International Journal of Economics, Commerce and Management
United Kingdom Vol. IV, Issue 4, April 2016
http://ijecm.co.uk/ ISSN 2348 0386

CONTEMPORARY APPROACH FOR COMPLEX ANALYSIS AND EVALUATION OF HAZARDOUS ENVIRONMENTS (CAEHE)

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Abstract

Prevention of industrial accidents in Europe and creation readiness of the authorities and the community for countering them are aimed not only at major catastrophes, but also at the small ones, which threaten the society, jobs and environment. Regardless of the internationally accepted framework for prevention and counteraction the industrial accidents involving hazardous substances (refers to the Seveso type site/area related accidents), there are fields that have not yet been developed. As substantial directions can be indicated: vulnerabilities assessment of various sectors of economy, their interdependencies and impact on social life; better risk assessment in terms of relative vulnerabilities assessed; improved protection measures of buildings and population; effective assessment and decision-making model and training and education of stakeholders. Namely through advanced research developments in the area it is expected the community protection to be improved and proper spending of costs *planned. Considering these challenges, the main objective of the current article is to bring to the attention of stakeholders an integrated package of advanced developments, both in terms of Seveso type site/area related accidents, caused by reason of technological failures (technological mistakes) or are due to targeted man-made activities (terrorism).*

Keywords: complex analysis and evaluation; hazardous environments, infrastructure protection

INTRODUCTION

In 1976, an explosion in a small chemical plant outside the town of Meda, in Italy's Lombardy region, led to the release of a toxic cloud that contaminated a densely populated area of about 10 square miles between Milan and Lake Como. The cloud was concentrated around the municipality of Seveso, located downwind from the plant.

The accident led to the adoption in 1982 of the European Union Directive 82/501/EC relating to major chemical accidents, which came to be known as the Seveso Directive. The document aims to prevent the occurrence of major accidents at sites that store, produce or make use of dangerous substances in sufficient quantities to constitute a serious health, safety and/or environmental risk, and to limit the consequences for people and the environment in the event of such an accident.

The latest version of the Seveso Directive was made in 2012 (DIRECTIVE 2012/18/EU). The changes include technical updates to take account of changes in EU chemicals classification, as well as better access for citizens to information about risks, how to behave in the event of an accident, more effective rules on participation in land-use planning projects related to Seveso plants, access to justice, and stricter standards for inspections (DIRECTIVE 2012/18/EU).

The Seveso Directive is also considered to be the European Union's legal and technical instrument to fulfil the obligations of the UNECE Convention on the Transboundary Effects of Industrial Accidents (Convention on the Transboundary Effects of Industrial Accidents).

With a view to strengthen Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) incidents and to protect citizens, institutions and infrastructure against such incidents, in May 2014 a new EU approach was adopted for detection and mitigation of CBRN-E risks (COM(2014) 247 final). The objectives of this new approach are to better assess the risks, to develop countermeasures, to share knowledge and best practices, to test and validate new safeguards with the ultimate goal to adopt a new security standards.

For drawing a roadmap for standardisation in security and for analysing the current security standards landscape in Europe, in May 2011, the European Commission and the EFTA (European Free Trade Association) launched Mandate M/487 addressed to the European Standardisation Organisations: European Committee for Standardization (CEN), European Committee for Electrotechnical Standardization (CENELEC) and European Telecommunications Standards Institute (ETSI), which has been accepted by CEN, TC 391 'Societal and Citizen Security'. The standardization "gaps" that have been identified are (N244 - M487 Final Report phase 2): standards for trace detection; standards for reference materials for the missing CBRNE materials in various types of samples; standards for testing and evaluation (T&E) methodologies to assess the performance of CBRNE Sampling and Detection equipment; EU-wide explosive detection standards and testing methodologies for trace particle and vapour based threats; standard(s) for sensors and sensor data and common interoperability standards between CBRNE detection and sampling equipment and end-users, between networked devices and systems for CBRNE detection and sampling equipment for the capture, processing, data communication, as well as the display and reporting of results to end-users and decision makers.

