Appendix 12c

REVIEW

to occupy the academic position:

"Professor"	
"Associate Professor"	X
	one of the academic positions indicated shall be marked with the sign "X"

Candidates to occupy the position:

1	Chief Assistant	Dr.	Vasil	Ivanov	Karastoyanov	UCTM
№	academic position	scientific degree	name	middle name	last name	workplace

Scientific area:

4.	Natural science, mathematics and informatics
code	name

Professional area:

4.2.	Chemical Science
code	name

Scientific specialty:

Physical Chemistry

The competition has been announced:

23	19.03.2024	Physical Chemistry	Faculty of Chemical Technology
in SG issue	date	for the needs of the Department	Faculty

The review was written by:

Assoc. Prof.	Dr.	Angelina	Konstantinova	Popova	UCTM
academic position	scientific degree	name	middle name	last name	workplace

1. Review for the candidate:

Chief Assistant	Dr.	Vasil	Ivanov	Karastoyanov
academic position	scientific degree	name	middle name	last name

1.1. Completion of the provided documents:

A) The competition documents are in full compliance with the Regulations	3 points	**X**

B) The documents are complete but do not fully comply with the requirements of the Regulations	2 points	
C) The documents are not completed in accordance with the requirements of the Regulations	0 points	
		one of the answers given is marked with the sign "X"

The submitted documents for the competition fully meet the requirements of the Regulations for the acquisition of scientific degrees and holding academic positions at the HTMU, as well as the ZRASPB and PPZRASRB. Both the large number of citations with which the candidate participated in the competition (158, with one of the publications being cited 80 times) and the high quality of the scientific output – from 16 articles, 8Q1 and 7Q2 – are impressive. It is worth noting that the candidate participated in 5 contracts, 2 of which were with the Scientific Research Fund. He also participated in 11 conferences, 7 of which were foreign.

1.2. Meeting the minimum requirements under the Regulations:

A) The candidate meets the minimum requirements	20 points	X
B) The candidate doesn't meet the minimum requirements	0 points	
		one of the answers given is marked with the sign "X"

It must be filled in if answer B is marked. The publication activity of the candidate is analyzed. The response of the results achieved (quoted) is analyzed.
The publications for the acquisition of the educational and scientific degree "doctor" (3 issues, all three with an impact factor) are presented separately from the publications for the acquisition of the academic position "associate professor". The candidate is the author of a university electronic teaching aid - "Practicum on Fuel Cell Technology" with reviewer Prof. Dr. Iva Betova. In the competition for associate professor, the candidate participated with 16 publications referenced in Scopus and Web of Science, of which: 8 nos. Q1; 5 pcs. Q2; 1 piece. in Q3, distributed as follows (pursuant to SG No. 15, Post. 26/13.02.2019): - According to indicator B4 – Habilitation thesis or scientific publications in refereed and indexed editions, the candidate participates with: 3 publications Q1 and 3 publications Q2 a total of 135 points with a minimum requirement of 100 points; - According to indicator G7 – 5 publications Q1, 4 publications Q2, 1 publication Q3 - total 220 points; Total 220 points with minimum requirements for G5-10 - 200 points; - According to indicator D11 Citations – the candidate participated in the competition for associate professor with 158 nos. citations = 316 points (with minimum requirements 50 points); - According to indicator E20 Published university textbook - 1 pc. 20/n = 20 items. The publications and citations on the articles for the acquisition of the scientific-educational degree "doctor" were not used in the competition for the academic position "Associate Professor".

According to all necessary indicators ch. Assistant Professor Vasil Karastoyanov meets and significantly exceeds the minimum requirements for holding the position of "Associate Professor".

1.3. Relevance of scientific and / or applied research:

A) The research is relevant. Part of the research is pioneering (no results are known on the topic by other authors)	7 points	X
B) Research is relevant. Results from other authors are known for each of the topics and / or applications studied.	5 points	
C) Most of the research is relevant, but also some results are presented that have no scientific and / or applied value	3 points	
D) The smaller part of the research is relevant	2 points	
E) Research is not relevant	0 points	
		one of the answers given is marked with the sign "X"

The evaluation of the relevance of the research must be substantiated.
The relevance of scientific research is indisputable. Most of them have been studied on processes and objects in nuclear energy - oxide films on structural materials of the first circuit of nuclear power plants, the water-chemical regime on the corrosion of the casings of nuclear reactors with pressurized water, corrosion erosion and sludge formation in the second circuit of nuclear power plants, reduction of stress corrosion cracking of the inner casing materials in fluidized bed nuclear reactors, modeling of oxide film formation processes on niobium, tungsten, titanium and titanium alloys, etc. The scientific value and relevance of the research is confirmed by the nearly 180 citations of works by specialists in the field.

