted students proceeded with the prescribed schedule, as expected. There

were only three persons, who could not follow the Master's in *SCME* curriculum. The number of the students, who will graduate this year is 8.

The study process is properly organized. Because of the low number of students, the study process is conducted in a familiar atmosphere, taking into account the students needs. Experts' team assumes, that probably that is why there is no problem with the examination schedules (mostly students are full-time employed). These are prepared in a common work of the professors and the students. This is also true for the knowledge, understanding, competences, for exercises and for laboratory work reports. All this helps the students to achieve the intended learning outcomes. In general, the assessment system of students' performance is adequate, transparent and publicly available. On the other hand, for the experts' team it is quite unusual, that according to the personal statements, most of the students of Master's studies have full-time jobs besides their university studies. This fact prevents them to devote their full intellectual capacity to the study programme.

The students of the Master's study programme take part in research activities during their studies. Those, who have new original scientific results, have several opportunities to show their research achievements at different conferences or seminars to the science community. According to the Department of Physics implemented poll results, the majority of postgraduate students (73.7%) reported to having been created conditions to participate in scientific conferences and research workshops. To publish the outcomes of students' scientific and applied research work, the Faculty of Fundamental Sciences holds the Lithuania conference of young scientists "Science – Future of Lithuania. Materials Research and Environmental Physics". The fifteenth conference took place in spring 2012; the sixteenth conference took place in April 2013. 2 (of 8) *SCME* study programme students participated in the mentioned conferences.

As stated in SER, mobility of the students is the weakness of the study programme. In experts' opinion, it would be a great achievement, if all students of the study programme, would have the opportunity to visit at least one university abroad, especially concerning the specific of the study programme.

VGTU has got good contacts with the labour market. Those, who participated at the meeting with experts group, have shown much interest in this Master's study programme. The first graduates are lined up for employment by the solar cells industry.

The social and academic support is given to the Master students according to the rules and procedures of VGTU. The students, who wish it, get dormitories, access sport and cultural activities.

6. Programme management

In the SER is indicated, that the main responsibilities for the implementation of the study programme and quality assurance are spread among Study Programme Committtee, Head of the Department of Physics and staff members of the Department. At this level decisions are taken on specific issues regarding the organisation of the study process, supply with facilities and learning resources, improvement of study quality, distribution of teachers' workload, amendment/replacement of course units within the study programme, contacts with social stakeholders, assignment of final thesis supervisors, etc.

The main means used by the study programme management seeking to assure studies quality are polls of students, teachers and employers conducted at the end of the semesters. The results of those questionnaires are used for the improvement of the study programme. However, experts' team highly recommends to take more clear efforts in developing systematic approach to the quality assurance. That is because internal quality assurance should be more study programme, than university related. Despite of the information provided in SER about the study programme level quality assurance, during the site visit it felt as it is more important to report upwards, seeking to create quality brand, while prospective students are looking for quality and relevant information about the study programme on study programme level.

It is undoubtful, that the study programme in *SCME* has a strong and dedicated leadership by the Head of the Physics Department. However the organograms sometimes felt more to define responsibility and less to promote opportunity. This became very clear when the experts' team discussed the reasons, why physics and chemistry graduates could not enter *SCME* Master's study programme.

The last one point concerning the study programme quality on the external evaluation of *SCME* study programme is the SER, which is quite well prepared, when one is taking into account the formal definition of the intended learning outcomes; clearly the Bologna principles implementation is in a right way. However, the attention by the study programme managers should be paid to the assessment methods, if the intended learning outcomes have been achieved and how through this create a better education. In reality, the intended learning outcomes and quality could be better interconnected.