Regardless of the internationally accepted framework for prevention and counteracting accidents, involving hazardous substances, the related fields have not yet been developed are: assessment of the vulnerability of various sectors of economy, their interdependencies and the impact on social life and sense of security of the population; improvement of the sustainability of buildings against CBRNE substances of concern, using modern concrete mixtures, reinforced concrete structures, window systems; application of early warning systems based on advanced sensor developments; implementation of state-of-the-art systems for contamination of air, water, food and working environment, in the area of impact and in the adjacent territories and standardization of related activities in the field.

Namely those fields serve as a basis for developing the concept of the proposed contemporary approach for complex analysis and evaluation of hazardous environments as an input signal for improvement of the sustainability of buildings against CBRNE.

CONCEPT

From the above mentioned it becomes clear that there are no systematic EU requirements in the field of construction, related to the buildings and facilities of critical infrastructure, central and local administration and society protection against the effects of CBRNE materials and explosive blast. All this imposes the need for modelling a comprehensive approach for assessment and analysis of hazardous environments, including buildings and associated infrastructure. The overall idea is aimed at closing the cycle of activities, through which to enhance the protection against terrorist threats, explosives, chemical agents and / or radiological materials - from the design of buildings, their construction, providing them with the relevant detection and early warning systems in the event of contamination with such reagents.

It is important to underline that the new approach, described in the article bellow, in advance has been discussed and improved with colleagues from different scientific and business organizations, as follows:

- SYNYO GmbH – Austria;
- University of Ruse “Angel Kanchev” - Bulgaria;
- Engineering, University of Cyprus – Cyprus;
- Athena Research and Innovation Center in Information, Communication and Knowledge Technologies – Greece;
- Intelligence for Environnent & Security SRL – IES Solutions SRL – Italy;
- NIER Ingegneria S.p.A – Italy;
- Kaunas University of Technology - Lithuania;
- Instituto de Telecomunicações, IT Branch – Leiria – Portugal;
- Universidade do Porto - Faculdade de Engenharia - Portugal;
- ACCENT PRO 2000 s.r.l. – Romania;
- ARHEL d.o.o - Slovenia;
- EVERIS AEROESPACIAL y DEFENSA SL – Spain;
- Universidade de Vigo – Spain;
- BHR Group, The Fluid Engineering Centre - United Kingdom;
- Medical University of Sofia – Bulgaria.

Discussions carried out, gave to the authors good reason to prepare current publication and to believe that after detailed development, a new approach will be successfully applied at European, regional, national and local level, in the frame and light of the Union Civil Protection Mechanism of the EU.

The main objective of this new approach is a model for assessment and analysis of hazardous environments to be developed, in order to enable the effective measures for infrastructure protection to be implemented, thereby increasing society’s level of protection.

Therefore, the main structural elements of the concept for building of the contemporary approach for complex analysis and evaluation of hazardous environments will be:

- Development of Risks Assessment Methodology for multi-sectoral interdependencies, concerning Seveso type site/area related accidents;

- Development of measures to enhance the protection and reliability of premises and buildings against explosive blast by improving structure and parameters of concrete and reinforced concrete;
- Preparation of the requirements for the development of procedures and equipment for chemical and radiation protection of Seveso type site/area (inside and in the immediate vicinity) and civilians;
- Development of models of stationary sensory units, with high sensitivity and fast detection of contamination by chemical agents and radioactive materials for early warning of the Seveso type site/area;
- Development of portable sensor units / models for analysis in real-time of air, food and water for chemical and / or radioactive contamination (including identification of the threats inside and around Seveso type site/area);
- Development of a model for decontamination of rooms, buildings, specialized (including electronic) equipment and the employees thereof from chemical agents and / or radiological materials;
- Development of model for localization of the personnel in restricted areas (inside and outside of the buildings) and remote monitoring of their physiological health parameters;
- Development of model for personnel training and education.

