International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 20 (2015) pp 40869-40872

Technology for Enhancing Safety of Buildings and Constructions

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Abstract
The article describes new approaches to comprehensive security of potentially hazardous, unique and technically complex facilities (high-risk facilities), population, and territories.

Keywords: Automated Monitoring Systems, Russian Unified Emergency Rescue Service, Emergencies, Risks Of Emergencies, Potentially Hazardous Facilities, Protection Of Population And Territories From Natural And Technogenic Threats.

Main part
In theory and in practice, the protection of population and territories from natural and technogenic threats, both globally and in the Russian Federation, is currently changing its focus from quickly responding to emergencies to forecasting and preventing them by means of software and hardware tools reducing the risk of emergencies and mitigating their consequences [1, 2, 3, 4, 5, 7, 8].
The conventional set of actions to prevent an emergency can be described as a system of regulations which charges the owners of high-risk facilities and municipal authorities with performing a number of requirements to prevent emergencies and to be ready to respond to them, which are often quite a burden on the budget. At the same time, the law says the authorities should declare that they have performed the aforementioned requirements [3, 6].
The supervisory and expert activities designed to provide a realistic assessment of the way the requirements to prevent emergencies and to be ready to respond to them have been implemented are not able to fully validate the declarations for a number of objective reasons and in some cases the national law renders them unable to cause an increase in the safety of a facility or territories[1].

New approaches to forecasting and preventing emergencies are needed now. Current technology, such as monitoring equipment, can considerably reduce the emergency risks at the high-risk facilities by providing quick and reliable information on the emergency threat or actual emergency to dedicated quick-response services. The social trend shows that people are unwilling to consider their own safety from the owner's perspective [9, 10].
The high-risk facilities are to be made safer also because the UN says the technogenic accidents are the third most important cause of human life loss among all types of disasters (see Figures 1, 2).
The following reasons for high occurrence of accidents at high-risk facilities are usually determined to be the major ones: high wear and tear of equipment, lack of effective systems monitoring the operation of emergency systems; deliberate or unprofessional actions taken by the management or workers to cause accidents.
The emergency response at high-risk facilities can be hampered by a lack of interaction and coordination between the authorities, the owners and the operators; missing or outdated safety regulations; lack of a systematic approach to performing the actions increasing the safety of high-risk facilities.

[1]Adapted from http://www.greenpeace.org/russia/ru/campaigns/nuclear/accidents/Fukushima-1/: As far back as 2008, the Japan Nuclear Energy Safety Organization published materials saying that the fuel might melt in case of a cooling system failure and that it might be caused by a tsunami hit. The NPP owner – the Tokyo Electric Power Company (TEPCO) – knew that Fukushima Daiichi would not survive a natural disaster. However, the company did nothing to enhance the safety of the power plant operation and simply ignored the possible threat. The greed finally caused a catastrophe.
Adapted from http://www.carnivorousplant.info/klimat/250-platforma-bp-rabotala-bez-signalizacii.html :
New details on the British Petroleum platform accident causing an ecological disaster in the Gulf of Mexico came to light. It became known that the alert system designed to warn about a dangerous concentration of flammable gases was turned off so that the workers should not be bothered by false alarms.
Adapted from http://www.synerjetics.ru/article/catastrophe.htm:
The failure of turbine two of the Sayano–Shushenskaya Hydroelectric Power Plant caused a large-scale catastrophe due to the lack of a proper protection system to close the water intake at the upper level if the turbine reached unacceptable vibration levels...

Fig.1 Fukushima NPP Explosion

Fig.2 Sayano–Shushenskaya Hydroelectric Power Plant accident caused by a failure of the automated system for process monitoring and control

The Russian Unified Emergency Rescue Service (RUERS) is designed to perform complex interagency tasks to protect population and territories from natural and technogenic threats.

The National Emergency Management Center (NEMC) and Emergency Management Centers at the federal districts and constituencies of the Russian Federation (see Figure 3) are designed for better interagency cooperation and management centralization in case of a risk of or actual crises.

Depending on the scale of the emergency, the management and response can be performed by the facility or, when necessary, it can be escalated up to the federal level. The daily management bodies in Russia are operations control desks (OCDs), 112 system, emergency management centers at the constituencies of the Russian Federation and at the regional center [12, 13]. The NEMC is the highest management body. The scale of emergency determines the level of the emergency commission to be established. The information on the threat of or actual emergency at a high-risk facility is initially fed to the facility operations control desk and the 112 system. The information is further escalated up to the NEMC level as determined by the emergency scale. Thus the response levels applied at the facility may differ.

