Chapter 13
Improving Safety of Soft Targets, Which Are Found Side by Side with Sewage Wells

Valentina Iurchenko and Elena Lebedeva

Abstract Improving safety of the soft targets includes protection of the objects that surround them. Compulsory element of immediate surrounding of the soft targets in urban environment is utility systems of city essential services. The sewage networks are open into ground space by means of mines and wells, located in the immediate vicinity of the soft targets as well. One of the potential preventive measures for protection of the soft targets, that are found side by side to sewage mines is engineering solutions that minimize the secondary effects, formed in these facilities: fire hazard/explosion hazard and high concentration of toxic gaseous compounds (hydrogen sulphide, alkyl sulphydrate, carbonic oxide and others). Concentration of methane in gas air environment of the sewage pipelines presents special hazard, which concentration in some areas of the sewage network exceeds the lower explosive limit. The technical solution is experimentally deduced, that allows efficiently and cost-effectively to minimize concentration of gaseous compounds in the sewage networks. The lasting monitoring of gas air environment compound in the urban sewage pipelines has been executed, as well in the mines (17.7% of total amount), located in the immediate vicinity from the various soft targets. It is found that methane concentration in gas air environment of the urban sewage mines has significantly decreased over the last 20 years. And at present the mines with explosive methane content and hazard content of toxic compounds in the neighborhood of the soft targets are not detected.

Keywords Soft targets · Sewage networks · Effects · Fire hazard/Explosion hazard · Minimization · Monitoring

V. Iurchenko (✉) · E. Lebedeva
Kharkov National University of Civil Engineering and Architecture, Kharkiv, Ukraine

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13.1 Introduction

At the present time the unprotected places of people meeting, where they communicate, study, take rest, live, travel and are treated, i.e. the facilities, named "soft targets", are subject to the terroristic attacks to the utmost. These are attackable facilities, chosen by terrorists that aim to kill and disable as many as possible people [1–3]. The soft targets are cheaper alternative to the attacks on more complex "hard targets", which are well secured and guarded facilities; the attack on the soft targets does not require complex and intense preparation of trigger men. In the meantime reliable protection of the soft targets in the urbanized territories represents the broad range of various activities, which are highly cost-based, including engineering ones [3, 4].

13.2 Safety of the Soft Targets in the Urban Environment

13.2.1 Ways to Improve the Security of Soft Targets

In many countries methods of safety improving of the soft targets and protection providing for the facilities of the urban environment are developed, as, otherwise, they are kept completely not protected, and therefore they are attractive for the terrorists. It led to the presentation of significant amount of recommendations (which consider current experience of hitting of the soft targets under terrorist attacks) [3–5], however they are not official standards. That is why such recommendations are not always known to the security staff members, community services members, owners of premises or other concerned persons, including persons who have professional knowledge of civil engineering and maintenance of engineering constructions. In the meantime in the Activities plan, presented by the European Commission COM (2017) 612 [6], whose aim is support for states with regards to protection and reduction of vulnerability of public space, it is indicated about the necessity of searching of technical solutions, that can help make public space more secure at the same time keeping their public and social character. The effective solution of this task is impossible without involving of information about technical features of city engineering systems and their operation, and also about potential risks produced by them.

It is recommended to take into consideration the facilities, that surround the soft targets, in the article [4] among ten main recommendations for increase in stability of the soft targets. In this document it is indicated that it is necessary to protect the whole area, and not the isolated section or the agency under strengthening of the soft targets. It is significantly right concerning the soft targets that are located tightly side by side or included in the complex of facilities of different assignment.

13.2.2 Impact of Utility Networks of City Essential Services on Soft Targets Security

The soft targets are mainly typical urban infrastructural facilities: schools, canteens, shopping centers, medical centers, cinemas and theatres, concert halls, clubs, restaurants and hotels, parks, museums, sports arenas, railway and bus stations, airport terminals, libraries and others [2, 4, 6]. Compulsory elements of their immediate surrounding are utility systems of city essential services, located in the underground space: water supply, sewer, heating supply, gas supply and electrical power supply networks, and without their operation proper functioning of these soft targets is impossible. Essential services facilities of the city can also become terroristic attacks objects. Although they can hardly be referred to the soft targets, as specialized guard and anti-terrorist protection of a number of facilities of such systems and their equipment are provided by the range of the legislative and department documents. The utility networks can become the element; where through the soft targets can be attacked in the nearest territory, or the element, that can be got in the danger area under the attack on the nearby soft targets.