NATURE OF THE APPROACH

The contemporary approach is built upon a series of technological developments that have already been elaborated and successfully tested. At the same time, to achieve sustainable operation of the proposed innovation it is necessary to improve their technical characteristics, which will allow their smart combination. All this is enriched with the proposed models of methodologies and standardized requirements which lie at the heart of the approach.

1 Risks Assessment Model for multi-sectoral interdependencies, concerning major-accident hazards involving dangerous substances

There is a need to better understand how society as a whole might be affected by risks of accidents and terrorist attack on sensitive sites/areas (involving potentially hazardous substances), in order to enable effective protection measures to be developed.

In this respect, the breadth of impacts of major-accident hazards involving dangerous substances have to be investigated, considering multi-sectoral (inter-) dependencies (notably transport, energy, communications and water). This implies developing knowledge on multiple types of sectors and socio-economic conditions around Seveso type sites/areas that might be affected by accidents, taking into account the type of sites/areas, CBRNE substances of concern, the vulnerability of various sectors and their dependencies/interactions with the population, risk evaluation based on advanced decision making techniques and scenarios mimicking different levels of severity of impacts.

In the light of adequate established policy goals, an effective assessment and decision-making model, related to the potential severity of a CBRNE accident, will identify ways to decrease the cost of this kind of crisis and develop adequate protection measures. Better risk assessment for evaluation of different sectors, regions or populations, for comparing them in terms of relative vulnerability can guide the proper allocation of funding on protecting measures. Thus, will be enhanced understanding by policy-makers and other stakeholders on how multiple sectors, community, region or nation could be affected in total by an accident from a Seveso site/area, and what the total impact might be (human, material and economic).

At the European level are known most relevant methodologies and approaches in the field of environmental risk assessment, as an outcome of an extensive research, such as ARAMIS (Accidental Risk Assessment Methodology for Industries in the framework of Seveso II directive) – coordinated by France; YMPÄRI, developed by several Finnish authorities; PROTEUS - developed by a number of Dutch authorities; Hazard & Vulnerability Index (H & V Index) – developed in the Czech Republic and “Guidance on the environmental risk assessment aspects of COMAH safety reports” – produced by United Kingdom’s competent authority (Definition of an environmental risk assessment methodology, within the framework of Seveso II directive - Application on a case study). All these approaches include the assessment of the human, socioeconomic and natural characteristics of the site’s surroundings or constitute set of criteria for the estimation of the severity of the environmental impacts caused by accidents involving dangerous substances, but no one offers a comprehensive approach for risk assessment directed towards multisectoral dependencies in case of Seveso type accidents.

2 Measures to enhance protection and reliability of premises and buildings against explosive blast by improving structure and parameters of concrete and reinforced concrete

The most important role of the structural system is to prevent building collapse. Because the main objective of a terrorist attack with explosives is to cause the building to collapse - and thereby inflict heavy casualties among the occupants - collapse prevention and strengthening of a building’s structural system must be the designer’s primary concern. This is especially important as the majority of fatalities in terrorist attacks directed against buildings result from building collapse, as evidenced by the Oklahoma City bombing in 1995, where 87 percent of victims were killed in the collapsed portion of the Murrah Federal Building, or the WTC attack in 2001 (9/11), where over 2,600 people died in the progressive collapse of both towers (www.911research.wtc7.net/non911).

Historically, explosive blast attacks have been a favorite tactic of terrorists and will likely continue to be into the future for a variety of reasons. Ingredients for Improvised Explosive Devices (IED) and homemade bombs can be easily obtained on the open market, as can the techniques for making bombs. Also, attacks with explosives are easy and quick to execute. IEDs bring large quantities of explosives to the doorstep of the target undetected.