III. RECOMMENDATIONS

1. To review the definition of the intended learning outcomes, paying attention to the operative approach, seeking to design courses, improve and assess quality according to the functioning concept of the intended learning outcomes.
2. To set clearer assessment procedures if students have achieved the intended learning outcomes, particularly linked to the personal and social abilities.
3. To review study programme aim and intended learning outcomes, seeking to clarify the relative weight between the engineering and the R&D competences, that students must acquire.
4. To fix the existence of differences between the intended learning outcomes stated in SER and the website version.
5. To include in the curriculum preparatory semiconductor physics and chemistry courses.
6. To distribute the core subjects to physics, chemistry and engineering fields of interest.
7. From the management perspective to pay attention to the staff professional development.
8. To pay attention to the renewal of laboratory equipment, especially to the development of the laboratory resources related to the "Mathematical Modeling of Solar Cells" and "Renewable Energy Technologies" courses, also software acquisition, and other facilities with specific focus on the new technologies of a very dynamic *SCME* industry.
9. To review admission requirements to the study programme by giving high priority to physics and chemistry Bachelors.
10. To increase the number of teachers and students mobility.
11. To take more clear efforts in developing systematic approach to the quality assurance, especially the attention should be paid to the development of feedback system from social stakeholders.

IV. SUMMARY

The main strenghts of *Sollar Cells and Modules Engineering* Master‘s study programme:

- High relevance for Lithuania energy industry;
- High scientific quality;
- Dedicated and qualified teaching staff;
- High quality of teaching material;
- Motivated students;
- Strong and dedicated leadership.

The main weaknesses of *Sollar Cells and Modules Engineering* Master‘s study programme:

- Lack of the operative approach in defining the intended learning outcomes;
- Lack of clear assessment procedures if students have achieved the intended learning outcomes, particularly linked to the personal and social abilities;
- Lack of preparatory semiconductor physics and chemistry courses;
- Restrictions concerning physics and chemistry Bachelors admission to the study programme;
- Low teachers and students mobility;
- Lack of the formalized approach to the feedback from the main social stakeholders.

V. GENERAL ASSESSMENT

The study programme *Sollar Cells and Modules Engineering* (state code – 621J91001) at Vilnius Gediminas Technical University is given **positive** evaluation.

Study programme assessment in points by evaluation areas.

No.	Evaluation Area	Evaluation Area in Points*
1.	Programme aims and learning outcomes	3
2.	Curriculum design	2
3.	Staff	4
4.	Material resources	3
5.	Study process and assessment (student admission, study process student support, achievement assessment)	3
6.	Programme management (programme administration, internal quality assurance)	2
	Total:	**17**

*1 (unsatisfactory) - there are essential shortcomings that must be eliminated;
2 (satisfactory) - meets the established minimum requirements, needs improvement;
3 (good) - the field develops systematically, has distinctive features;
4 (very good) - the field is exceptionally good.

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Vilnius
2013

Vertimas iš anglų kalbos

VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETO ANTROSIOS PAKOPOS STUDIJŲ PROGRAMOS *SAULĖS ELEMENTŲ IR MODULIŲ INŽINERIJA* (VALSTYBINIS KODAS – 621J91001) 2013-08-19 EKSPERTINIO VERTINIMO IŠVADŲ NR. SV4-300 IŠRAŠAS

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V. APIBENDRINAMASIS ĮVERTINIMAS

Vilniaus Gedimino technikos universiteto studijų programa *Saulės elementų ir modulių inžinerija* (valstybinis kodas – 621J91001) vertinama **teigiamai**.

Eil. Nr.	Vertinimo sritis	Srities įvertinimas, balais*
1.	Programos tikslai ir numatomi studijų rezultatai	3
2.	Programos sandara	2
3.	Personalas	4
4.	Materialieji ištekliai	3
5.	Studijų eiga ir jos vertinimas	3
6.	Programos vadyba	2
	Iš viso:	**17**

* 1 - Nepatenkinamai (yra esminių trūkumų, kuriuos būtina pašalinti)
2 - Patenkinamai (tenkina minimalius reikalavimus, reikia tobulinti)
3 - Gerai (sistemiškai plėtojama sritis, turi savitų bruožų)
4 - Labai gerai (sritis yra išskirtinė)

IV. SANTRAUKA

Pagrindinės *Saulės elementų ir modulių inžinerijos* magistrantūros studijų programos stiprybės*:*

- Didelė svarba Lietuvos energetikos pramonei;
- Aukšti mokslinės veiklos rodikliai;
- Atsidavęs ir kvalifikuotas akademinis personalas;
- Kokybiška mokomoji medžiaga;
- Motyvuoti studentai;
- Stipri lyderystė.

