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FROM ORDER TO CHAOS WITH STANDARD MAP AND ORTHOGONAL FAST LYAPUNOV INDICATOR

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Abstract: The standard map is an apparently simple system that is well suited to explain the transition from regular behaviour to global chaos. Its dynamics depends strongly on a control parameter that influences the degree of chaos. For low or high parameter values the resulting dynamics is entirely regular or chaotic. At intermediate parameter values, however, the map exhibits a complex behaviour characterized by a mixture of chaotic and regular regions in the phase space. It is the purpose of this paper to emphasize this remarkable dynamics. Using phase planes and the Orthogonal Fast Lyapunov Indicator (OFLI) plots we try to determine the control parameter levels at which the main transformations take place and determine how quickly the chaotic orbits replace the regular ones in the phase space. Some comments referring the implementation and the efficiency of the OFLI test are included in the paper.

Keywords: CHAOS INDICATOR, STANDARD MAP, OFLI PLOTS

1. Introduction

More than thirty detection tools there exist nowadays in order to study the regular or chaotic behavior of orbits of dynamical systems, no matter they are dissipative or conservative. Some of the most reliable and fast techniques are based on the so-called variational equations describing the evolution of deviation vectors related to the studied orbit. This set of indicators includes the Fast Lyapunov Indicator and its variants [1-3], the Smaller Alignment Index [4], the Generalized Alignment Index [5], and so on.

The Orthogonal Fast Lyapunov Indicator was introduced in 2002 by Fouchard et al. as a means of separating robustly, on one hand, the regular from chaotic dynamics and, on the other hand, the periodic orbits among the ordered components of the phase space. The test was successfully applied to some conservative discrete/continuous dynamical systems.

Our purpose in this contribution is to extend the research performed by Fouchard and co-workers on the OFLI test and standard map. In this view, we present a sequence of plots demonstrating the efficiency of OFLI in distinguishing between ordered and chaotic regions of the phase plane as the control parameter of the standard map is gradually modified.

2. Standard map. Definition and evolution with parameter

The standard map, also known as Taylor – Chirikov map, is a two-dimensional area-preserving map from a square (with side 1 or $2\pi$) onto itself. It represents an exact or an approximate description of many physical systems including kicking rotor, a ball bouncing between oscillating walls, magnetic field lines, etc., and has several mathematical descriptions. Brian Taylor and Boris Chirikov have proposed for the map the variant

\[
\begin{align*}
x_{n+1} &= x_n + y_n + k \sin(2\pi x_n) \\
y_{n+1} &= y_n - \frac{k}{2\pi} \sin(2\pi x_n)
\end{align*}
\]  

(1)

with $x_n$ a periodic configuration variable and $y_n$ the momentum variable [7]. In the paper we consider a slightly modified variant of (1), introduced by Froeschlé and Lega [1]

\[
\begin{align*}
x_{n+1} &= x_n + k \sin(x_n + y_n) \\
y_{n+1} &= x_n - y_n
\end{align*}
\]  

(2)

where the role played by $x_n$ and $y_n$ is reversed. In both cases $k$ is a control parameter which, in the original form, signifies the strength of the kick.

As $k$ is gradually decreased/increased starting with $k = 0$, the standard map exhibits a transition from order to local and, finally, to global chaos. For $k = 0$, the equations (2) are integrable. After $n$ iterates the map one has $x_n = \omega = \text{constant}$, $y_n = y_0 + n\omega \pmod{2\pi}$, so the phase plane consists in a set of parallel lines with constant momentum. For the case of the kicked rotor, the dynamics is that of a uniform circular motion with angular velocity $\omega$. Depending on $\omega$, the associated orbit may be either periodic or quasi-periodic (a torus). When $|k|$ is small, the dynamics described above is slightly perturbed in that the vertical tori are curved. Increasing $|k|$, the phase plane shows invariant tori separating different small chaotic regions. Part of the tori are destroyed while several resonances make their appearance. The last invariant tori is destroyed when $|k| \geq 0.971635406$ (Green’s number) and the local chaotic zones merge together to form a large chaotic sea. For $|k| > 2$ the phase plane becomes mostly chaotic, several islands of small size continuing to “survive” (the biggest one being centered on the elliptic point (0, 0)). Finally, for $|k| \leq 7$ transition to global chaos is completed.
This rich dynamics is illustrated in Fig. 1, where the phase planes of the standard map (2) are plotted for representative $k$ values. Each panel includes about 40 orbits restricted to the square $[-\pi, \pi] \times [-\pi, \pi]$.

From the definition (2) and Fig. 1 some useful properties of standard map are obvious, the most important being:

- the $2\pi$ - periodicity both in $x$ and $y$; this permit to know everything about the phase plane from a single unit cell, the square $[-\pi, \pi] \times [-\pi, \pi]$.

- the commutativity with the reflection, $M(x, y) = M(-x, -y)$; this allow to identify the lower and upper parts of the phase plane and to study the map just for $[-\pi, \pi] \times [0, \pi]$.

These properties may be used for saving computational time when the chaos indicators are applied.

Fig. 2. Typical orbits of standard map for $k = -0.4$. The initial conditions are: $(0.001, 3.1)$ – chaotic orbit, $(2.2, 0.0)$ – periodic orbit; $(0.5, 0.5)$ – quasiperiodic orbit.

For a given $k$, the orbits may have different behaviors depending on the initial condition. As a typical example, for $k = -0.4$ the orbit starting from $(0.001, 3.1)$ is weakly chaotic, while those having as initial points $(2.2, 0)$ and $(0.5, 0.5)$ are periodic (with period 3) and quasiperiodic, respectively (see Fig. 2 and Fig. 1 a).

3. Orthogonal Fast Lyapunov Indicator (OFLI). Short presentation

In this section we briefly describe the OFLI method for the case of a mapping, following [6]. Consider four objects, namely

- a mapping $x_{n+1} = M(x_n)$

from $\mathbb{R}^d$ to $\mathbb{R}^d$, $n$ belonging to $\mathbb{N}$, and an orbit with the initial condition $x_0$;

- the tangent map associated to (3)

$$v_{n+1} = \frac{\partial M}{\partial x}(x_n) \cdot v_n$$

and an initial vector $v_0$. The OFLI is defined as

$$OFLI(x_0, v_0, n) = \sup_{0 \leq i < n} \log \left| v_i^T \right|$$

where $v_i^T$ represents the component of $v_i$ orthogonal to the map at point $x_i$ ($i$ denotes the iteration’s number), that is

$$\left| v_i^T \right| = \sqrt{\|v_i\|^2 - \left(v_i, M(x_i)\right)^2/\|M(x_i)\|^2}$$

and the base of the logarithm is taken to be $e$ (the Neper’s number).

As it was found in [6], the OFLI tends to a constant value for periodic orbits, grows linearly with the number of iterations for quasi-periodic orbits and exponentially fast for chaotic orbits. Moreover, the rates of change for the resonant regular orbits and non-resonant ones are different, giving the possibility to distinguish between them. Let us note that in the literature there exist too a slightly different definition of the OFLI [8].

The above-mentioned behaviors are illustrated in Fig. 3 for the three particular orbits analyzed in Fig. 2.

Fig. 3. Evolution of OFLI with the number of iterations for the standard map with $k = -0.4$ for three initial conditions:

$x_0 = 0.001; y_0 = 3.1$ - chaotic orbit; $x_0 = 2.2; y_0 = 0.0$ - periodic orbit; $x_0 = 0.5; y_0 = 0.5$ - quasiperiodic orbit.

When computing the OFLI and searching for a threshold value between order and chaos we must to know that there is a certain dependence of the results on the initial choice of $v_0$. Thus, Fig. 4 shows the OFLI plots for the periodic orbit of standard map with $k = -0.4$ and $x_0 = 2.2, y_0 = 0.0$, for three initial vectors, namely $v_0 = [1; 0], v_0 = [0; 1]$ and $v_0 = [0.6; 0.8]$. Although the general trend is similar, the final values after 1 000 iterations are sufficiently far each other.
4. Detecting regions of order and chaos with OFLI

In order to present the effectiveness of the OFLI in separating regions of order and chaos we computed the OFLI for a large grid of 251 x 251 = 63 001 equally distributed initial conditions on the phase plane of the standard map. We assigned a colored little square to every individual initial condition according to the OFLI value after N iterations. The relationship between the color and OFLI value is indicated on a vertical bar near the OFLI picture.

A first problem to solve was the maximum number of iterations necessary for a reliable separation between order and chaos. A small number may lead to wrong conclusions, at least for the so-called “sticky” orbits, which remain at the borders of an island of regularity for a long time before enter in the chaotic sea. On the other hand, a large number of iterations will require considerable CPU time without yielding additional information.

To clarify this, on Fig. 5 we show the OFLI plots for $k = -1.3$ and $N = 600$, respectively $N = 2000$. We observe as when $N = 600$ in the chaotic sea (the lighted zone) an important number of dark points are still present, which seem to describe regular orbits. For $N = 2000$ the color of these points have changed in white (chaotic orbits) and the picture is in a very good agreement with the associated phase plane. The initial vector seems to have little influence on the final result. Thus, using $v_0 = [1,0]$ a number of 24 992 initial conditions (39.67%) are colored in black while for $v_0 = [0,1]$ the same color is attributed to 24491 initial conditions (38.87%). For the rest of the paper the vector $v_0 = [1,0]$ is used and the number of iterations is restricted to 2000.

Other OFLI plots proving the appearance and growth of chaos with increasing $|k|$ are reported in Fig. 6. The first sign of chaotic behavior is revealed by OFLI in the proximity of the hyperbolic point $(0, \pi)$.

For $k = -0.8$ the chaotic area is well-developed and make a clear separation between the regular resonant orbits having elliptic shape located around the origin $(0, 0)$, and the surviving regular non-resonant orbits separated by islands of tori. New unstable hyperbolic points are also visible (see Figs. 1b and 6a).

Once with outrunning the Greene’s number the chaotic zone start to merge and to grow in measure. Apart from the big central island of regularity, a lot of small islands with regular resonant orbits are still embedded in the chaotic region (see Figs. 1c and 6b for $k = 1$). For $k = -2.2$ only four of these islands have survived and the central island covers just a quarter of the phase plane (see Figs. 1d and 6c). Further increases of the control parameter yield to a slowly disappearance of the regularity island, as presented in Table 1 and Fig. 7.
Fig. 6. OFLI plots demonstrating the growth of chaos with increasing $|k|$.