The dynamic of the development of modern means of terrorist impact on buildings and people, and the accelerated development of the economy dictates necessity of adequate policies by the EU to be taken. In this connection, within the scope of EU policy in the field of construction, requirements (Regulation (EU) № 305/2011 of the European Parliament and of the Council) are developed, relating not only to safety of buildings and other construction works but also to health, durability, energy economy, protection of the environment, economic aspects, and other important aspects in the public interest. Construction works as a whole and in their separate parts must be fit for their intended use, taking into account in particular the health and safety of persons involved throughout the life cycle of the works.

Provided that they are properly maintained, construction works must satisfy these basic requirements in order to meet the societal expectations for an economically reasonable working life while providing (FEMA-426/BIPS-06/October 2011, Edition 2):

- Mechanical resistance and stability

The loadings that are liable to act on them during their constructions and use will not lead to any of the following problems: collapse of the whole or part of the work; major deformations to an inadmissible degree; damage to other parts of the construction works or to non-structural components such as fittings or installed equipment as a result of major deformation of the load-bearing construction; damage by an event to an extent disproportionate to the original cause.

- Safety in case of fire

In the event of an outbreak of fire the load-bearing capacity of the construction can be assumed uncompromised for a specific period of time; the generation and spread of fire and smoke within the construction works are limited; the spread of fire to neighbouring construction works is contained; occupants can leave the construction works or be rescued by other means; the safety of rescue teams is taken into consideration.

- Hygiene, health and the environment

The construction will, throughout it life cycle, not be a threat to the hygiene or health and safety of workers, occupants or neighbours, nor have an exceedingly high impact, over their entire life cycle, on the environmental quality or on the climate during their construction, use and demolition, in particular as a result of any of the following: the giving-off of toxic gas; the emissions of dangerous substances, volatile organic compounds, greenhouse gases or dangerous particles into indoor or outdoor air; the emission of dangerous radiation; the release of dangerous substances into ground water, marine waters, surface waters or soil; the release of dangerous substances into drinking water or substances which have an otherwise negative impact on drinking water; faulty discharge of waste water, emission of flue gases or faulty disposal of solid or liquid waste; dampness in parts of the construction works or on surfaces within the construction works.

- Safety and accessibility in use

The buildings do not present unacceptable risks of accidents or damage in service or in operation such as slipping, falling, collision, burns, electrocution and injury from explosion and burglaries. In particular, construction works must be designed and built taking into consideration accessibility and use for disabled persons.

On the basis of the above it is necessary that standardized requirements to be developed at European level so as to increase sustainability of buildings (and especially critical infrastructure), including provision against explosions, and to be developed innovative methods to improve the parameters of materials and systems from which the buildings are built

Below directions can be performed with the objective to improve the parameters of materials and systems:

- Materials and Systems (FEMA-426/BIPS-06/October 2011, Edition 2)

Reinforced concrete and steel are the two materials often used in construction of the supporting structure of buildings. Reinforced concrete is also used in the form of frames and walls, which, in conjunction with glazing, may provide the exterior envelope and nonstructural elements of a building.

  - Steel

Steel frame systems are used for the construction of a variety of building types but are typically used in high-rise buildings. Steel is an inherently ductile material capable of sustaining large deformations. Steel structural systems should be detailed to take advantage of this inherent ductility, and connections should be designed to provide continuity between members.

Steel is used in the form of frames, whereas the nonstructural elements and the exterior envelope are constructed of other materials. Steel is used in three basic frame systems: moment-resistant frames, in which lateral resistance is provided by specially detailed beam/column connections; braced frames, in which diagonal steel bracing members provide lateral resistance; simple steel frames, in which lateral bracing is provided.

- Reinforced Concrete Construction

Blast-resilient design incorporating ductile reinforced concrete should exhibit the following attributes: walls should span from floor to floor rather than from column to column; splices should be staggered away from high-stress areas; reinforcing bars should be spaced no more than one wall thickness apart, and no less than one-half the wall thickness apart; special ductile seismic-type detailing should be used at connections; development lengths should be used to develop the ultimate flexural capacity of the section; ties should be closely spaced along the entire length of beams, spirally reinforced columns, and connections with a minimum bend angle of 135 degrees with spacing not exceeding d/2 (where d represents the distance from compression face to tension reinforcement); design for preventing progressive collapse should consider a scenario in which an exterior wall measuring verticall one floor height and laterally one bay width is lost (assessment of the building's integrity and redundancy).