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Pagrindinės *Saulės elementų ir modulių inžinerijos* magistrantūros studijų programos silpnybės:

- Operatyvaus požiūrio stoka apibrėžiant numatomus studijų rezultatus;
- Aiškaus tarpusavio ryšio tarp studijų programos ir studijų dalykų numatomų studijų rezultatų nebuvimas;
- Aiškių vertinimo procedūrų, skirtų nustatyti, ar studentai pasiekė numatomus studijų rezultatus, ypatingai susijusius su asmeniniais ir socialiniais gebėjimais, nebuvimas;
- Įvadinių puslaidininkių fizikos ir chemijos studijų dalykų nebuvimas;
- Apribojimai nustatyti fizikos ir chemijos bakalaurų priėmimui į šią studijų programą;
- Nedidelis dėstytojų ir studentų judumas;
- Formalaus požiūrio į pagrindinių socialinių dalininkų grįžtamąjį ryšį trūkumas.

III. REKOMENDACIJOS

1. Peržiūrėti numatomų studijų rezultatų apibrėžtis, vadovaujantis operatyviuoju požiūriu, kai studijos vykdomos, studijų kokybė gerinama ir vertinama atsižvelgiant į numatomų studijų rezultatų koncepciją.
2. Nustatyti aiškesnes procedūras, skirtas įvertinti, ar studentai pasiekė numatomus studijų rezultatus, ypatingai tuos, kurie susiję su asmeniniais ir socialiniais gebėjimais.
3. Peržiūrėti studijų programos tikslą ir numatomus studijų rezultatus, siekiant nustatyti tinkamą santykį tarp inžinerijos ir mokslinių tyrimų bei plėtojimo kompetencijų, kurias studentai turi įgyti.
4. Pašalinti savianalizės suvestinėje ir interneto svetainėje egzistuojančius numatomų studijų rezultatų skirtumus.
5. Įtraukti į studijų programą įvadinius puslaidininkių fizikos ir chemijos studijų dalykus.
6. Pagrindinius studijų dalykus paskirstyti pagal fizikos, chemijos ir inžinerijos sritis.
7. Žvelgiant iš studijų programos vadybos perspektyvos, reikėtų daugiau dėmesio skirti personalo profesinės kvalifikacijos tobulinimui.
8. Atnaujinti laboratorinę įrangą, ypatingai materialiuosius išteklius, susijusius su „Saulės elementų matematinio modeliavimo“ ir „Atsinaujinančių energijos išteklių technologijos“ studijų dalykais, taip pat įsigyti programinės įrangos bei kitų išteklių, daugiausia dėmesio

skiriant naujoms technologijoms, kurios yra ypatingai aktualios labai dinamiškoje saulės elementų ir modulių inžinerijos industrijoje.

9. Peržiūrėti priėmimo į šią studijų programą reikalavimus, prioritetą skiriant fizikos ir chemijos bakalaurams.
10. Padidinti judumo programose dalyvaujančių dėstytojų ir studentų skaičių.
11. Reikėtų imtis aiškesnių priemonių plėtojant sisteminį požiūrį į studijų kokybės užtikrinimą, ypatingai daug dėmesio reikėtų skirti sisteminio grįžtamojo ryšio iš socialinių dalininkų gavimui.

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Paslaugos teikėjas patvirtina, jog yra susipažinęs su Lietuvos Respublikos baudžiamojo kodekso[1] 235 straipsnio, numatančio atsakomybę už melagingą ar žinomai neteisingai atliktą vertimą, reikalavimais.

[1] Žin., 2002, Nr.37-1341.