Table 1: Percentage of chaotic orbits for different $k$

<table>
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<th>$k$</th>
<th>$%$</th>
<th>$k$</th>
<th>$%$</th>
<th>$k$</th>
<th>$%$</th>
</tr>
</thead>
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<td>-0.3</td>
<td>0.03</td>
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<tr>
<td>-1.3</td>
<td>60.09</td>
<td>-3.5</td>
<td>88.90</td>
<td>-7</td>
<td>99.99</td>
</tr>
</tbody>
</table>

Fig. 7. OFLI plots showing the transition from order (black color) to chaos (white color) with increasing $|k|$ on the $x$–axis of the standard map. The border between the ordered and chaotic regions shows fractal features.

Fig. 8. A rescaling of OFLI values which allows for a better separation between different types of orbits of standard map. White color stands for chaotic orbits, while grey and black colors represents quasiperiodic orbits, respectively periodic orbits and their neighborhood.

5. Conclusions

In this work, we have shown that the Orthogonal Fast Lyapunov Indicator (OFLI) is a powerful tool to characterize the regular or chaotic behavior of orbits in discrete dynamical systems like standard map. We have presented a sequence of OFLI pictures showing the dynamical evolution of the system from order to chaos as its control parameter is gradually modified. The features revealed by these plots cannot be obtained entirely by complementary techniques, like time series or phase planes.

References

CONSTRUCTION AND CLASSIFICATION OF OPTIMAL (v,5,3,1) OPTICAL ORTHOGONAL CODES

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Abstract: We classify up to multiplier equivalence maximal (v, 5, 3, 1) optical orthogonal codes (OOCs) with lengths up to 100.

Keywords: OPTICAL CODE-DIVISION MULTIPLE ACCESS SYSTEM, OPTICAL ORTHOGONAL CODE

1. Introduction

One of the basic concepts in data communication is the idea of allowing several transmitters to send information simultaneously over a single communication channel. This is called multiple access. There are several techniques to provide multiple access and one of them is code division multiple access (CDMA). Although used in various radio communications systems, the most widely known application of CDMA is for cellphones.

A binary signature sequence (codeword) is assigned to each user in a CDMA system. The data to be sent is mapped onto the codewords and the different users codewords are mixed together and sent over the channel. At the receiver end a decoder, which is individual for each user, compares the incoming sequence with stored copies of the codewords to be able to extract the information bits.

Optical code-division multiple access (OCDMA) systems attract much attention as they have several benefits such as asynchronous transmission, being flexible in network design, accommodation of burst traffic, etc. A main problem connected with the use of OCDMA systems is the search for powerful code structures that allow a large number of users to communicate simultaneously with a low error probability. Among the most famous codes considered to date are optical orthogonal codes (OOCs). They also have applications in mobile radio, frequency- hopping spread-spectrum communications, radar, sonar signal design, constructing protocol - sequence sets for the M-active-out-of T users collision channel without feedback, etc.

Since the introductory paper by Chung, Salehi and Wei [7] the optical orthogonal codes existence problem has been intensively studied. Many constructions of optimal optical orthogonal codes are known, see for instance [4,5,6,8,9,11]. In particular, OOCs of weight 5 have been considered in [1,2,3,4,9,10,11]. Most classes of optimal (v,5,1,1) OOCs that are known were obtained by the powerful difference family apparatus either as ordinary (v,k,1) difference families (corresponding to the perfect (v,k,1,1) OOCs) or relative (v,k,n,1) difference families with n ≤ k²⁻k.

Constructions and classification of (v,5,2,1) OOCs of small lengths are presented in [2] and [4]. In this paper we classify (v,5,3,1) OOCs with lengths up to 100.

2. Basic definitions

For the basic concepts and notations concerning the classified combinatorial objects we follow [4] and [9]. We denote by \( \mathbb{Z}_v \) the ring of integers modulo \( v \) and by \( \oplus \) addition in it.

Definition 1. A \((v,k,\lambda_a,\lambda_c)\) OOC is a collection \( C=\{c_1,\ldots,c_s\} \) of \( k \)-subsets (codewords) of \( \mathbb{Z}_v \), such that any two distinct translates of a codeword share at most \( \lambda_a \) elements, and any two translates of two distinct codewords share at most \( \lambda_c \) elements:

\[
|c_i \cap (c_j \oplus t)| \leq \lambda_a, \quad 1 \leq i < j \leq s, \quad 1 \leq t \leq v-1
\]

\[
|c_i \cap (c_j \oplus t)| \leq \lambda_c, \quad 1 \leq i \leq j \leq s, \quad 1 \leq t \leq v-1
\]

Codewords of an OOC can also be represented as \{0,1\} sequences of length \( v \) having ones at positions \( c_i \).

Condition (1) is called the auto-correlation property and (2) the cross-correlation property.

Definition 2. The size of \( C \) is the number \( s \) of its codewords.

Consider a codeword \( C=\{c_1,\ldots,c_s\} \). Denote by \( \Delta C \) the multiset of the values of the differences \( c_i - c_j \), \( i \neq j, i,j=1,2,\ldots,k \) and by \( \Delta C \) its corresponding set. The type of \( C \) is the number of elements of \( \Delta C \) i.e. the number of different values of its differences. The auto-correlation property means that at most \( \lambda_a \) differences are the same. For \( \lambda_c = 1 \) the cross-correlation property means that \( \Delta C_1 \cap \Delta C_2 = \emptyset \) for two codewords \( C_1 \) and \( C_2 \).

Definition 3. A \((v,k,\lambda_a,\lambda_c)\) OOC is perfect if \( |J_{\lambda_c} \cap \Delta C| = v-1 \), that is if all nonzero differences are covered.

Example. Codewords of a perfect \((37,5,3,1)\) OOC

\( C_1 = \{111000100000000000000000000000000000000\} \) or \( \{0, 1, 2, 7, 32\} \)

\( C_2 = \{100100000001000000010100000000000000\} \) or \( \{0, 3, 11, 19, 22\} \)

\( C_3 = \{1000100000001001000000000000000000\} \) or \( \{0, 4, 13, 17, 27\} \)

\( \Delta C_1 = \{1,2,5,6,7,12,25,30,31,32,35,36\} \)

\( \Delta C_2 = \{3,8,11,15,16,18,19,21,22,26,29,34\} \)

\( \Delta C_3 = \{4,9,10,13,14,17,20,23,24,27,28,33\} \)

Among the OOCs with given parameters those ones which have more codewords are more interesting from application point of view and research efforts are directed there.
Definition 4. A \((v,k,\lambda_1,\lambda_2)\) OOC is optimal if it has maximum size.

Since we want to classify all OOCs with given parameters, we need to define an equivalence relation on them.

Definition 5. Two \((v,k,\lambda_1,\lambda_2)\) OOCs \(C\) and \(C'\) are isomorphic if there exists a permutation of \(Z_v\), which maps the collection of translates of each codeword of \(C\) to the collection of translates of a codeword of \(C'\).

Definition 6. Two \((v,k,\lambda_1,\lambda_2)\) OOCs are multiplier equivalent if they can be obtained from one another by an automorphism of \(Z_v\) and replacement of codewords by some of their translates.

There can exist OOCs which are isomorphic, but multiplier inequivalent.

3. Classification method

We classify up to multiplier equivalence the \((v, 5, 3, 1)\) OOCs by a modification of the algorithm used in [2]. The algorithm performs backtrack search on the set of all possible codewords, i.e. all 5-sets which meet the auto-correlation requirement. In the present modification we check which types of codewords are available in this set and exclude from it the codewords of types that are impossible for a code with the predefined size.

At each stage of the back-track search we add a codeword to the current partial solution. In order to make the classification feasible we speed up the algorithm by performing a minimality test and a type test to the partial solutions.

Minimality test: we check if the current partial solution can be mapped to a lexicographically smaller one by the automorphisms of \(Z_v\). If it can, an equivalent partial solution has already been considered, and we look for the next possibility for the current codeword.

Type test: Suppose that \(r\) codewords of the code have been already found. Let \(T\) be the type of the \(r\)-th codeword, and let \(d\) be the number of distinct differences covered by the \(r\) codewords. The type of the remaining codewords (of the array we choose them from) is at least as big as that of the \(r\)-th chosen one. That is why

\[d + (s - r)T \leq v - 1.\]

If this does not hold, the next possibility for the \((r-1)\)-st codeword is considered.

4. Classification results

The classification of maximal \((v, 5, 3, 1)\) OOCs with \(29 \leq v \leq 100\) is presented in Table 1. We start with \(v=29\) because \(s < 2\) for all smaller lengths. For each \(v\) we give the size \(s_{opt}\) of the optimal OOCs, the number of all multiplier inequivalent optimal OOCs, and the number of the perfect ones among them.

<table>
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Abstract: Elaboration of effective ways of elimination of spilled oil and oil products are very actually now. One of the most effective methods for solving this problem is the absorption of the oil by sorbents. Supersorbent on the basis of thermally expanded graphite has unique characteristics. It is a special modification of the graphite obtained by multi-stage thermo-chemical treatment of natural flakes graphite. We have developed different methods of preliminary preparation and subsequent application of this sorbent considering a specificity of emergency spill, properties of spilled liquid, the nature of cleaning surface and weather conditions. Also, question of spent sorbent utilization has been studied. The recycling process involves the desorption process up to 85% with subsequent use of the sorbent to 10 cycles of regeneration. Obtained while desorption liquid can be used for another purpose or as an additive to fuel oil. Technology and equipment for liquidation of emergency oil spills on water surface and coastal sand have been developed and tested.

KEYWORDS: SUPERSORBENT, THERMALLY EXPANDED GRAPHITE, OIL SPILLAGES, REGENERATION OF SPENT SORBENT, STABLE AND MOBILE UNITS

1. Introduction

At the present time to eliminate pollutions on the water surfaces and sand beaches from oil, petroleum and other organic fluids spills as rule porous substances of natural and artificial origin are used. They are: peat, sawdust, shredded twigs, perlite, polystyrene foam, various fibrous materials. Sorbents are applied to the contaminated area after that the major part of spilled product is collected more often by mechanical means. Also, special bacteria that decompose organic matter into the neutral substance is used [1].

2. Objective and research methodologies

At liquidation of emergency spills of oil and oil products by the method of sorption the most promising method is the use as oil-absorbing sorbent termoexpanded graphite (TEG). TEG represents by itself a special modification of the graphite obtained by multistage natural graphite thermochemical processing. This kind of graphite found in the literature also under the names of exfoliated graphite, foamed graphite and thermografenite. This product is characterized by very low bulk density (2-5 kg/m³) and high specific surface which in combination with its selectivity for oil causes a high absorption capacity relative to oil and other organic liquids. One gram of this substance can absorb 30-60 grams of oil (see Table 1). An important feature of this sorbent is its inertness, the ability to desorption up to 90% of absorbed liquids and the possibility of thermochemical regeneration for repeated use [2-4].