The Automated Information and Control System of the Russian Unified Emergency Rescue Service (AICS RUERS) is designed to support decision-making in an emergency. The system is supported by a set subsystems, which have software and information links. They comprise the subsystems for monitoring and forecasting, dispatching, navigation, high-risk facility information acquisition, and managerial documents drafting. All the subsystems are coordinated with the geoinformation system. The information on the threat of or actual emergency at a high-risk facility is fed to the monitoring and forecasting subsystem in an automated and formalized form. The information on the emergency at a facility, ready response plans, data on the facility and forecast tasks of possible emergency development are used to automatically draft managerial decisions to prevent or respond to the emergency, which are conveyed to the designated emergency response services [11, 12, 13].

Fig. 3. The National Emergency Management Center

The FGBU VNII GOCHS (FTs), MGSU and some other research institutions have developed the following innovative technologies ordered by the EMERCOM of Russia to increase the safety of the high-risk facilities:

- a structured scheme for monitoring and preventing emergencies at high-risk facilities for an automated monitoring of the engineering life-support systems, technological processes and safety at the monitored facilities;
- a system for monitoring the engineering (load-bearing) structures of buildings and constructions, dangerous natural processes and phenomena for an automated monitoring of changes in the conditions of foundations, engineering structures of buildings and constructions; engineering protection facilities, and mudflow, mudslide, and avalanche flow paths in the construction and operation area of the facility under monitoring;

- an all-Russian comprehensive system for public alert and notification on a threat of or actual emergency in en masse locations;
- a system for protection against natural and technogenic emergencies, alert and notification of population on vehicles.

A structured system for monitoring and preventing emergencies at high-risk facilities is designed to prevent an emergency or considerably mitigate its consequences, including technogenic, natural emergencies and those caused by terrorist attacks [9, 10, 11]. See Figure 4 for a structural and functional monitoring layout for high-risk facilities.
The unique features of the Russian system include:

1. An automatic, continuous comprehensive control over the changes in the critical parameters of the life-support and safety systems, the condition of the facility structures, natural processes and phenomena in the exploitation area.
2. An automated real-time transfer of information on the incident or accident with detailed parameters to the facility dispatcher service, the RUERS routine management bodies (up to the NEMC if necessary), and to the facility owners.
3. A 'black box' approach to building the monitoring systems.

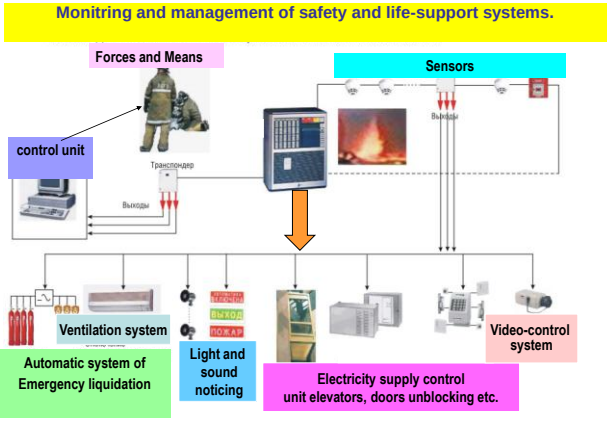

Fig.4 Structural and Functional Layout for Monitoring High-Risk Facilities

The aforementioned features of the system designed to monitor high-risk facilities support timely measures to be taken at different levels to prevent emergencies at facilities under monitoring or to minimize their consequences.
Based on the aforementioned technology and with the end of legal and technical regulation of activities to be performed to establish a system for comprehensive safety and emergency prevention, a set of national standards and methodologies has been developed to determine the requirements to its design and installation at facilities, and also methods to confirm compliance with the requirements.
Russia has mandated automated monitoring and emergency prevention systems for the following facilities: nuclear and/or radiologically hazardous facilities, hazardous waste disposal or burial facilities; first and second class hydrotechnical constructions; large oil storage facilities (more than 20, 000 tonnes) and refrigerator storage facilities for liquefied gases; facilities related to production, generation or processing of explosives; companies extracting (mining depth over 150 m) and processing solid minerals; heat power plants with the capacity over 600 mW; sea ports; airports with the main landing strip of no less than 1, 800 m; bridges and tunnels longer than 500 m; metros; large industrial facilities with more than 10, 000 workers; high constructions, stadiums, large shopping malls, cinemas, etc. [10, 12].
Russia currently has emergency monitoring and prevention systems installed at a number of sports and recreation arenas, high buildings, theatres, and industrial facilities. It is noteworthy that no emergencies have been allowed at all the facilities under monitoring. Preliminary estimates say that the total amount saved by installing the system presented exceeds $1 billion annually.
Russian experts have used the expertise acquired to design the Monitoring High-Risk Facilities draft standard within the framework of the ISO international standardization, which it is going to submit for consideration to a corresponding technical committee. We are confident that it is time to address the issues at the international level and that we need consolidated solutions ensuring the future of the planet.
God created the world! Will we take care of the rest?

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