- Methods of enhancing the sustainability of buildings (FEMA-426/BIPS-06/October 2011, Edition 2)

There are a variety of methods to improve the sustainability of buildings against explosions. In the following lines these are outlined only with reinforce to the proposal's context.

- Poured-in-place Concrete Frames and Walls

Blast-resistant design incorporating poured-in-place reinforced concrete should exhibit the following attributes: both faces should have symmetrical reinforcement; walls should span from floor to floor rather than from column to column; steel reinforcing splices should be staggered away from high-stress areas; the size and spacing of reinforcing bars should correspond to the demands of the design basis hazard; special seismic-type ductile detailing should be used at connections; development lengths should be used to develop the ultimate flexural capacity of the section; ties should be closely spaced along the entire length of beams, spirally reinforced columns, and connections with a minimum bend angle of 135 degrees with spacing not exceeding d/2.

- Reinforced Concrete Masonry Units (CMU)

Reinforced CMUs are commonly used for the load-bearing walls of buildings. Fully grouted and reinforced CMU façades can provide effective protection against blast loads.

- Structural Retrofit

Structural hardening, or the provision of localized improved resistance, is intended to enable specific structural components to meet the calculated blast loads. For example, if a particular column or set of columns in the structural system is vulnerable to the design basis threat, the retrofit for the column would be designed to resist that particular threat.

This method of providing localized improved resistance is particularly useful for retrofitting existing structures, where renovating the entire structure may be cost prohibitive or unnecessary. Although analyzing the threat and vulnerability and designing a hardening retrofit (selective retrofitting) are relatively simple, the space limitations of the current layout or conditions make the implementation of the retrofit difficult and costly.

- Building Envelope

The building envelope comprises the elements that separate the interior of a building from the outdoor environment. The building envelope is a critical set of building components because it separates the occupants, contents, and functions inside the building from the effects of explosive blast outside the building. This section focuses on the most important building envelope elements: the exterior facade, composed of glazed and opaque systems and roof structures.

The damage to exterior walls, windows, and other components that are expected to fail under a very large blast load generates flying debris that increases the risk of injuries and fatalities, both inside and outside the building. Additionally, the damage to the building envelope components and other nonstructural systems may significantly deter evacuation, rescue, and recovery efforts. To reduce the casualties from hazards associated with flying fragments, and to facilitate effective emergency response, the concepts of balanced design, ductile response, and redundancy should be considered in the design of the building envelope system.

- Structural Load-Bearing Exterior Wall Systems

Exterior load-bearing walls may also form the exterior envelope. Separate glazed systems are necessary to provide the glazed portions of the envelope; windows may be inserted in the wall or walls may alternate with curtain wall facade portions.

Ballistic-resistant design involves the use of materials that minimize the effectiveness of the weapons. To provide the required level of resistance, the walls must be constructed using the appropriate thickness of ballistic-resistant material, such as reinforced concrete, masonry, mild steel plate, or composite materials. The required thickness of these materials depends on the level of ballistic resistance required. Resistance to a high-level ballistic threat, such as a high-powered rifle, may be achieved using16.5 centimeters of reinforced concrete, 20 centimeters of grouted CMU or brick, a 2.5-centimeters mild steel plate, or 1.9-centimeters armor steel plate. A 1.3-centimeter layer of bullet-resistant fiberglass may provide resistance up to a medium-level ballistic threat.

Ballistic-resistant window assemblies contain multiple layers of laminated glass or polycarbonate materials and steel frames. Because these assemblies tend to be both heavy and expensive, the number and size should be minimized. Roof structures should contain similar materials as the ballistic-resistant wall assemblies.