1.4. Knowledge of the problems subject of research:

A) The candidate knows in detail the achievements of other authors on the researched topics and/or applications	6 points	X
B) The candidate is partially familiar with the achieved results on the researched topics and / or applications	4 points	
C) The candidate has no prior knowledge of the status of the researched problems	0 points	
		one of the answers given is marked with the sign "X"

The evaluation must be substantiated if answer C is marked.
The cited literature in the publications shows both the in-depth knowledge of the state of

scientific problems and the topicality of the topic.

1.5. Type of research:

A) Theoretical	4 points	
B) Applied	4 points	
C) Theoretical with application elements	4 points	X
D) It does not correspond to the level specified in the Act for the Development of the Academic Staff in the Republic of Bulgaria and the Regulations	0 points	
		one of the answers given is marked with the sign "X"

The level of research must be substantiated if answer D is marked.
The research is of a scientific and applied nature. They can be characterized as substantiating a new scientific problem, a new theory; enrichment of existing knowledge and theories; application of scientific achievements in practice and realized economic or social effect. The practical aspect of the research is illustrated by the implementation of scientific achievements in the Kozloduy NPP.

1.6. Objectives of the research:

A) Realistic and of scientific and / or applied interest	8 points	X
B) Realistic, but not of scientific and / or applied interest	4 points	
C) Unattainable (unrealistic)	0 points	
		one of the answers given is marked with the sign "X"

Objectives must be specified. The type of the set objectives must be justified.
The objectives of the various studies are correctly and realistically set and represent scientific and scientific-applied interest. To achieve them, specific tasks have been defined, which are carried out within the framework of research in the relevant thematic directions. In general, they can be systematized in the following way: 1) quantitatively described corrosion processes occurring on the surfaces of the primary loop of nuclear reactors by applying the mixed conductivity model; 2) development of a quantitative model of the corrosion of zirconium alloys as fuel claddings of nuclear power plants, describing the growth processes of a protective oxide layer; 3) study of the mechanism of corrosion erosion and sludge formation in the second loop of nuclear power plants; 4) modeling of the processes of formation of oxide films on niobium, tungsten, titanium, titanium alloys, steel and its oxides; 5) simulating online NobleChem technology in fluidized bed nuclear reactors to reduce stress corrosion cracking of in-shell materials, etc.

1.7. Methods of research:

A) Adequate to research and set scientific objectives and /or applications	8 points	X
B) Partially appropriate, enabling part of the scientific objectives and / or applications to be achieved	4 points	
C) Inappropriate methods	0 points	
		one of the answers given is marked with the sign "X"

Methods must be specified. The type of methods used is justified.
In his research, the candidate has mastered, used and correctly interpreted a number of modern scientific methods. They are appropriately selected according to the set scientific goals. The most commonly used are the following: 1. Electrochemical methods – electrochemical impedance spectroscopy (EIS), galvanostatic and potentiodynamic method, voltammetry, chronoamperometry, etc. 2. Spectral methods - X-ray photoelectron spectroscopy (XPS); arc discharge optical emission spectroscopy; photocurrent spectroscopy with light intensity modulation (IMPS); mass spectrometry, etc. 3. Surface characterization methods – scanning electron microscopy (SEM).