Table 1. TEG sorption characteristics for some organic liquids

<table>
<thead>
<tr>
<th>The name of the substance</th>
<th>Sorption capacity, g/g sorbent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>30</td>
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<tr>
<td>Turpentine</td>
<td>30</td>
</tr>
<tr>
<td>Benzene</td>
<td>35</td>
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<tr>
<td>Diesel fuel</td>
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<td>Kerosene</td>
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<tr>
<td>Vegetable oil</td>
<td>45</td>
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<tr>
<td>Machine oil</td>
<td>50</td>
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<tr>
<td>Crude oil</td>
<td>55</td>
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</tbody>
</table>

Actually liquidation process of emergency spills of oil, oil products and other organic liquids on the water surfaces and sand of coastal zone with sorbent on the basis of thermoexpanded graphite includes such stages:

- sorbent obtaining – thermo expanded graphite (if it required directly on the place of emergency spill);
- pre-treatment (preparation) of the sorbent;
- applying of a sorbent on contaminated surface;
- collecting of a saturated sorbent;
- separation and recycling of on absorbed liquid;
- regeneration of a waste sorbent and its reuse.

Scientists from Gas Institute of National Academy of Sciences of Ukraine have designed, manufactured and tested series of units with different performance, autonomy and automation for TEG manufacturing.

- pilot unit with a capacity of 8.5 m³/h (35 kg/h by raw material). One example of the unit was manufactured and put into operation at the Argonne National laboratory, Chicago, USA (Fig. 1);
- autonomous automatic unit of a local destination with capacity of 1-2 m³/h (5 kg/h by raw material) (Fig. 2);
- TEG autonomous knapsack generator with a capacity of 0.8 m³/h (3 kg/h by raw material) (Fig. 3) [5];

Significant technical obstacle when using oil-absorbing sorbent on the basis of expanded graphite is its extremely low bulk density, resulting in low profitability of the technology as a whole with TEG delivery to the place of emergency spill. Spreading of the sorbent in the form of a dry powder to the contaminated surface is also associated with its entrainment (losses), which causes an increase in specific consumption of sorbent and contamination of the surrounding area. In the Gas
Institute of NAS of Ukraine various methods of preliminary TEG treatment have been investigated and tested on a pilot scale. Different modifications of the sorbent have been elaborated. They are:
- granulation by mechanical method with some binder (Fig. 5) [6, 7];
- pressing of TEG to obtain the sorption elements using a binder and without them, as well as using reinforcing interlaying and without them, followed by applying mechanical methods (Fig. 6) [8-10];
- preparation of the water-graphite suspension with subsequent application by means of a centrifugal pump (Fig. 7) [11, 12];
- preparation of the water-graphite foam suspense followed by the application of air-foam jetting [13].
Choosing the method of sorbent preparation on the basis of TEG is accomplished taking into account a specificity of an emergency spill, properties of adsorbed liquid, the nature of the polluted surface and surrounding area conditions (e.g., availability of water sources for the preparation of water-graphite suspension).

It should be noted that the sorption capacity of any sorbent modification obtained after preprocessing of the original TEG is lower than sorption capacity of dry powder due to increasing of its density. For example, at granulation of TEG powder with the use as a binder 2.5% solution of the glue – “PVA”, sorption capacity of the pellets, sufficient for reliable manipulation strength (0.15 kg/cm²) is 23.9 g/g for diesel fuel, i.e., 40% lower than the original TEG. Sorption capacity of pressed sorption elements with density of 12.5 kg/cm³ is 12-14 g/g, i.e. three times less than that of the original TEG. However, considering the high degree of adaptability of cleaning operation of contaminated area on the whole a significant reduction of costs for sorbent delivery to the place of an accidental spillage – the economic feasibility of pre-treatment and preparation of initial TEG is justified. A little decrease in sorption capacity compared to original sorption capacity of TEG – 8.5-20% is observed when oil-absorbing sorbent from the TEG in the form of water-graphite and foam-graphite suspension is used. Thus, a high degree of cleaning of water surface and coastal sands is provides. Also, pollution of an environment by sorbent is prevented. In addition, this technology is characterized by relative simplicity and does not require the development of special technological equipment. Regardless of the type of pre-processing the original TEG and the method of its application on contaminated surface collecting the saturated sorbent is produced by any known and proven in practice methods: a perforated material or grid with a mesh size of up to 12 mm [14, 15] or vacuuming [1]. When emergency spillage is small collecting of saturated sorbent can be effected by any suitable means at hand. As noted above, a significant advantage of oil-absorbing sorbent compared to known is the possibility of desorption of absorbed liquid and regeneration of a "pressed" sorbent for reuse [4]. Up to 85% of absorbed oil is separated when desorption occurs by centrifugation. After appropriate treatment this product can be used for its intended purpose. Developed at the Gas Institute of NAS of Ukraine the technology of thermochemical regeneration of the spent sorbent provides for a high-temperature treatment of the waste and subjected to a desorption of a sorbent in the furnace of the cyclone type (Fig. 8) [16]. Wherein the content of residual oil in the pressed sorbent allows accomplish a thermo-chemical regeneration in the autothermal regime [17]. Experimentally it was proven a principle possibility of 10 regeneration cycles with maintaining an acceptable sorption capacity of the regenerated sorbent (Fig. 9).
3. Conclusion

Proven technologies and technical solutions can be used as a basis for the creation of technical units in ministries and departments, responsible for the effective and rapid elimination of consequences of emergency spills of oil and oil products on water surface and sand beaches.

4. Literature


EFFECT OF ADDITIVES IN PHASE COMPOSITION OF CARBON CATALYSTS OTHER THAN ASC WHETLERITE TYPE CARBONS ON THEIR REMOVAL EFFICIENCY AGAINST HYDROGEN CYANIDE VAPORS IN THE AIR

1. Introduction

HCN is widely used, strongly toxic precursor for many laboratory and industrial syntheses, whose world production exceeds 0.5 million tons per year, besides, HCN is formed in the ignition of a series of materials of domestic use. Historically, HCN is used as chemical warfare agent during the World War I. Despite the restricted opportunity to use HCN by the modern armies as a CWA, it represents a highly effective potential terrorist poisonous substance.

An optimal protection of the respiratory organs of the armed forces staff and the population in case of terrorist actions and the occurrence of centers of chemical contamination, they provide for the filtering breathing masks, founding their effect in terms of most of the known toxic substances on physical adsorption of activated carbon materials in the breathers or the filtering adsorbing substance.

Since the physical adsorption of highly volatile non-persistent chemical warfare agents such as hydrogen cyanide, cyagen chloride, phosgene, arsenic and phosphin of the non-impregnated activated carbons is weak and hence, reversible at room temperature, the breathers of the modern breathing masks and filter-absorbers of the collective means for protection, are equipped with impregnated activated carbons. As of the moment, to remove the vapours of HCN, CICN, COCl₂, AsH₃ and PH₃, from the air by the breathers of gas masks and filter absorbents, the activated carbons have found the widest application, impregnated with Cu and Cr salts, known as ASCWhetlerite carbons.

Despite of their proven high efficiency in terms of the protection from the vapors of the highly volatile non-persistent chemical warfare agents, the impregnated carbons containing Cr⁶⁺ are considered as non-perspective by the specialists, such as the ones of the US Environmental Protection Agency [1] due to:

- the risk of cancer-producing effect of some of the forms of Cr⁶⁺[9] for the production personnel and the army staff, using the relevant gas masks and collective means of protection [2];
- a problem with annihilation of this type of impregnated carbon, after the expiration of the term of use defined by the manufacturer;
- the irreversible deactivation that this type of impregnated carbons are easily susceptible to as a result of the increased temperature [3] and/or enhanced humidity [4-6].

A solution of the problems referred is the creation of a generally new types of impregnation compositions on a basis other than the one of Cu/Cr compositions. Such impregnated carbons are the ones on a Cu/Znbase, alike the American impregnated carbon of new generation, ASZM-T, developed by Calgon Corp. [7].

Due to the complex nature of the removal of vapours of HCN by the impregnated carbons and the existence of a relation between the reaction capability of vapours and other highly volatile non-persistent chemical warfare, it was decided that the studies of the impregnated carbons on Cu/Znbase start namely with the vapours of HCN.

The absence of Cr⁶⁺ in the impregnation compositions, on the other hand, leads to the forming as a by-product of (CN)₂ as a result of the decomposing of the chemically unstable Cu(CN)₂, a product of the removal of HCN. To solve this problem, we have received and studied a new type of impregnated carbon onCu/Znbase, with addition of insignificant amounts of Ag and Cr (< 0.6%). This type of impregnated carbon, signified withVSZC, is characterized with protection effect against the vapours of HCN, practically equal to the same parameter for the ASC Whetleritetype of impregnated activated carbons however with impaired parameter in terms of the forming of (CN)₂compared to them.

The last can be corrected via the increase of the content of Cr⁶⁺, which is however inadmissible due to its cancerogenity, via overall replacement of Cr with Mo or via the introduction in the impregnation composition of VSZCof an alkaline additive – for instance K₂CO₃. In the presence of K₂CO₃ in the active phase, the removal of HCN runs on a two-grade mechanism whereat the unstable cupricyanide reacts with KCN in alkaline medium, forming K₂[Cu(CN)₃].

It is a practical interest to study the impact on the protection effect against the vapours of HCN and on the forming as a by-product of (CN)₂in the impregnated carbons on Cu/Znbase of the complete replacement of Cr, with Mo or the introduction in the impregnation composition of VSZCof an alkaline additive – K₂CO₃.

Therefore the objective of this work is to study the effect of Mo and of the alkaline ingredient (K₂CO₃) in the composition of the active phase of the impregnated carbons on Cu/Znbase, in terms of efficiency of defusing HCN vapours from the air, compared to the same in the ASC Whetlerite type of carbons.

2. Experimental part

2.1. Samples

The activated carbon used in the studies is a commercial product obtained from apricot shells with particle size 1.0 – 1.5 mm, signified as ACVM.

The textural parameters of the starting and the impregnated activated carbons as well as the impregnation compositions of the latter are presented in Table 1.
The samples were obtained via standard impregnation procedure of the activated carbon. The following salts (individually or in suitable combinations) were used to prepare the impregnation solutions: basic copper carbonate, zinc oxide, chrome oxide, molybdenum oxide and silver nitrate. The indicated compounds were dissolved in a solution of ammonia carbonate, water and ammonium hydroxide (25 %). In some of the cases, the impregnation solution was added up with TEDA.

Each of the samples was obtained via slow spraying of the relevant impregnation solution on the activated carbon in a rotating flask on a modified rotary evaporator.