- Increasing sustainability of the windows (FEMA-426/BIPS-06/October 2011, Edition 2)
    - Window Systems

Punched or punched-in windows consist of conventional windows set in an opaque structural or nonstructural wall or closely set conventional windows creating a continuous ribbon appearance.

Spandrel glazing consisting of continuous glazing, is typically inserted above a continuous structural or nonstructural spandrel. This is a common glazing pattern for commercial and institutional buildings.

Conventional curtain walls are of two basic types: stick-type wall systems and panelized systems. The response of curtain wall systems to explosive loading is highly dynamic, highly inelastic, and highly interactive. By controlling flexibility and resulting deformations, curtain walls can be designed to dissipate considerable amounts of blast energy.

- Glazing Materials
    - Annealed Glass also known as float, plate, or sheet glass, is the most common glass type used in commercial construction.
    - Wire-reinforced Glass is a common glazing material, primarily used as a fire-resistant barrier.
    - Heat-Strengthened Glass also called double-strength glass, is intermediate in respect to strength between annealed and fully tempered glass materials;
    - Fully Thermally Tempered Glass (TTG) also known as toughened glass, is typically four to five times stronger than annealed glass;
    - Laminated Glass is composed of multiple glass layers with pliable interlayer materials (usually made from polyvinyl butyral);
    - Polycarbonates are very strong and suitable for blast-load-resistant window design. With 250 times the impact strength of glass, monolithic polycarbonate is available in thicknesses up to 1.3 centimeters and can be fused or laminated to obtain any thickness needed;
    - Film also known as anti-shatter film, shatter-resistant window film or security film, is the most economical retrofit measure to strengthen the exterior glazed elements of the facade.

General security considerations for the design of glazing and windows include the following: windows should not be placed adjacent to doors, because, if they are broken, the doors can be unlocked; window openings should be protected with guards, such as grills, screens, or meshwork, firmly affixed to the structure; the operable section of a sliding window should be on the inside of the fixed section and should be secured with a broomstick, metal rod, or similar device placed at the bottom of the track.

Development of a model for buildings vulnerability assessment against chemical or radiological attack is a natural result of the complexity of achieving prevention against chemical, radioactive and explosive impact on the buildings in the conditions of Seveso type site/area related accidents.

3 Quick detection of chemical and radioactive substances contamination for early warning of Seveso type site/area and population in the adjacent areas

During the impact (for example terrorist attack) on the Seveso type site/area, chemical agents or radiological materials can be used to overcome protection of the object and hence the realization of the main goal, interrupting its functionality with a number of other means used by terrorists.

That's why the Early Warning System is mandatory for security and protection of the respective object. The most reliable elements of these systems are sensors and sensor systems. The scenarios under which sensors will be needed and the protocols for their use may be as varied as each object’s specific mission. Because chemical and nuclear weapons, each pose different threat scenarios, differences in sensors and their operational protocols will be considered. Whatever type of attack the sensors are designed to prevent or respond to the roles, that sensor systems play can be described in terms of four specific categories:

- Threat warning covers point-of-entry monitoring for preattack detection, as well as area monitoring of presumed target areas;
- Incident response scenarios, by contrast, require handheld deployable sensors and minimal training for operators;
- For treatment, the sensors’ greatest contribution will be made in the aftermath of a chemical or radiological attack. They will be able to provide quick and accurate diagnoses, without the hours or days of time lag associated with standard culture growth techniques;
- For recovery, the speed at which information is available is usually less important than the accuracy of the data. For recovery, sensors would be useful for monitoring the level of contamination at a site during and after cleanup activities.

Either way, to carry sensor-system performance to the level needed, the protection will require not only continued improvement in basic sensor performance but also a better definition and understanding of overall performance - when many sensors are networked together. Communications protocols (D 5.1 Software Sensor Communication Standards) will be needed, and network architecture issues associated with connectivity, bandwidth allocation, signal processing, and data fusion must also be addressed.