1.8. Candidate research contributions:

A) With lasting scientific and / or applied response, they form the basis for new research and applications	20 points	X
B) They are of significant scientific and / or applied interest, complete and / or summarize previous research	16 points	
C) They are of scientific and / or applied interest	12 points	
D) Lack of significant contributions	8 points	
E) Lack of contributions	0 points	
		one of the answers given is marked with the sign "X"

Contributions must be specified. The type of results achieved must be justified.
The scientific research work of Ch. Assistant Professor Vasil Karastoyanov is in the field of electrochemistry. I fully agree with the scientific contributions formulated by the candidate. They are related to the thematic areas in which he works. I accept their systematization by areas, as done by the candidate. I will briefly draw attention to the following: - The corrosion processes occurring on the surface of the first circuit of nuclear reactors are quantitatively described. The thickness and chemical composition of the oxide layers were characterized. The depth profiles of the metallic components of the inner layer of the oxide on a structural material during its growth through the dependences of the respective atomic fractions on the distance to the alloy/inner layer interface are presented. The rate constants and diffusion coefficients of the oxide components were obtained and calibrated with the estimated values of these parameters based on the transfer function of the mixed conductivity model from the

impedance data. A kinetic model was proposed and software was developed to predict the accumulation of radioactivity in the primary loop of nuclear power plants, implemented at Kozloduy NPP in 2010. This model is

extended and refined to quantify the effect of the water chemistry regime under simulated hot-running conditions on the electrical and electrochemical properties of the passive film on an alloy containing Fe, Cr and Ni. Increasing the LiOH concentration in the simulated hot-running conditions was found to result in the formation of a more defective oxide. Additions of H3BO3 have a beneficial effect that counteracts the accelerating influence of Li. An optimal hot run-in water chemistry regime with low to medium Li content and B addition is proposed, which leads to the growth of layers with better electrochemical stability and corrosion resistance.

- The influence of the water-chemical regime on the corrosion of fuel claddings in nuclear reactors with pressurized water was investigated. A quantitative model of the corrosion of zirconium alloys as nuclear fuel claddings has been developed, which quantitatively describes the processes. To develop, validate and verify the model, long-term in-situ electrochemical measurements during the growth of oxide layers in simulated hydrochemical regimes of the first circuit of pressurized water plants were carried out. Created a database on the corrosion behavior of the in-hull materials. For this purpose, a laboratory recirculation circuit was designed, built and put into operation for conducting electrochemical measurements at temperatures up to 350 °C and pressure 15 MPa. The developed kinetic model of the oxidation of fuel shells in a first circuit coolant is based on the coupled currents approach and the mixed conduction model.

- The mechanism of corrosion erosion and sludge formation in the second circuit of nuclear power plants was investigated. The corrosion erosion of carbon steel in the heat carrier of the second circuit of nuclear power plants with pressurized water was investigated by impedance spectroscopy in the temperature range 100-240 °C. The results are interpreted with a quantitative kinetic model involving two parallel processes - growth and dissolution of oxide with the final product colloidal magnetite and dissolution of Fe through the protective film, with product soluble iron ions (probably FeOH+). The model was calibrated with the thickness of the oxide, which was estimated by galvanostatic reduction and parameterized by evaluating the experimental impedance spectra to the corresponding transfer function depending on the temperature (100-240 °C). Software was developed for the application of the model, which was implemented in Kozloduy NPP in 2021.

A preliminary assessment of the electrical properties of the magnetite particles in the heat carrier was made and a quantitative model of sludge formation was developed depending on the water chemical regime in the second circuit. Model predictions are compared with literature data from laboratory experiments and operational data, and conclusions are drawn regarding its applicability for quantitative assessment of sludge deposition and consolidation kinetics. Software was developed for the application of the model, which was implemented in Kozloduy NPP in 2021.

- The formation processes of barrier oxide films on niobium and tungsten were studied. A conceptual model of the nanopore initiation process was established. Causes of surface instability and pore nucleation are indicated.

- The formation processes of anodic oxide films on titanium and its alloys were investigated. A quantitative model for the growth of oxide films on titanium in fluoride-containing electrolytes was parameterized by quantitative fitting with electrochemical data. For the first time, in-situ photocurrent-time curves have been successfully measured for the Ti/TiO2/EG-H2O-NH4F system over a wide range of potentials and fluoride concentrations. A comparison was made of the anodic oxidation of a titanium alloy (Ti-15%Mo-3%Nb-3%Al) with that of pure titanium in an ethylene glycol-water-fluoride electrolyte by electrochemical impedance spectroscopy, photocurrent transients, photocurrent energy spectroscopy, light intensity modulation photocurrent spectroscopy, and surface analyses. The oxide film on the alloy was found to provide a better corrosion and dissolution barrier, but had poorer electronic properties than that on pure Ti.