The terrorist attacks on the utilities systems networks can cause formation of secondary effects that far exceed in their scale and severity of consequences of damage effects, resulting from the initial effect on the facility. For that reason the utility networks are the element that is able to intensify the damage effects of the terrorist attacks, which effect on the soft targets, as well as to weaken them. In that context the urban sewage networks draws attention, although water supply and sewage networks are excluded from the objects, that require protection [7], in the known governmental regulations about the requirements to the anti-terrorist protection.

13.2.3 Basic Risks for the Soft Targets, Formed in the Sewage Networks

Water discharge networks penetrate the whole underground space of cities and are open into above ground urban space by means of mines and wells, located in the territories of different facilities of urban infrastructure, including in close vicinity to the soft targets. Accidents of the sewage networks are followed by serious financial damage and strong pollution of the underground space with toxic gaseous and dissolved maters for this reason the sewage networks are always located lower than other networks [8, 9]. At present the sewage networks already draw attention of anti-terrorist services. Thus, under the program of detection Emphasis the Swedish scientists have developed a special sensor, which can be installed in the sewage network for detection of clandestine laboratories for production of explosive devices. As production of explosive devices is necessarily connected with emission

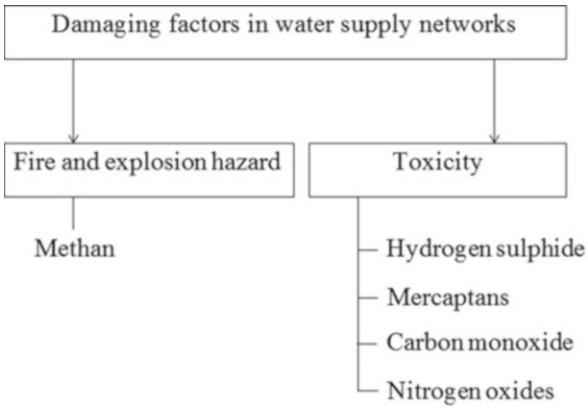

Fig. 13.1 The main hazards posed by sewage mines

Table 13.1 Chemical compounds in air of the underroof space of the sewerage pipelines [9, 12]

Compounds	Concentration	Rate of MPC excess working area
CO_2, volume %	0.1–3.5	to 7
CO, mg/m^3	0–25	to 1.4
CH_4, volume %	0.2–6.0	to 3
H_2S, mg/m^3	0–250	to 25
SO_2, mg/m^3	5–30	to 3
Dimethylsulphid, mg/m^3	(1–4) 10^{-4}	to 10^2
NH_3, mg/m^3	0–5.0	to 4
NO_x, mg/m^3	0–5.0	–

of chemicals of specific nature into the sewage facilities, then location of clandestine laboratory can be found due to motion in the network regarding increase of specific matter concentration [10].

Under security system engineering for the specific soft target (place or event) potential hazards for guarded facilities, considering their surrounding with sewage facilities – pipelines, mines and wells must be considered, and then it is necessary to choose and implement appropriate security measures. One of the potential measures from the preventive ones is engineering solutions that minimize the secondary effects. Let us consider critical threats to the soft targets, that can form the most common ways of terrorist attacks (57% [4]) – Bombing/Explosion in the sewage networks. Not only direct destructive effect can be related to the main risk factors, but also the secondary effects, which are specifically formed in these facilities: fire/explosion hazard and high concentration of toxic gaseous compounds [9, 11] (see Fig. 13.1, Table 13.1).

As it can be seen from the data from Table 13.1, gaseous compound concentration in the gas air environment of sewage pipelines varies widely, achieving extremely dangerous values in some areas. Concentration of methane in gas air environment of the sewage pipelines presents special hazard. Its compound with air explodes on

contact with flame or spark. The lower explosive limit is 5, the upper one is 15 volume % [13], and in some sewage networks areas its concentration can reach 6%.

