

**COMPATIBLE CONSIDERATION OF MOTOR FUEL VAPOR AND THERMAL  
ENERGY EMISSIONS IN CRITERIA-BASED ASSESSMENT OF THE  
ECOLOGICAL SAFETY LEVEL OF EXPLOITATION OF FIRE-FIGHTING  
AND EMERGENCY-RESCUE EQUIPMENT IN CONDITIONS OF ARMED  
AGGRESSION**

Ecological safety (ES) is a critical component of national security on both global and local scales. Particular emphasis is placed on the economic aspects of the complex, criteria-based assessment of ES levels, which constitutes the final stage of the ES management system (ESMS) within the broader framework of civil defense system. These assessments serve as a foundation for management decisions in the field of civil defense service, relying on a specialized methodological framework [1]. The relevance of the study arises from this context. Moreover, the results may contribute to the development of methodologies for forecasting the operational costs and service life of firefighting and emergency rescue vehicles (FERV) equipped with reciprocating internal combustion engines (RICE) [2]. This is particularly pertinent in scenarios where enhancing ES involves transitioning to the use of alternative, renewable motor fuels [3].

**Purpose of the study.** Improving the method for compatible consideration motor fuel vapor and thermal energy emissions during complex criteria-based assessment of the ES level of exploitation of PP with RICE, namely FERV units, taking into account the realities of the functioning of the divisions and institutions of the SES of Ukraine in conditions of armed aggression and in the perspective of the post-war reconstruction of critical infrastructure and the economy of our country. **Problem of the study.** The imperfection of existing methods for complex criteria-based assessment of the ES level of the exploitation of the PP with RICE, especially considering the realities of the functioning of the institutions and divisions of the SES of Ukraine and their FERV units in conditions of armed aggression and in the perspective of the post-war reconstruction of the critical

infrastructure and economic of our country. **Main task of the study.** Determination of quantitative and qualitative aspects of the effect of compatible consideration of the thermal energy motor fuel vapor and thermal energy emission into the environment during a complex criteria-based assessment of the ES level of the exploitation process of PP with RICE, namely FERV units of the institutions and divisions of the SES of Ukraine, using the steady standardized ESC test cycle (in accordance with UNECE Regulations № 49 [9]) based on the improved mathematical apparatus of the complex fuel-ecological criterion  $K_{fe}$ . **Object of the study.** ES level of the exploitation process of PP with RICE, in particular FERV units of the institutions and divisions of the SES of Ukraine, taking into account the negative technogenic impact of compatible thermal energy motor fuel vapor and thermal energy emissions into environment. **Subject of the study.** Contribution to the numerical values of the indicators of the object of the study of the compatible thermal energy motor fuel vapor and thermal energy emissions into environment.

The mathematical framework for the complex fuel-ecological criterion  $K_{fe}$  was originally developed by Prof. Ihor Parsadanov (NTU "KhPI", Kharkiv) [4]. Ecological safety of transport is the component of national security of Ukraine during armed aggression and as a prerequisite for a «green» transition during post-war reconstruction [5]. The study aligns with national strategic documents, including Presidential Decree № 722/2019 dated 30.09.2019 «About the Sustainable Development Goals of Ukraine for the period up to 2030» [6], and the «Regulation on the Organization of Environmental Support of the SES of Ukraine», approved by Order № 618 dated 20.09.2013 [7].

**Scientific novelty of the results of the study.** The method for compatible consideration of the emission of thermal energy and motor fuel vapor emissions from fuel tank into the environment from PP with RICE, in particular FERV units, in a complex criteria-based assessment of the indicators of the ES level during their exploitation has been further developed.

**Practical significance of results of the study.** The results obtained are suitable for providing a quantitative and qualitative assessment of the studied effects and developing on this basis technical solutions and organizational measures to reduce or eliminate them by developing an appropriate EPT with executive devices on the methodological basis of the ESMS.

This study has been carried out as a part of the scientific and research work of the Department of Fire and Technogenic Safety of Objects and Technologies of the Scientific and Educational Institute of Fire and Technogenic Safety of the National University of Civil Protection of Ukraine of State Emergency Service of Ukraine «Development of a methodology for complex assessment of the impact of exploitation and application of special equipment on the environment in conditions of military aggression» (State Registration № 0124U000374, 01.2024–12.2026). At the same time, the materials from the VCU library system were used, including electronic versions of journals and other materials, databases, interlibrary subscription as part of participation in Non-Resident Academic Associates program co-sponsored by the College of Humanities and Sciences at Virginia Commonwealth University (VCU) and the Davis Center for Eurasian Studies at Harvard University in 202–2025 academic year.

This study has been carried out within the framework of the implementation of the educational component of the mastery of the educational and scientific program of higher education «Technogenic and ecological safety» for applicants for higher education of the third (educational and scientific) level in the specialty 183 «Environmental protection technologies» (corresponds to the Detailed branch according to the code of the International Standard Classification of Education ISCED-F 2013 0712 «Environmental Protection Technologies» in accordance with the Resolution of the Cabinet of Ministers of Ukraine dated July 7, 2021 № 762 «On Amendments to the List of Fields of Knowledge and Specialties in Which Applicants for Higher Education Study», as well as the specialty G2 «Environmental Protection Technologies» in accordance with the Resolution of the Cabinet of Ministers of Ukraine № 1021 dated August 30, 2024 «On Amendments to the List of Fields of Knowledge and Specialties in Which Applicants for Higher and Professional Pre-Higher Education are Trained education») in the field of knowledge 18 «Production and Technology» (G Engineering, Production and Construction), in accordance with the Higher Education Standard, approved and put into effect by Order of the Ministry of Education and Science of Ukraine № 1427 dated 12/23/2021, as well as the Professional Standard for the group of professions «Teachers of Higher Education Institutions», approved by Order of the Ministry of Economic Development, Trade and

Agriculture № 610 dated March 23, 2021, namely as the part of the lecture course «Environmental monitoring methods» (3 ECTS credits).

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