The samples prepared in this way were signified as follows:

VSZ – activated carbon, impregnated with mixed ammoniacal copper zinc + silver nitrate solution.
VSZ-A2 – activated carbon, impregnated with mixed ammoniacal copper zinc + silver nitrate solution, containing 2 mass % K₂CO₃.
VSZC - activated carbon, impregnated with mixed ammoniacal copper zinc + chromic acid solution.
VSZC-T - activated carbon, impregnated with mixed ammoniacal copper zinc + chromic acid solution, containing TEDA.
VSZC-A2 - activated carbon, impregnated with mixed ammoniacal copper zinc + chromic acid solution, containing 2 mass % K₂CO₃.
VSZC-A4 - activated carbon, impregnated with mixed ammoniacal copper zinc + chromic acid solution, containing 4 mass % K₂CO₃.
VSZC-A6 - activated carbon, impregnated with mixed ammoniacal copper zinc + chromic acid solution, containing 6 mass % K₂CO₃.
VSZC-A8 - activated carbon, impregnated with mixed ammoniacal copper zinc + chromic acid solution, containing 8 mass % K₂CO₃.
VSZM - activated carbon, impregnated with mixed copper ammoniacal zinc molybdate + silver nitrate solution.
VSZM-T – activated carbon, impregnated with mixed copper ammoniacal zinc molybdate + silver nitrate solution, containing TEDA.
VC5W - ASC Whetelite type of carbon, obtained as per standard procedure (“whetlerization process”).

After each application of the precursors, the samples were allowed to stand in a controlled closed volume at room temperature for 2 hours.

The samples prepared in this way were heated at not higher than 423 K in a draft oven (under pressure), as in the case of the VSZC-T and VSZM-T samples, the heating temperature was maintained to preserve the main part of the pyridine.

2.2. Test methods

The characterization of the specific surfaces and porous texture of the initial activated carbon (ACVM) and the impregnated samples was carried out via low temperature adsorption of nitrogen (77.4 K) using Quantachrome Instruments NOVA 1200e (USA) apparatus.

Based on the adsorption – desorption nitrogen isotherms, via the specialized software set in the equipment, the following texture parameters were calculated: specific surface area (A(BET)) according to the Brunauer–Emmett–Teller (BET) equation, for the interval P/P₀ = 0.05 - 0.35 (adsorptive N₂, 77.4 K); total pore volume (Vₜ) as per the Gurvich-rule for P/P₀ = 0.95 (adsorptive N₂, 77.4 K); micropore volume (Vₘ) using the density functional theory (DFT) (adsorptive N₂, 77.4 K); volume of the mesopores (Vₘₑₘ) as a difference between the total volume and the micropore volume (adsorptive N₂, 77.4 K); average radius of the pores (Rₑ) as a ratio of the double Vₑ and A(BET)(adsorptive N₂, 77.4 K); the half-width (x₀) of the micropores (as per the flat parallel model) for the maximum of the distribution curve as per the simplified equation [8,9].

The textural parameters of the samples calculated by the methods referred are presented in Table 1.

The copper, zinc, chrome, molybdenum and silver were determined by atomic absorption using a Pye Unicam SP 90B spectrometer.

The photoelectrons and Auger specters of the samples were registered using an ESCALAB MkII (VG Scientific) XR photoelectron spectrometer with AlKα (1486.6 eV) source. The C 1s peak at 284.6 eV, was used as an internal standard for calibration of the connecting energies. The samples surface composition according to XPS, was determined based on the photoelectron intensities estimated by the corresponding Scofield cross sections.

2.3. Adsorption –dynamic studies

The experimental dynamic equipment and the procedures for study of the sorption, resp. protective properties of the impregnated carbons against HCN, are analogous to the ones described in [4].

The predried (378 K, 2 hours) impregnated carbons were reproducibly packed in glass dynamic tubes and air (HCN)- vapor flow was passed through the samples, following the parameters set:
- sample bed depth 3.0 cm
- sample bed diameter 2.0 cm
- volume flow rate 1.57 l/min
- relative humidity 50%
- temperature 293 + 3K
- HCN challenge concentration 3× 0.3 mg/l
- HCN breakthrough concentration 10 ml/m³
- (CN)2 breakthrough concentration 5 ml/m³

The removal efficiency of the impregnated carbons was evaluated indirectly, during the (t₅) removal action, against HCN and (CN)₂ (in the cases when free dicyan is formed), as the resolution of HCN and (CN)₂ is based on the difference in the interaction of the two substances with AgNO₃ solution.

The registration of the relevant breakthrough concentrations was carried out by:
- reaction between HCN and aqueous solution containing benzidine, copper acetate and acetic acid;
- reaction between (CN)₂ and aqueous solution of KCN, containing 8-hydroxyquinoline.

3. Discussion of the experimental results

3.1. Adsorption -textural characterization

Via comparing the adsorption textural parameters of the impregnated samples with the ones of the initial activated carbon (Table 1), it was estimated that the impregnation process concerns more the microporous than their mesoporous textures, respectively their specific surfaces.

The reduction of the micropore volumes is most likely due to blocking parts of the micropore space of the samples or to blocking the access to the micropores.

The increase of the microporous heterogeneity of the samples (characterized via the alterations of the values of x₀), best expressed in the impregnated samples VC5W, VSZC-A2, VSZC-T, is related to the distribution of the micropores of the initial carbon by size [10], with the stage of heating and attending migration of the active phases and the metal ions nature.

Despite of the fact that as a result of the impregnation and following heating, the parameters of the porous texture and all sample specific surfaces change, Table 1 displays that the biggest changes occur in the samples including in their phases K₂CO₃ and TEDA.

In this sense, the change is bigger of the parameters referred in the samples including TEDA (VSZC-T and VSZM-T) compared to the single type VSZC and VSZM, than the samples containing various quantities of K₂CO₃.

It must be noted that, with the increase of the content of K₂CO₃ (> 2%), the specific surfaces decrease and the average radiiuses of the sample pores increase in synchrony (Table 1), which is an evidence for the simultaneous change of the external and internal surfaces of the impregnated carbons.
3.2. Chemical analysis and sample surface analysis

The content of Cu, Zn, Cr and Mo in the studied samples was determined via atomic absorption. The results are presented in Table 1.

The determination of the oxidative state of the studied elements in the impregnants, element composition of the sample surface as well as the location of the impregnants on the surface or in the sample volume, was carried out via XPS.

Due to the higher sensitivity of the Auger signal towards Cu (1+), as well as the relative invariance with respect to the oxidation state of Zn in the values of the Zn 2p photoelectron peak, Auger spectroscopy was also used to characterize the copper and zinc phases. The photoelectron spectra obtained for the Cu 2p photoelectron area, in all copper containing samples, demonstrate binding energies for Cu (2+) oxidation state of the Cu 2p3/2 peaks, whose shoulders to the higher binding energies on their turn demonstrate the presence of incompletely decomposed CuCO3 and Zn(OH)(2) phases. Via studies using Cu L3M4,5M4,5 Auger specters, Auger line. The data obtained are likely to demonstrate the presence of incompletely decomposed CuCO3 and Cu(OH)2 phases. Via studies using Cu L3M4,5M4,5 Auger specters, presence of Cu (1+) was not found in the samples of Table 1.

In the case of the samples containing zinc (VSZ, VSZ-A2, VSZC-A2, VSZC-A4, VSZC-A6, VSZM, VSZ-ACM-T), the oxidation state of Zn was determined by the Zn L3M4,5M4,5 Auger line. The data obtained are likely to demonstrate the presence in our samples, except of a main component of the zinc phase, ZnCO3 and of hydroxycarbonate, with approximate composition 2ZnO.H2O. (Zn(OH)2) (k.e. 988.0 eV), whose composition is not permanent and depends on the conditions of receipt and thermal treatment.

In the case of the samples VSZC, VSZC-T, VSZC-A2, VSZC-A4, VSZC-A6, VSZC-A8, the content of Cr is relatively low (approximately 0.61 mass. %, Table 1), which is a reason for the lack of adequate reliability in the results regarding its valent state. Nevertheless, by analogy with VCSW [11], it can be assumed that Cr (6+) appears under the form of CrOH. NH4. CrO4[22]). The latter is close to the adopted composition CuCrO4, NH4. H2O, according to the references cited by Nikolov [4].

It is an obscure picture of the type and nature of the Mo-phase in the case of VSZM-ACM TSV. Various authors assume that in the case of this type of carbon, Mo exists under various forms (above all as a fine dispersed phase, distributed predominantly in the volume of VSZM [12]). However, the one responsible for the removal of the forming (CN)2 is Mo(2+) [13]. Our photoelectron specters for the Mo 3d5/2 photoelectron area provide for ground in the Mo-phase of VSZM (VSZM-T) to distinguish MoO3 (b.e. 231.7 eV), (NH4)2MoO4 (b.e. 232.1 eV) and (NH4)[2]Mo2O7 (b.e. 232.5 eV).

The inclusion of TEDA to Cu- and Zn-phase (regardless of the presence of Cr (VSZC-T) or Mo (VSZM-T) (VSZM-T) affects the copper phase as its content in the volume of the samples referred to increase with about 10% compared to VSZC and VSZM, accordingly, as in parallel, the content of Zn on our surface also increases. On the opposite, the inclusion of K2CO3 to the composition of the impregnants (in the case of samples VSZC-A2, VSZC-A4, VSZC-A6, VSZC-A8) results in the re-distribution compared to VSZC, of the Cu- and Zn-phase between their volume and external surface. Thus, depending on the quantity of K2CO3, the content of the Cu-phase decreases in the volume, whereas, otherwise, the content of the Zn-phase on the external surface increases.

3.3. Breakthrough time of the samples

In the case of gas-mask equipment, the service time (tB) is defined as time during which the concentration of PS in the air vapor flow, after the sorbent bed, reaches a preset value for the relevant experimental conditions.

Table 2 present tB against HCN and (CN)2 of the studied impregnated carbons and for reference, the ones of the initial activated carbon (ACVM).

As it can be expected, ACVM practically does not remove the vapors of HCN. Table 2 displays that the studied samples (except VSZ, VSZ-A2, VSZC-T) are characterized with tB against the vapors of HCN > 50 min.