13.3 Research Objective

Estimation of potential hazard of sewage mines of the city for security of the soft targets by means of monitoring of gas air environment compound in the sewage pipelines.

13.4 Research Methods

In the present work the results of the lasting monitoring of gas air environment compound in the sewage pipelines, executed together with sewage networks maintenance departments, are presented. The measurements of the gases concentration in the environment of the underroof space of the sewage networks were performed with three gas analyzers: UG-2, "Dozor", a mine interferometer ShI-11.

13.5 Research Results

The regular control of gas air environment compound is carried out at 62 mines of sewage network of the city. From sewage pits, subject to control, 11 mines are in immediate vicinity from various soft targets (at a distance not more than 40 m):

- apartment block – 6 mines (11.3%);
- hospitals – 2 mines (3.2%);
- recreation areas – 2 mines (3.2%);
- nursery school – 1 mine (1.6%).

According to the measurements (see Fig. 13.2), over the last 20 years the tendency of decrease of methane concentration in gas air environment of city mines has been noted.

At present the mines with methane content $\geq$5% volume %. in gas air environment are not indicated. And if in the end of 90s and in early 2000 among sewage mines with increased methane concentration ($\geq$5% volume %) 4 mines were located in immediate vicinity from the soft targets, then in 2006 such mines were not detected. In 2016 only one mine with methane content $\geq$2% volume % was registered, that is located at 30 m from the soft target – an apartment block. Methane concentration in gas air environment of sewage pipelines positively correlated with high toxic (second hazard class) hydrogen sulphide compound concentration (Table 13.2).

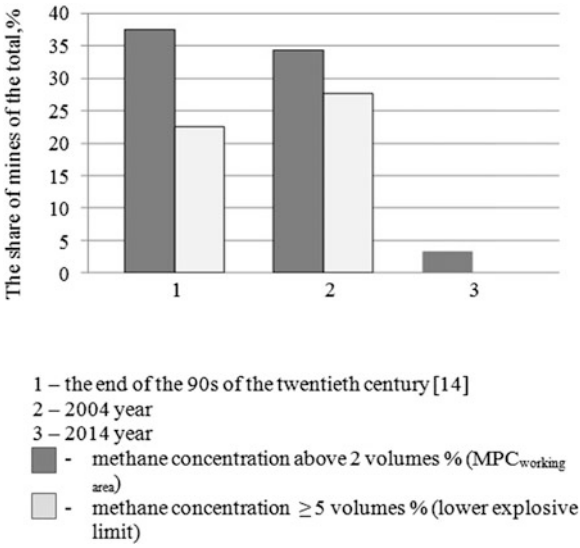

Fig. 13.2 The number of mines in the sewer network with a high content of methane

Table 13.2 The change in the concentration of gaseous compounds in the sewer shaft for 3 months

Month	SO_2, mg/m^3	H_2S, mg/m^3	CO, mg/m^3	CO_2, volume %	CH_4, volume %
May	35	110	0	0.6	0.2
June	35	125	0	0.6	0.4
July	35	132	0	116	2.16

Different methods of concentration decreasing of explosive and toxic compounds in gas air environment of sewage networks are examined experimentally and on operating sewage networks. It is found that the most advanced method is decreasing of the temperature of sewage water that is transported by the networks by means of heat pumps. Such measure allows practically to decrease these compounds concentration in networks twice, and consequently to decrease potential risk of secondary effects, formed in these facilities under terrorist attack.

13.6 Conclusions

On the basis of carried out theoretical, practical and experimental researches the following can be concluded:

- the sewage networks are dangerous neighbor objects for the soft targets, as they can intensify destructive effect of terrorist explosions:
- main secondary effects, formed in these objects under terrorist attack, are decrease of concentration of fire/explosion hazardous and high toxic gaseous compounds, formed in some areas of the sewage networks;

- under inspection of urban sewage mines, that are found side by side with the soft targets, the mines with dangerous methane content and toxic compounds (hydrogen sulphide, alkyl sulphydrate, carbonic oxide and others) are not detected at present.

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