The next important step is the system-design approach, which in our case includes:

- Establishment of standards - covering response time and field stability/ durability, for example - for detection of weapons of mass destruction;
- Use of two-level sensor systems in which a low-false-alarm-rate sensor - one with low specificity - triggers a second sensor with a higher false-alarm rate but with high specificity;
- Use of multiple sensors and reasoning algorithms to obtain lower overall false-alarm probability, predict contamination spread, and provide guidance for recovery actions;
- Use of networked sensors to provide wide-area protection of high-threat targets.

The quick detection of chemical and radioactive substances contamination is envisaged to be achieved by developing a stationary sensor system.

4 Real-time analysis of air, food and water for chemical and / or radioactive contamination (including. the identification of threats in and around Seveso type site/area)

Improvement "…the development and use of detection systems across the EU" (COM(2009) 273 final) is one of the core measures in the field of new CBRN policy of the EU. Effective protection of Seveso type site/area requires increased innovation and development of advanced, intelligent detection and sensor systems for physical early warning of hazardous environments, which include a real-time analysis of air, food and water for chemical and / or radioactive contamination. The sensors, as the elements of sensor system, can also be used to monitor and report the condition of the various nodes (such as power plants and industrial complexes) and links (such as transportation systems and utilities) that form Seveso type site/area networks. In addition to advanced sensing capabilities and increased reliability, sensors must communicate with each other and be deployed at many locations to form a robust network.

Massive amounts of data will need to be processed and analysed to selectively filter out background signals in order to detect anomalies or patterns. The data and analysis results will feed into many other sensors and sensor systems, and undergo further analysis to provide actionable information to intelligence, law enforcement, and decision makers about terrorist or other suspicious or potentially damaging activities. Advancement of pattern recognition analyses will require novel approaches, possibly based on human thinking processes and instincts.

Wireless technologies are increasingly crucial to automation, communication, and information technology systems pervasive throughout the Seveso type site/area sectors. Wireless networks, already vulnerable due to limited security, face increased risks from mobile wireless nodes that can enter, traverse, and leave the network.

We can satisfy the abovementioned requirements by development of sensor systems that can monitor and report the condition of Seveso type site/area and environment, measure and report damage, quantify diminished service, and estimate downtime for refunctioning. Smart sensor systems can be programmed to suggest alternatives, which will require integration and communication with the advanced analysis and decision support systems.

The sensor systems will be “taught” to be threat-aware, self-configuring, and self-healing. They may be wired or wireless or a combination of the two – but they will be resistant to data transmission.

The on-board and system computers will have “reasoning” and data fusion analysis systems capable of interpreting and integrating spatially and temporally distributed, multi spectral, and seemingly disparate data. One potential approach is to use these reasoning capabilities while addressing threats using “anticipation” theory, which uses detected patterns to project or anticipate next steps, based on comparisons with archived patterns and profiles. Intelligent systems will have data archiving capabilities that are designed for increased reliability and that are distributed for complete recording and continuous coverage of the system.

As a final result, the real time analysis of air, food and water for chemical and / or radioactive contamination will be achieved by portable sensor system development.

5 Localization of personnel in restricted areas and remote monitoring of their physiological health parameters

For prevention of the impact of hazardous environments, the physical and mental aspects of health of workers on duty at the Seveso type site/area must be ensured. For that purpose, it has to be developed and tested a system for real-time, remote location of personnel, performing responsible tasks and working in sites of Seveso type site/area and monitoring of physiological parameters of human health, such as heart rate, skin conductance, temperature and intensity of movements. System development will be conducted in compliance with European regulations in this area (DIRECTIVE 2007/47/EC and MEDDEV 2.1/6, January 2012).

Localization of personnel can be achieved with active Radio Frequency Identification (RFID) tags and antennas located at a suitable points in the building and / or on the terrain.