The sample VSZ (appearing to be basic with its Cu/Znactive phase) is characterized simultaneously with the lowest tB among the rest of the samples both against the vapors of HCN, and against (CN)2. Nevertheless, Table 2 displays that tB against the vapors of HCN in the case of VSZ is practically the same as of the sample VSZC containing Cr, accordingly less against the vapors of (CN)2 and significantly less regarding this parameter compared to the sample VSZM containing Mo.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Content (mass %)</th>
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<th>V1max (cm3/g)</th>
<th>V3 (cm3/g)</th>
<th>x_H (nm)</th>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZC-A8(10)</td>
<td>5.7</td>
<td>5.3</td>
<td>0.59</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZM(16)</td>
<td>5.5</td>
<td>5.2</td>
<td>-</td>
<td>1.9</td>
<td>827</td>
<td>0.807</td>
<td>0.498</td>
</tr>
<tr>
<td>VSZM-T(16)</td>
<td>5.6</td>
<td>5.3</td>
<td>-</td>
<td>1.8</td>
<td>783</td>
<td>0.788</td>
<td>0.536</td>
</tr>
</tbody>
</table>

(a) - Sample contains about 0.05 mass % Ag
(b) - Sample contains K2CO3, in a quantity (mass %) indicated after "A"
(c) - Sample contains about 3 mass % TEDA

Table 1 Elemental phase composition and main texture parameters of the initial activated carbon and of impregnated samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>Content (mass %)</th>
<th>A_BEST (m2/g)</th>
<th>V1 (cm3/g)</th>
<th>V1max (cm3/g)</th>
<th>V3 (cm3/g)</th>
<th>x_H (nm)</th>
<th>f_P (Å)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACVM</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>VSZC(2)</td>
<td>7.1</td>
<td>2.07</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZ-A2(10)</td>
<td>6.2</td>
<td>5.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZC(8)</td>
<td>5.7</td>
<td>5.4</td>
<td>0.63</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZC-T(1)</td>
<td>5.7</td>
<td>5.3</td>
<td>0.60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZC-A2(10)</td>
<td>5.6</td>
<td>5.3</td>
<td>0.62</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZC-A4(10)</td>
<td>5.5</td>
<td>5.2</td>
<td>0.61</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZC-A6(10)</td>
<td>5.7</td>
<td>5.4</td>
<td>0.61</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZC-A8(10)</td>
<td>5.7</td>
<td>5.3</td>
<td>0.59</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VSZM(16)</td>
<td>5.5</td>
<td>5.2</td>
<td>-</td>
<td>1.9</td>
<td>827</td>
<td>0.807</td>
<td>0.498</td>
</tr>
<tr>
<td>VSZM-T(16)</td>
<td>5.6</td>
<td>5.3</td>
<td>-</td>
<td>1.8</td>
<td>783</td>
<td>0.788</td>
<td>0.536</td>
</tr>
</tbody>
</table>
Table 2. Breakthrough times for initial and impregnated carbon samples

<table>
<thead>
<tr>
<th>Образ</th>
<th>t_B (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCN</td>
<td>(CN)_2</td>
</tr>
<tr>
<td>ACVM</td>
<td>2.5-3.0</td>
</tr>
<tr>
<td>VC5W</td>
<td>53.0</td>
</tr>
<tr>
<td>VSZ</td>
<td>49.0</td>
</tr>
<tr>
<td>VSZ-A2</td>
<td>49.0</td>
</tr>
<tr>
<td>VSZC</td>
<td>51.0</td>
</tr>
<tr>
<td>VSZC-T</td>
<td>49.0</td>
</tr>
<tr>
<td>VSZG-A2</td>
<td>51.0</td>
</tr>
<tr>
<td>VSZG-A4</td>
<td>53.0</td>
</tr>
<tr>
<td>VSZG-A6</td>
<td>51.0</td>
</tr>
<tr>
<td>VSZG-A8</td>
<td>51.0</td>
</tr>
<tr>
<td>VSZM</td>
<td>52.0</td>
</tr>
<tr>
<td>VSZM-T</td>
<td>53.0</td>
</tr>
</tbody>
</table>

(a) - Not determined experimentally. According to literature data it is close to breakthrough time against HCN.
(b) - breakthrough concentration of (CN)_2 not reached.

In the case of VSZC, after the exhausting of Zn-phase (as a result of the chemisorption of HCN) the function of the direct destruction of (CN)_2 is taken by Cr^{VI}. The presence of Cr^{VI} in the composition of the impregnants of VSZC practically does not change t_B by the HCN of the sample compared to the one of VSZ. On the opposite, t_B by (CN)_2 increases with about 10% against the same for VSZ, however remains lower than the same parameter for the other sample containing Cr^{VI} (about 2%) - VC5W (Table 2).

The sample VSZM proves the positive impact of Mo in the composition of Cu/Znactive phase, appearing an alternative variant of the sample with best parameters in the study VC5W. In its case, t_B by HCN is practically the same as of the sample VC5W, and the formation of (CN)_2, starts upon spending its time for removal of HCN. The mechanism of effect of the impregnants against HCN, in this type of impregnated carbons is not entirely clear. Our studies demonstrate that there is an analogy in the functioning of Zn- and the Cu-phase in the samples VSZM and VSZC, as, after spending the Zn-phase in VSZM (as a result of the chemisorption of HCN), the (CN)_2 being formed reacts with the Mo-phase to tightly bound with the carbon surface, non-toxic product (likely oxamide).

The most likely explanation of the difference (although insignificant) in the values of t_B by HCN and by (CN)_2 between VC5W and VSZM are: the less content of the Mo-phase than needed (Table 1) or of some of the Mo-forms, and also increase of the content of the Cu-phase on the external surface, at the expense of the same in the volume in the case of VSZM [M1].

The samples of the type VSZ and VSZC (VSZ-A2, VSZC-A2, VSZC-A4, VSZC-A6 and VSZC-A8) are interesting, containing in the composition of their impregnants K_2CO_3 (between 2 and 8 mass. %), which, upon removal of HCN impedes or even disables the formation of (CN)_2.

Based on the results in Table 2, it can be concluded that the inclusion of K_2CO_3 in the composition of the impregnants (except the sample VSZC-A4, containing 4 mass. %) does not result in the increase of t_B against the vapors of HCN. The impact of K_2CO_3 is much more significant regarding t_B against (CN)_2. In this case, there is dependence even between t_B and the content of K_2CO_3 which passes through maximum with the content of K_2CO_3 about 4 mass. %. Probably in case of content of K_2CO_3 above the determined, exhaustion of the Cu-phase appears via the binding to K_2[Cr(CN)_6] and the exclusion of it from the general process of removal of HCN.

The inclusion of TEDA in the composition of the phase of the samples VSZC and VSZM, i.e. the samples VSZC-T and VSZM-T, increases insignificantly t_B by (CN)_2 compared to VSZC and VSZM. Analogically, t_B against the vapors of the HCN in the case of the two samples changes within the limits of 2-4 %. Most likely the effect of TEDA in the phase composition of the impregnants can be related to the fact that TEDA to a very slight extent affects the Cu-phase as this is more likely to manifest in the stronger expressed positioning of the Cu-phase in the mesoporous space of the VSZM-T, compared to the same for the sample VSZC-T. TEDA does not affect the Zn-phase. Generally, it can be concluded that TEDA practically does not affect the chemisorption of HCN.

4. Conclusion

A study has been carried out of the effect of additives to the phase composition of the carbon catalysts on Cu-Zn base in terms of their effectiveness for the elimination of the HCN vapours in the air. It was found that the inclusion in Cu-Zn phase of the samples of Mo, Cr^{VI} (~ 0.60 mass. %), K_2CO_3 or TEDA results in their commensurable effectiveness in terms of the removal of the HCN vapours in the air (determined as a breakthrough time) with the one of the standard ASC Whetlerite type of carbon.

Despite of the fact that the inclusion of the additives referred in the Cu-Zn phase composition results in the increase of t_B of the samples against the vapours of (CN)_2, by this parameter, they stay behind the ASC Whetlerite type of carbon.

Regardless of the fact that the sample containing Mo in their phase composition is closest to the t_B against the vapours of (CN)_2 of the ASC Whetlerite type of carbon, as the same parameter in its case remains smaller, probably due to the smaller amount of the Mo-phase than the needed or of any of the Mo-forms.

The inclusion to the phase composition of the carbon catalysts on Cu-Zn base (containing or not Cr^{VI}) K_2CO_3 does not result in the increase of t_B against the vapours of HCN (except the sample VSZC-A4, containing 4 mass. %). The impact of K_2CO_3 however is much more significant in terms of t_B against (CN)_2. In this case, there is even dependence between t_B and the content of K_2CO_3, which passes through a maximum in the event of content of K_2CO_3 about 4 mass. %.

The inclusion of TEDA in the composition of the phase of samples VSZC and VSZM practically does not affect their effectiveness for the removal of the HCN vapours, but in all cases, it provides further protection also from the CICN vapours.

5. References

2. Николов, Р., Д. Механджиев, Структура и състав на фазата на перспективни медно-цинкови въгли цатори, предназначени за защита от парите на токсични вещества, ВТНИ, Научна сесия „Въоръжение и военна техника на 2000та година”, Химия и ядрена физика 8, 1995, 77-82.
air depending on their phase composition and porous texture, J. Colloid Interface Sci. 273, 2004, 87-94.

ABSTRACT: Removal of large monovalent cations, as highly toxic thallium (Tl), from the waters is a subject of significant interest due to the hazards its pose. Active materials on the basis of activated carbons intended for removal of Tl ions from drinking water was synthesized and characterized in two stages. During the first, deposition and stabilization of the Fe (3+) phase in the internal surface of activated carbon samples (AC/Fe (3+)) was carry out. During the second, deposition on the AC/Fe (3+) of K₄[Fe(CN)₆]₃ phase and subsequent chemical reaction were realized. The removal performance of the samples prepared for Tl ions in aqueous solution was investigated by adsorption process. Increased sorption possibilities were observed toward Tl ions as compare to initial carbons.

KEY WORDS: TI COMPOUNDS AS TERRORISTIC POISONOUS AGENTS, TI COMPOUNDS AS SOURCE OF WATER CONTAMINATION, ACTIVE MATERIALS INTENDED FOR REMOVAL OF TI IONS FROM DRINKING WATER, COMPLEX COMPOUND Fe₄³⁺[Fe²⁺(CN)₆]₃ ("PRUSSIAN BLUE")

1. Introduction
It is known that the thalium compounds appear to be extremely strong poisons [1,2] to man and animals.

The main source of thalium compounds in water, including underground waters are various mines, mostly for gold yielding but also coal mining, enriching factories and facilities of the color metallurgy. Another source of thalium in waters is the cement factories, the manufacturers of electronic elements, of art glass articles[2,3,4].

A likely source of water contamination (above all potable) with thalium could be the domestic crimes and terroristic actions.

The first ones are made possible by deratization agents (rodenticides) available in the population of a series of countries on a thalium base.

In terms of the use of thalium compounds by terrorists in the quality of poisonous agents for contamination of potable waters, precedents exist which provide for a ground for the priority inclusion of the thalium in the group of terroristic – diversion means [5,6,7,10], etc.

