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**Доценко Д.Г., Бойко І.С.**  
ПРЕДИКТОРИ НЕКРОЗУ КИШКИ ПРИ СТРАНГУЛЯЦІЙНІЙ  
КИШКОВІЙ НЕПРОХІДНОСТІ.....471

**Lisova V.O., Horodetska O.O.**  
ASSESSMENT OF THE QUALITY AND LIFESTYLE OF MODERN  
YOUTH DURING SOMATOPUBERTIC PERIOD .....473

#### **SECTION: OCCUPATIONAL HEALTH**

**Горденко С.І.**  
КЕЙС-МЕТОД У СИСТЕМІ ВИКЛАДАННЯ БЕЗПЕКОВИХ  
ДИСЦИПЛІН : ІННОВАЦІЙНІ МОЖЛИВОСТІ ТА ПЕДАГОГІЧНІ  
ВИКЛИКИ .....475

**Носенко О., Остапов К., Бондар Д., Тряпкін К.**  
ОСОБЛИВОСТІ ВЕДЕННЯ РОБІТ ПОЖЕЖНИМИ-РЯТІВНИКАМИ  
В ЕКСТРЕМАЛЬНИХ УМОВАХ НС ТА ЗБРОЙНОЇ АГРЕСІЇ.....479

#### **SECTION: OIL AND GAS TECHNOLOGIES, ENGINEERING AND THERMAL POWER ENGINEERING**

**Гуцу Я.**  
НАФТОПРОДУКТОПРОВОДИ: СВІТОВИЙ ТА УКРАЇНСЬКИЙ  
ДОСВІД.....482

#### **SECTION: PEDAGOGY, PHILOLOGY AND LINGUISTICS**

**Fərəsova G.**  
STEM (ELM, TEXNOLOGIYA, MÜHƏNDİSLİK, RİYAZİYYAT)  
TƏHSİLİNDƏ LAYİHƏ ƏSASLI YANAŞMALAR .....490

**Avetisyn V., Khusainov O.**  
FEATURES OF PASSENGER RESCUE AND FIRE SUPPRESSION IN  
UNDERGROUND METRO STRUCTURES: TACTICS OF SCBA TEAMS  
OPERATING OVER LONG DISTANCES.....497

**Mazanova S.B., Həziyeva S.A.**  
İNFORMATIKA DƏRSLƏRİNDƏ PROBLEMLİ TƏLİMİN ƏHƏMİYYƏTİ 499

**Guliyeva S.**  
THE IMPACT OF CHILDHOOD TRAUMA.....505

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# **FEATURES OF PASSENGER RESCUE AND FIRE SUPPRESSION IN UNDERGROUND METRO STRUCTURES: TACTICS OF SCBA TEAMS OPERATING OVER LONG DISTANCES**

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Metro systems are classified as high-risk facilities where fires may result in significant loss of life and substantial material damage. The structural features of underground stations, tunnels, technical rooms, and ventilation facilities create extremely challenging conditions for firefighting and rescue operations. The presence of a large number of passengers, limited evacuation routes, intense smoke conditions, and extensive underground communications significantly complicate the actions of emergency response units. Under such circumstances, the professional training of personnel and the effective organization of Self-Contained Breathing Apparatus (SCBA) teams become crucial factors in ensuring successful emergency response.

Underground metro facilities are characterized by the rapid spread of fire hazards. Smoke and toxic combustion products can travel long distances through tunnels, posing a threat not only near the fire source but also at adjacent stations. Fires involving rolling stock, cable tunnels, transformer substations, and technical facilities are particularly dangerous. In such situations, the primary tasks of fire and rescue units include conducting reconnaissance, searching for and rescuing victims, organizing evacuation procedures, suppressing the fire, and ensuring the safety of emergency personnel.

Analysis of major metro fire incidents worldwide indicates that most casualties are caused by exposure to toxic combustion products and panic among passengers. Therefore, the immediate priorities during emergency response include timely public warning, effective smoke control, and the establishment of safe evacuation routes. In many cases, the prompt and coordinated actions of SCBA teams determine the possibility of saving people trapped by smoke or fire in tunnels and underground facilities.

A specific feature of SCBA operations in metro systems is the necessity to perform tasks at considerable distances from safety posts and sources of fresh air. The distance from the entry point to the fire location may reach several hundred meters and, in some cases, exceed one kilometer. Such conditions significantly increase physical workload and air consumption in breathing apparatus. Consequently, continuous monitoring of air supply, accurate calculation of operational time, and determination of safe withdrawal points become critical components of firefighter safety. Errors in these calculations may result in life-threatening situations for rescue personnel.

When organizing SCBA team operations, it is necessary to consider not only the distance to the fire source but also route complexity, changes in elevation, stairways, technical areas, and possible obstacles. To improve firefighter safety, intermediate safety posts should be established to monitor personnel movement and maintain reliable communication with the incident commander. An important tactical element is the systematic recording of entry and exit times and forecasting the remaining air supply required for a safe return.

Communication management represents another significant challenge. Due to the depth of underground structures and the complex geometry of tunnels, conventional radio communication systems may not provide reliable information exchange. Therefore, the use of repeaters, wired communication systems, and advanced digital technologies is recommended. Timely information regarding operational conditions allows incident commanders to adjust tactical decisions and deploy additional resources when necessary.

Particular attention must be paid to search and rescue operations. Under conditions of limited visibility and dense smoke, SCBA teams should follow a clearly defined search algorithm, systematically inspecting train cars, station platforms, technical rooms, and evacuation routes. Thermal imaging cameras, video surveillance systems, and other modern technical devices can significantly improve victim detection efficiency. Evacuation should be conducted using the safest and shortest routes, while rescue hoods and respiratory protection equipment may be provided to affected passengers.

Successful fire suppression in metro systems also depends on the proper management of ventilation systems. Incorrect ventilation settings may contribute to the rapid spread of smoke and hinder evacuation efforts. Therefore, decisions regarding ventilation operation should be based on reconnaissance data and fire development forecasts. Effective coordination between metro administration personnel and fire-rescue units is essential to achieve optimal smoke control conditions.

The development of modern technologies provides new opportunities for enhancing SCBA operations in underground structures. Promising solutions include personnel tracking systems, electronic air consumption monitoring devices, robotic reconnaissance platforms, and decision-support systems. The implementation of these technologies can improve firefighter safety and reduce the time required for rescue and firefighting operations.

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