- Steel and titanium oxides have been investigated as photocatalysts for water decomposition. The chemical composition of the oxide film in depth, the electrochemical and photo-electrochemical properties of anodic oxides formed by different methods are quantitatively characterized.

- NobleChem technology is simulated online to reduce stress corrosion cracking of core materials in fluidized bed nuclear reactors. Solutions of noble metal salts (e.g. Pt) are dosed into the feed water during reactor operation. In order to investigate the deposition and redistribution behavior of Pt, a laboratory loop was developed to simulate a high-temperature steam-water cycle in which samples could be exposed to a simulated Pt-containing coolant. Pt deposition was found to

be more effective at higher rates, resulting in better protection against stress corrosion cracking.

1.9. Participation of the candidate in the achievement of the presented results:

A) The candidate has at least an equal participation in the submitted papers	8 points	
B) The candidate has at least an equal participation in most of the submitted papers	7 points	X
C) The candidate has a secondary participation in most of the submitted papers	4 points	
D) The candidate participation is unnoticeable	0 points	
		one of the answers given is marked with the sign "X"

Critical notes must be provided if one of the items C or D is marked.

1.10. Pedagogical activity:

A) The candidate has effective and sufficient pedagogical activity at the university. The textbooks issued are modern and useful (they meet the requirements of the Regulations). The work with undergraduate and doctoral students is at a high professional level.	8 points	X
B) The candidate has sufficient pedagogical activity at the university. The textbooks issued satisfy the requirements of the Regulations.	6 points	
C) The pedagogical activity and / or textbooks issued are insufficient (do not meet the requirements of the Regulations)	0 points	
		one of the answers given is marked with the sign "X"

Critical notes must be provided if one of the items B or C is marked.
The candidate has been a chief assistant in the "Physical Chemistry" department since 2014. As such, he led laboratory and seminar classes. In addition, he has been assigned lectures with full-time and part-time students in the disciplines: • "Physical Chemistry" - for students compensatory course, OKS Master • "Hybrid systems. Hydrogen technologies and fuel cells" - for students majoring in "Renewable energy systems", OKS Master • "Formal Kinetics" - for students majoring in "Chemical and Biochemical Engineering with teaching in French", OKS Bachelor, the lecture course is conducted in Bulgarian • • "Physicochemical foundations of hydrogen energy" - for students majoring in "Hydrogen Technologies", OKS Master

- • "Hydrogen energy generators" - for students majoring in "Hydrogen Technologies", OKS Master
- • "High-temperature electrochemical technologies" - for students majoring in "Hydrogen technologies", OKS Master
- • "Chemical technologies for obtaining hydrogen" - for students majoring in "Hydrogen Technologies", OKS Master

1.11. Critical notes:

A) Lack of critical notes	8 points	X
B) Critical notes of a technical nature	7 points	
C) Critical notes that would partially improve the results achieved in a small part of the research	5 points	
D) Critical notes that would partially improve the results achieved in most of the research	3 points	
E) Significant critical notes	0 points	
		one of the answers given is marked with the sign "X"

Critical notes must be provided if one of the answers C, D or E is marked.

1.12. Conclusion

A) The evaluation of the candidate's activity is **POSITIVE**	This evaluation is assigned to a total number of at least 65 points	
B) The evaluation of the candidate's activity is **NEGATIVE**	This evaluation is assigned to a total number below 65 points	
		one of the answers given is marked with the sign "X"

To be filled in if requested by the reviewer
The materials submitted to me for review clearly demonstrate the high level that the applicant has achieved as a researcher and teacher. His scientific contributions are substantial and significant. This gives me the reason to give a positive assessment to the only candidate in the competition ch. assistant professor Vasil Ivanov Karastoyanov, PhD, according to the Regulations for the acquisition of scientific degrees and holding academic positions at HTMU, as well as ZRASRB and PPZRASRB. I propose to the Faculty Council of the Faculty of Chemical Technologies of HTMU to choose the only candidate ch. assistant professor Vasil Ivanov Karastoyanov, PhD, for the academic position "Assoc. Professor" in the field of higher education 4.2. Chemical sciences, scientific specialty "Physical Chemistry".

25.07.2024	The review was written by:	
date		signature