The decontamination of the industrial (the mines in particular) waters from the thalium compounds represents a subject of a series of studies.

For this purpose, various methods have been studied such as reverse osmosis, biological treatment, sulfide sedimentation, etc. [3].

Trials proved that the only generally effective method for decontamination of the industrial and potable waters is the adsorption method.

Due to the nature of the antiterrorist problematic, the literature is lacking data for the decontamination of potable waters contaminated with thalium compounds, but it is absolutely sure that the sorbents used for this purpose are different for the industrial and potable waters.

In this sense, the natural and most of the synthetic zeoliths used (NaY, NaA), incl. modified, cannot provide for decontamination to the required minimal contents of thalium in potable waters, which is 5-7 times lower than the admissible for the decontaminated industrial waters.

A very important reason for this can be the fact that the sorption of thalium ions of industrial waters is realized under controlled pH, whereas in the case of potable water, the pH of water cannot vary but an optimal ratio must be sought: physisorption / chemisorptions, whereas the chemisorbing phases are characterized with high efficiency.

In this sense, the best variant is the use as a chemisorbent, of the complex compound Fe₄³⁺[Fe²⁺(CN)₆]₃ ("Prussian blue") [8].

The "Prussian blue" according to the American specialists is the active substance of the only antidote used as of the moment against intoxications with thalium compounds[9].

The selection of suitable sorbents for purification of thalium compounds of potable waters is based on the presence in them of suitable texture parameters which are advantageous for the introduction of the chemisorptions phase in the porous texture of the sorbents. Only in this case, the processes of physical adsorption (physisorption) and chemisorptions can be realized optimally and simultaneously in the process of water decontamination from the thalium compounds.

The synthesis of complex compounds in the porous texture of the sorbents however is complicated by the fact that the active phase which provides the chemisorptions of thalium ions should not impede the physical adsorption, respectively to reduce the specific surface and volume of sorbing pores.

As per the literature data, for the synthesis if the metal ferrocyanides in single pore systems, the Kurim method is most suitable [11]. It is a serious problem that this method has not been applied for micro-mesoporous materials such as for instance the activated carbons, sorbents, suitable for sorption of various water compounds.

The activated carbons are characterized with high specific surface and strongly developed porous structure which makes them suitable both with their adsorption function and as carriers of active phases in various processes for water decontamination.

A problem in the case of the activated carbons would be the synthesis in their porous texture of the relatively large molecules of Fe₄³⁺[Fe²⁺(CN)₆]₃, without significantly reducing the volumes of the sorbing pores and of the admission pores to the chemisorbing phase.

The last necessitates some variation (modification) by the Kurim method for synthesis in the pores as per the specificities of the compound (micro-mesoporous textures) such as the activated carbons'.

Besides, considering the dependence of the sorption of metal ions in water media of pH of the latter, it is very important to establish the interval of pH, in which the activated carbons with iron hexaferratic complex x sorbe effectively Tl²⁺ ions and its conformity to pH specific to the most frequent potable waters.

As a result of all stated above, the objective of the study is to obtain activated materials based on activated carbon through a synthesis in their porous texture by the modified method of Kurim of iron (3+) hexacyanoferratic (2+) complex, which active materials should be studied in their quality of sorbents for purification of potable waters contaminated with thalium compounds, as per pH of these waters.
2. Experimental part

2.1. Samples

Since no requirements have been formulated for the basic activated carbons intended for the synthesis of the active materials in the conditions of technological difficulties for the performance of the Kurim synthesis in micro-mesoporous systems, we have adopted the empirical approach for selection. For the purpose, the selected activated carbons were predetermined using the low-temperature (77 K) adsorption of nitrogen some of their texture parameters. On the other hand, the chemical nature of the carbon surface was characterized through the determination of the IEP of these.

For the purposes of study, three types of activated carbons were selected (commercial products) on wooden basis (signified BAC), based on apricot shells (signified AAC) and based on coconut shells (signified CNAC), differing by the values of the specific surfaces and of the rest of the texture parameters. The three activated carbons have been obtained through gas-vapor activation. Their main adsorption – texture parameters and values of the IEP are given in Table 1.

Table 1 Main parameters of the porous texture and values of IEP of the studied activated carbons

<table>
<thead>
<tr>
<th>Samples</th>
<th>( \text{A}_{\text{BET}} \text{, m}^2/\text{g} )</th>
<th>( \text{V}_t \text{, cm}^3/\text{g} )</th>
<th>( \text{V}_{\text{MI}} \text{, cm}^3/\text{g} )</th>
<th>( \text{V}_{\text{MES}} \text{, cm}^3/\text{g} )</th>
<th>( \text{R}_P \text{, Å} )</th>
<th>IEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAC</td>
<td>658</td>
<td>0.38</td>
<td>0.20</td>
<td>0.18</td>
<td>11.6</td>
<td>6.1</td>
</tr>
<tr>
<td>AAC</td>
<td>895</td>
<td>0.50</td>
<td>0.29</td>
<td>0.21</td>
<td>11.2</td>
<td>7.6</td>
</tr>
<tr>
<td>CNAC</td>
<td>1019</td>
<td>0.61</td>
<td>0.33</td>
<td>0.28</td>
<td>12.0</td>
<td>6.8</td>
</tr>
</tbody>
</table>

\( \text{A}_{\text{BET}} \) – specific surface; \( \text{V}_t \) – total pore volume; \( \text{V}_{\text{MI}} \) – volume of the micropores; \( \text{V}_{\text{MES}} \) – volume of the mesopores, \( \text{R}_P \) – average radius of the pores; IEP – isoelectric point.

2.2. Synthesis of \( \text{Fe}^{3+}\left[\text{Fe}^{2+}(\text{CN})_6\right]^3\) in the porous texture of the activated carbons

The synthesis by the Kurim method, in the porous texture of the activated carbons of \( \text{Fe}^{3+}\left[\text{Fe}^{2+}(\text{CN})_6\right]^3 \) represents a practical problem.

The main reason is reduced to the need of preparative provision of uniform distribution on the internal surface of the samples of FeCl₃·3H₂O maximally preserving the contact surface considering the follow up interaction with \( \text{K}_4\left[\text{Fe} (\text{CN})_6\right]\text{H}_2\text{O} \), as well as to the iron (3+) hexacyanoferratic (2+) complex of the thalium ions of the water solutions.

The opportunities for introduction of the ferric chloride from aqueous and non-aqueous (methanol) solutions were studied. Based on a comparison of the adsorption-texture parameters (determined via low-temperature adsorption of nitrogen) of samples of activated carbons with introduced FeCl₃·3H₂O from water and methanol media, it was found that in the case of use of the aqueous solution, probably as a result of blocking parts of the porous texture, the specific surfaces, total and mesoporous volumes decrease with the average of about 20-23% for the three carbons.

The introduction of \( \text{K}_4\left[\text{Fe} (\text{CN})_6\right]\text{H}_2\text{O} \) was carried out from aqueous solutions, after vacuum drying of the samples with ferric chloride at room temperature.

The samples with introduced ferric chloride and \( \text{K}_4\left[\text{Fe} (\text{CN})_6\right]\text{H}_2\text{O} \) phases were left in a desiccant, at room temperature for 24 hours, during which it was assumed that the forming of the complex \( \text{Fe}^4\left[\text{Fe} (\text{CN})_6\right]^3 \) is complete.

The main adsorption – texture parameters of the synthesized activated materials (signified accordingly as Fe/BAC, Fe/AAC and Fe/CNAC), calculated based on their adsorption isotherms (77 K), are given in Table 2.

Table 2 The summary assay of iron and main texture parameters of active materials

<table>
<thead>
<tr>
<th>Active material samples</th>
<th>Summary content of Fe (mass %)</th>
<th>( \text{A}_{\text{BET}} \text{, m}^2/\text{g} )</th>
<th>( \text{V}_t \text{, cm}^3/\text{g} )</th>
<th>( \text{V}_{\text{MI}} \text{, cm}^3/\text{g} )</th>
<th>( \text{V}_{\text{MES}} \text{, cm}^3/\text{g} )</th>
<th>( \text{R}_P \text{, Å} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe/BAC</td>
<td>12.6</td>
<td>547</td>
<td>0.39</td>
<td>0.23</td>
<td>0.16</td>
<td>11.3</td>
</tr>
<tr>
<td>Fe/AAC</td>
<td>12.3</td>
<td>743</td>
<td>0.50</td>
<td>0.27</td>
<td>0.22</td>
<td>10.5</td>
</tr>
<tr>
<td>Fe/CNAC</td>
<td>13.0</td>
<td>825</td>
<td>0.50</td>
<td>0.27</td>
<td>0.22</td>
<td>12.1</td>
</tr>
</tbody>
</table>

2.3. Methods of study

The activated carbons and synthesized activated materials on their base are characterized via the low-temperature nitrogen adsorption (77.4 K) with Quantachrome Instruments NOVA 1200e (USA) apparatus.

Based on the adsorption-desorption nitrogen isotherms, via the specialized software set in the equipment, the following texture parameters were calculated:
- specific surface area \( (\text{A}_{\text{BET}}) \) by the equation of Brunauer–Emmett–Teller, for the interval \( P/P_O = 0.05 - 0.35 \) (adsorptive \( N_2 \), 77.4 K);
- total volume of the pores \( (\text{V}_t) \) as per the Gurvich rule for \( P/P_O = 0.95 \) (adsorptive \( N_2 \), 77.4 K);
- volume of the micropores \( (\text{V}_{\text{MI}}) \) using the Density functional theory (DFT) (adsorptive \( N_2 \), 77.4 K);
- volume of the mesopores \( (\text{V}_{\text{MES}}) \) as a difference between the total volume and the volume of the micropores (adsorptive \( N_2 \), 77.4 K);
- average radius of the pores \( (\text{R}_P) \) as a relation of the double \( \text{V}_t \) and \( \text{A}_{\text{BET}} \) (adsorptive \( N_2 \), 77.4 K);

The texture parameters of the samples calculated by the methods referred are presented in Table 1 and 2.

The isoelectric points (IEP) of the carbons were determined by the method of NohSchwarc [12]. For the purpose, for each of the carbons, three different initial solutions were prepared with different pH (accordingly 3, 6 and 11), using HNO₃ (0.1 M) and NaOH (0.1 M). Six flasks were filled each with 20 ml of the solutions and with different quantities of activated carbon (0.05, 0.50, 0.75, 1.00, 5.00 and 10.00 g). The balance pH was determined after 24 hours. The curves of the dependences of pH on the carbon masses demonstrate plateau and the isoelectric point is defined as the value which turns the change of pH to zero.
The summary content of iron (Fe³⁺ and Fe²⁺) in the activated materials was determined via atomic absorption using a spectrometer type Pye Unicam SP 90B.