The active RFID tags will monitor in real time the power of the signal supplied by the antenna, located in the vicinity, such as used the method of triangulation for determination the exact location of the person with the tag. Parallel task, together with reporting the possibility of accurate localization of personnel is the physiological parameters of human health (heart rate, skin conductance, temperature and intensity of movements):

- Heart rate and variation of heart rate is indicative of current emotional and health condition of person and can justify a decision to withdraw the person from the field or to send help;
- Skin conductance directly related to the work of the vegetative nervous system and the current emotional condition of the person. It is measured relatively easily and provides information on the level of stress;
- The temperature sensor is indicative of the health of person;
- The motion sensor (accelerometer) takes into account the acceleration of that area of the human body, on which is mounted. The signal is indicative of the instantaneous physical activity of the person. The sensor does not require contact with the skin, but the signal it must be interpreted according to the attachment location.

Combined, the proposed four physiological parameters outlined picture of the current status of person and his working capacity, as well as indirect evidence of the environment in which it is located, thereby helping the business process and / or control.

All these sensory elements (sensor for heart rate, accelerometer, sensor for skin conductance, thermometer and active RFID tag) will transmit information, with once per minute frequency, to the nearest RFID antenna, respectively, to the command center.

The command center software will analyze in real time information on the physiological parameters and location of personnel and when these parameters go beyond the predefined rates will alert the operator on duty.

Along with, the software will back up data obtained for possible later inspection and / or for statistical analysis.

6 Personnel training and education

To achieve better preparedness of society against Seveso type accidents, unless improvement of prevention and protection measures, timely implementation of training and education activities is important step in the field. Effective training, education and awareness are an essential process for properly implementing security measures against impact of CBRNE materials on the STO and the population. The efforts to improve awareness and training capacity building should also be stepped up.

It should include more work on sharing best practices and developing guidance in tune with EU policy, which provides:

- Support for training and education abilities of Member States to help the EU to build its capacity to be prepared for crises, create synergies and eliminate duplication in protecting EU citizens;
- Skilled operators behind the equipment, well trained and motivated to enhance the person's performance, while making full use of the technology on hand.

Thus is expected to be achieved (COM (2014) 247 final):

- Further develop training tools, encourage the sharing of best practices and develop guidance materials to support practitioners with state-of-the-art training;
- Address the human factor risks by promoting a programme to ensure that those who operate detection equipment are well trained and motivated, and improve communication between industry, security service providers and Member States through workshops and tools and improve the level of security;
- Ensure CBRNE risks are taken properly into account in the development of the European Emergency Response Capacity;
- Closer links with training and exercises provided in the framework of the EU Civil Protection Mechanism.

CONCLUSION

Expected impact and benefits of the approach developments is a better preparedness of the society and all levels of stakeholders as a whole towards the "Seveso type site/area related accidents" to be achieved, via improved protection measures, including people training and education. Also, in the light of adequate established policy goals, an effective assessment and decision-making model, related to the potential severity of a CBRNE accident, will point out ways to decrease the cost of this kind of crisis and develop adequate protection measures. Better risk assessment for evaluation of different sectors, regions or populations, for comparing them in terms of relative vulnerability can guide the allocation of protecting measures financing properly. Thus, understanding by policymakers and other stakeholders will be enhanced on how multiple sectors, community, region or nation could be affected in total by an accident from a Seveso site/area, and what the total impact might be (material, human, economic).

ACKNOWLEDGEMENTS

We express our gratitude to Directorate General “Fire Safety and Civil Protection”, Bulgarian Ministry of Interior, Municipality of Sofia, Bulgaria; Municipality of Ivanovo, Bulgaria and special thanks to Municipality of Tartu, Estonia and Municipality of Giurgiu, Romania and all our colleagues from the organization mentioned at the beginning if this publication who supported our idea for this contemporary approach for complex analysis and evaluation of hazardous environments. The management of these organisations stated that it is necessary to work in the direction described herein. On this basis, we will continue to work in Bulgaria for the realization of this work.

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