The study of the sorption of the thallium ions (Tl⁺) in potable water of the initial activated carbons and the activated materials Fe/BAC, Fe/AAC, and Fe/CNAC, obtained on their ground, was carried out by the method of the periodic adsorption (concentration 0.91 mg/land pH in the interval 3-7.5, 293 K), as a difference of the concentrations before and after adsorption determined through atomic absorption analysis (spectrometer type Pye Unicam SP 90B).

The sorption effectiveness (S, %) of the initial activated carbons and the synthesized active materials on their ground in terms of the thallium ions (Tl⁺) in potable water, depending on pH of water has been expressed in percentage against the initial concentration (100 %).

### 3. Discussion of the experimental results

The results for the sorption effectiveness (S, %) of the initial active carbons and the synthesized active materials on their base in terms of the thallium ions (Tl⁺) in potable water, depending on the pH of water, under the conditions of the experiments are presented in Table 3.

#### Table 3 Sorption effectiveness of the initial activated carbons and the synthesized active materials in terms of the thallium ions, depending on the pH of water

<table>
<thead>
<tr>
<th>pH</th>
<th>BAC</th>
<th>AAC</th>
<th>CNAC</th>
<th>Fe/BAC</th>
<th>Fe/AAC</th>
<th>Fe/CNAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>15</td>
<td>19</td>
<td>16</td>
<td>57</td>
<td>54</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>23</td>
<td>27</td>
<td>20</td>
<td>71</td>
<td>63</td>
<td>59</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>28</td>
<td>22</td>
<td>58</td>
<td>66</td>
<td>74</td>
</tr>
<tr>
<td>6</td>
<td>28</td>
<td>20</td>
<td>21</td>
<td>84</td>
<td>73</td>
<td>90</td>
</tr>
<tr>
<td>7</td>
<td>21</td>
<td>18</td>
<td>21</td>
<td>77</td>
<td>72</td>
<td>92</td>
</tr>
<tr>
<td>7.5</td>
<td>20</td>
<td>17</td>
<td>19</td>
<td>75</td>
<td>70</td>
<td>86</td>
</tr>
</tbody>
</table>

The analysis of the results from Table 3 demonstrates the determining role of pH of water medium on the sorption activeness of the samples both for the initial activated carbons and the activated materials synthesized on their base.

Impression is made by the strongly dominating sorption capability of the activated materials compared to the initial activated carbons on the base of which these are obtained, and also that the maximal sorption of Tl⁺ ions in the activated carbons was displaced compared to the activated materials in the field of the lower pH (pH about 4 - 5), and also that, regardless of the difference in the adsorption texture parameters, the sorption effectiveness in the studied activated carbons is very close. Most likely, a limiting factor in the sorption of the Tl⁺ ions by the activated carbons happen to be their IEP.

Except that, the sorption activity of the activated materials in terms of the Tl⁺ ions is significantly higher compared to the initial activated carbons, it is determined also by the pH of water. The three studied samples sorb best within the interval pH: 6 - 7, which is a very important interval since it corresponds to the pH of most of the potable water in our country.

In the field of the low values of pH (pH = 3 - 4), the sample Fe/BAC sorbs best the Tl⁺ ions.

Based on the results of Table 2 and 3, it can be concluded that a direct dependence between the specific surfaces, total and mesoporous volumes of the pores of the activated materials (for practically identical amounts of Fe₂O₃[Fe(CN)₆]₃phase) on one hand, and their sorption capacities in terms of Tl⁺ ions in the potable water, is lacking.

For the interval of values of pH (pH=5-7), characterizing with the highest sorption in the studied process, by its sorption activity against the thallium ions, the activated materials can be presented in the following downward row: Fe/CNAC > Fe/BAC > Fe/AAC.

### 4. Conclusion

Activated materials have been synthesized through modified method of Kurim based on activated carbon and the iron (3+) hexacyanoferric (2+) complex, intended for the decontamination of potable water poisoned with Tl⁺ ions.

The active materials obtained possess significantly higher sorption effectiveness against the thallium (Tl⁺) ions compared to the initial activated carbons.

Dependence has been established between pH of the water media and the sorption effectiveness in terms of the Tl⁺ ions on behalf of the activated materials. The maximal sorption effectiveness is observed for the interval of pH (pH about 6-7) specific to most of the potable water in our country.

The results obtained provide us a ground to continue our studies on the synthesis of activated materials with introduced iron hexacyanoferric phase and other micro-porous carriers other than the activated carbons.

### 5. References

Abstract: in the article is considered questions of the organization structure of the software of information-management systems in railway transport. A new approach based on matching software structure with functions and their level criticality by safety. Received results allow to implement the synthesis of structures of systems with regard to their purpose and the functions they perform.

KEYWORDS: SYSTEMS STRUCTURE, SAFETY, SOFTWARE AND HARDWARE.

1. Introduction

Railway transport is one of the most intensively developing sectors in the global economy. Modern train control systems is a difficult complex software and hardware. Besides the usual technological tasks assigned to them a very important function - providing traffic safety and continuity the transportation process. Most of the functions of information-management systems implemented at the software level. In connection with this question of improving the software of these systems are timely and relevant.

Problems of safety and reliability of the application software of railway automation has traditionally been considered from the standpoint of classical reliability theory, as evidenced by the work [1-3]. Usually authors in the process of synthesis of software and hardware structure not take into account the specifics of the technology of functioning of the control object. Often enough the software structure is tied to the structure of the hardware. Some few authors, try to link the structure of software and hardware complex with the singularity technology work of the control object, as that can be a railway station.

This work is a logical continuation of this direction. The objective is to formulate the basic principles of synthesis of software and hardware systems considering the specifics of the functions information and control system.

If we consider from this positions functions automated train control system on the station, in accordance with [4], it is possible to allocate:
- responsible functions, implementation of which ensures the functioning of the control system and its safety factor;
- functions related to ensuring of the system which are not critical to safety;
- service functions.

Regulatory documents of the EU and Ukraine (IEC 61508) sets different levels of risk dangerous events, as well as qualitative and quantitative indicators of the safety of functioning management systems.

2. Preconditions and means for resolving the problem

With this in mind, let us consider options for organization of software structure with classical two-channel reserve of station microprocessor control system, pic.1.

According to the scheme in picture 1, channels interact in scheme logical "AND", and reservation in each channel is carried on scheme "OR". Obviously, all the functions of control and management will be implemented by this logic.

After this we transform the scheme on picture 1, keeping in mind all the responsible functions, which are most critical to safety. In a case of failure, the system must go into the condition, so-called "the defensive condition", wherein it's functioning is limited. Basing on this limits, we have no need in reservation. And the main task consists find and to block mistake. For a software implementation of such functions, mostly fits the logical structure "AND"—"AND", pic.2.
The output signal can be created only with full identical work of A and B programs of both channels. A priori, such a structure loses in reliability, but can have good safety parameters. With the help of this structure, can be realized functions of object blocking, artificial opening, enabling of inviting light etc. The structurally-logic scheme "AND"—"OR" can be used for realisation of functions, which are not so critical to safety, pic.3.

Such a structure is designed for the realisation of the main system commands, which are linked with the setting of the route, and also with locking and automatic unlocking. At the expense of the balance between the indicators of safety and reliability, it can provide an effective work of the hardware and software complex under the influence of destabilizing factors.

Failure operation serves as a main indicator of success for the service functions of information-management systems. According to this requirement, it's logical to suggest usage of operation "OR", pic.4.

In this approach, some ambiguity is not excluded if one of the programs will crash. But it doesn't matter in two reasons. The first one, is that information is provided to the human operator. And the second one. It's not critical to the railway traffic safety.

Pic.3 The structural scheme of realisation of management functions, which are not critical to safety.

Pic.4 The structural scheme of realisation service functions.

4. Results and Discussion

Taking into account the above the functions of probability of failure, for each of the proposed structures:

\[ Z_0 = 4X^2 - 4X^3 + 4X^4 - 4X^5 + 4X^6 - 4X^7 + 4X^8 - 4X^9 + 4X^{10} - 4X^{11} + X^{12} \]

Figure 5 shows the probability of refusal \( Z_0 \) from the system which characterize refusal of component A, B, A', B', respectively.

Based on the fact that control system an arbitrary time \( t \) implements only a single function, and in the range \([t; t + \Delta t]\) system may implement a row of basic functions. Then the function of refusal of the whole system is written like:

\[ Z_0 = Z_1 \lor Z_2 \lor Z_3. \]

We assume that the intensity of refusal of programs A, A', B and B' are the same, \( \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 \). This assumption may have a right to exist in connection with the setting task of comparison potential capabilities of different structures of the organization of the software. To simplify further change of the last expression, considering previously adopted assumptions about the equality of the intensities of refusals components A, B, A', B', we make the change of variables \( Y_1 = Y_2 = Y_3 = Y_4 = X \). Then in the final form the function of refusal of system can be represented by the equation:

\[ Z_0 = 4X^2 - 4X^3 + 4X^4 - 4X^5 + 4X^6 - 4X^7 + 4X^8 - 4X^9 + 4X^{10} - 4X^{11} + X^{12} \]
5. Conclusion

The considered embodiments structure of hardware and software do not exhaust all the possible implementations. This is most likely just a basic configurations, icombining and extending them will allow to get considerable quantity of different modifications. The choice of a particular type is determined by the requirements for the overall system and for its individual functions.

Also it should be noted that to obtain the expected properties in reliability and safety it is advisable to allocate a hardware implementation of the programs A and B in the main and standby channels. Otherwise, malfunctions and failures on the general reasons may significantly to worse the expectation of developer.
STRESS IMPACT AT THE WORKING PLACE – COMPARATIVE STUDY FOR BULGARIA, MACEDONIA AND GERMANY

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Abstract
The modern society is highly material and financially oriented. Due to this reason, the processes have to be cost-effective with optimizing the expenses. Despite the tendencies of modernization, technological progress and automating proceedings, the role of a person as an “actor” in these processes is irreplaceable. Unfortunately, especially in the countries with highly developed economy, the expenses for staff are really high. The worker’s protection from occupational accidents and professional illnesses, as well as the employees’ efficiency in a long-term plan are connected with consumption resources which for the factories are often quite high. In short-term aspect, the resource-saving in a way of good working conditions is not a decision.

During the last years, more and more attention is given to a factor that remains at the background of a workplace – the stress. There are many studies about its negative effect on the workers, as that reflects on the whole effectiveness of the companies and the factories. The stress-management and the prevention of the Burnout syndrome are important prerequisites for sustainable economic growth because the performance, creativity, productivity, and competitiveness of every factory depend on the qualified, healthy, motivated and organized employees who work there. The aim of the study is a comparative analysis of the working conditions in Bulgaria, Macedonia and Germany for several branches for which personal indicators as environment, habits, motivation, etc. are observed. Based on assessment of the workplace stress, conclusions should be drawn for its impact as a factor, threatening the workers’ health.

Key words: WORKING STRESS, SAFETY, WORKPLACE FACTORS, BURNOUT

INTRODUCTION
The safety neglect on the working place is quite higher in the countries with developing economy compared to the developed countries.

The technical progress and automation of the working processes are high and the result of that is the fewer number of working must have higher performance. More and more people feel the consequences of the modern society through psychological bundle as time pressure, social isolation, alienation, concentration problems. At this time the psychological stress on the working place increases due to noise, heat, night shifts, heavy physical work. Each of these factors can be a reason for violation of a person’s emotional balance. It can be noted that when a person is under stress, the people around him are affected as well. Every person has their own idea of perfection and experiences situations in which they can react chaotically or nervously. In these cases the body sends a signal for attention and people resort mostly to “sources for calming the emotions” and unfortunately they are unhealthy eating, alcohol, drugs or medicaments.

The chronic stress leads to chronic illnesses: asthma and breathing difficulties, back pains, other muscle pains and high blood pressure, cardiovascular risk as heart attack, heart diseases, etc; difficulties with metabolism, gnashing of teeth, alcoholism, depressions.

Assessing the importance of this factor and the World’s work safety and health day – 28 April, the International work organization organizes a campaign in 2016 under the slogan: “Stress on the working place”.

According to healthcare in Germany for treatment of chronic diseases around 200 billion euro are granted annually. It is considered that 50 to 60% of the sick days are connected with stress. (BGI-609: Stress am Arbeitsplatz, Metall-Berufsgenossenschaft, 2003). The World health organization (WHO) defines stress as one of the biggest reasons for illnesses of 21 century.

Eight out of ten Germans feel their life as stressed; every third person is feeling under pressure almost always. This shows and the actual Forsa – a research on behalf of the Technical Health Insurance Fund (Germany). “Especially worrying is the fact that the number of Burnout-diseases increased to 17% in the last five years… ”, says Helen Heinemann from Hamburger Institut für Burnout-Prävention.
Stress management and the prevention of the Burnout-syndrome are significant factors for stable economical success. The productivity, creativity and competitiveness of each factory depend on the qualified, healthy, motivated and organized employees and workers.

**Aim of the research**

Through comparing the working conditions in Bulgaria, Macedonia and Germany of the chosen branches the aim is to be given an assessment of how the stress occurs on the working place and eventually turns into health endangering factor. For the assessment are considered the personal characteristics of the respondents as dwelling, habits, motivation, etc.

Each country offers different work conditions. What actually matter are the mentality, living standard, the developing level of the economy. For same type of job is given different payment. Not only the workplace and the related benefits are the reasons why many qualified people are looking for fulfillment in Western Europe.

It is a fact that in Bulgaria and Macedonia are observed processes, connected with searching for new workplaces outside the territories of the countries. The reason is often the low payment, as well as the lack of perspectives of development for young and qualified people. There are also cases of job positions which are inconsistent with the level of qualifications of the candidates.

When we speak for work conditions on the workplace most commonly are understood the methods and means of protection of the workers from occupational diseases (hearing loss, skin problems, or of the musculoskeletal system) and environmental factors connected with their safety.

The psychological states connected with emotional depletion as the so called Burnout-syndrome, other psychological misbalances or psychiatric diseases were not in the group of occupational diseases to that moment.

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### Table 1: summary of the more important stress factors

<table>
<thead>
<tr>
<th>Type of stress factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological stressors</td>
<td>Time pressure; traffic jams; large crowds of people; competition; monotony; illness/death of a colleague; separation of partners; unemployment; change of the workplace; new setting</td>
</tr>
<tr>
<td>Physical stressors</td>
<td>Heat, wintriness, noise, light, air pollution</td>
</tr>
<tr>
<td>Psychic stressors</td>
<td>Starvation, pain injury</td>
</tr>
<tr>
<td>Load at work</td>
<td>Overload, underload, ambition, examinations</td>
</tr>
<tr>
<td>Social stressors</td>
<td>Mobbing, conflicts with colleagues, injustice, isolation</td>
</tr>
<tr>
<td>Resources as stress factors (look Hobfoll p.71)</td>
<td>Non-material: marriage, citizenship</td>
</tr>
<tr>
<td></td>
<td>Material: food, clothing, cars</td>
</tr>
<tr>
<td></td>
<td>Personal: intelligence, optimism, talents</td>
</tr>
<tr>
<td></td>
<td>Convertible actives: money, knowledge, time</td>
</tr>
<tr>
<td>Chemical stressors</td>
<td>Drugs, chemical substances, alcohol, cigarettes</td>
</tr>
</tbody>
</table>

### Questionnaires

All participants in the polls answered or gave an assessment of the following formulations:

1. I go to work with pleasure.
2. I feel **motivated** by my workplace.
3. I trust my colleagues.
4. **Teamwork** it is not a problem at my workplace.
5. My attitude towards the **management staff** is good.
6. What does make me happy?
7. I live a **healthy life** – nutrition and free time.
8. During work I feel…
9. **Problems** connected with stress.
10. Do you feel under stress and what do you do about it?

**Explanation notes to the polls:**

Questions are selected so as to allow swift and spontaneous answers, thus believing that they can be on a subconscious level and to be objective. This matters for the fact that the stress is a really subconscious experience and in case of any matter having to think long, there is a chance the answer is not likely to correspond to the real situation.

In order to be able to place representative and time distributed analysis of individual perceptions of
respondents, it is necessary surveys to be carried out for a specific period during which each employee and managing staff answer to all questions. In that way, the dependencies between work conditions and personal experiences of each individual could be defined.

The survey should be done in big enough time interval in order to observe all the changes in the assessment of people about the stress situations.

**Why was this poll held?**

Summarizing the answers of the polls does not have the significance of the psychological survey. On that topic enough number of surveys and studies of large groups of people have been done. For the exact case the analysis is done on purpose and through observations of daily situations as well as personal conversations stands the point of view of people towards the problem which can be analyzed by medical aspect as well.

**Participants in the survey**

The poll includes 60 people (20 people from each country) and has no power as a representative sample. The number of the asked people is not big in order to cover as big a topic as “Stress on the workplace” but the results of each country are interesting.

In fact, the aim of this survey is not to make representative conclusions but rather to show the methodology of that kind of survey. An important thing to mark is that with really simple resources it is possible to make an adequate assessment of the state of the personal in each company or factory, the situation can be described as well as the efficiency of the implemented measures can be tracked.

For the current survey were interviewed in identical way people from three countries – Bulgaria, Macedonia and Germany. This allows evaluation and comparison of the stress level, taking into account the specifics of each country in terms of mentality, values, working conditions, etc.

**Why was the poll done in three countries – Bulgaria, Macedonia, and Germany?**

It does not matter in which part of the world a person lives or where we are; all people have similar needs, complemented by the country-specific. A person’s psychic health is important in order to feel satisfied and to live a healthy life. At the heart of it lies the balance between stress and relaxation. Although these countries are located in Europe, each one of them has its own cultural specifics. The manners and customs are different. Despite numerous information sources such as press, radio, and television, as well as the internet, one can get acquainted with real life in a country only when they begin to reside there. A serious role for understanding a culture has the fluency in the native language, knowledge about the literature and history of the country. The mobility of human resources within the EU is relatively easier and cultural transition is much smoother in comparison with Japan, for example, where there is completely other public orderliness.

This is the position from which the three countries are analyzed in the present survey, as it is appropriate to be noted that the comments made are based on the personal appraisal of the author referring to conversations with the people and general information about the countries as a whole. It is important to write down some of the typical details of each country before analyzing the results from the polls.

**Macedonia** is a country in process development and at the moment is currently in a transitional period. Generally the labor market does not offer enough work places. Due to this limitation the occupation of a position is connected either with excellent qualities of the candidate, or with a certain social status having privileges. Regarding to the influence on the public sector, the country and the institutions have strong influence. In long-term aspect, given work positions prefer candidates who can guarantee loyalty to the institutions. Because of this reason a lot of well-educated and qualified people emigrate to the USA looking for better work opportunities and better life. Compared to Germany, the individualism is not so highly developed among the Macedonians. People generally are open-minded, friendly, kind and ready to respond and help in case of need. The feeling for one big family applies for a group, team or a collective as well. Exactly the opposite situation is in Germany where the individualism is really important.

**Bulgaria** is quite a new country-participant in EU and also is at a process of development and changes. After it becomes full member, a lot of Bulgarians begin working out of the country. Generally, the mentality in Bulgaria and Macedonia is alike. Bulgarians are friendly and open-minded as well, but there are essential differences. Compared to Macedonia, individualism in Bulgaria is more expressed but it has not reached the level of Germany. The tendency these years is that a lot of men and women live on their own. The number of divorces is much higher than in Macedonia.

**Germany** is preferred as a place of living and working among Bulgarians and Macedonians. There are
significant differences in the mentality of the Germans living in the former eastern and western provinces.

Germans are quite alienated from one another. For all spheres of life there are standards and rules. There is an emotional distance no matter how long the people know each other (or work together). This is somewhat a form of defense since people in general and Germans in higher degree show a form of opportunism. Individualism is striving for maximizing success (professional, financial, and social layer) increase steadily in Germany.

As these factors harm the common good, where the state has regulatory mechanisms – intervenes. This in turn leads to discouragement and passive resistance of the people who have chosen this lifestyle.

In Bulgaria, there are a lot of foreigners, among which Germans as well, who say that here they feel better and live more relaxed than in Germany. This positive attitude is connected to their resistance on stress, which leads to better results during work.

Change in the mentality

The figure shows schematically the change in the mentality of the population in a given country in aspect of its economic situation. Regardless this, people settle and seek realization there, where they feel satisfied.

Scope of respondents – three separate branches (universities, IT and call-centers).

The three chosen branches in which the survey was done are quite different in nature and accordingly people work in an environment with a different kind of mental load. In the branches “universities” and “IT”, the workers are personally motivated and the polls show that the stress level is less than in the Call-centers. The work in a Call-center is characterized by a routine but is also about mental load and this is why the stress level has been the highest.

Results

Only some of the answers of several questions from the survey are going to be commented because of the large data amount.

Results, received as an answer of the statement: “I go to work with pleasure” (fig. 2, fig. 3, and fig. 4):

Bulgaria:
- 20% - with pleasure,
- 25% - without pleasure
- 55% - middle score

Germany:
- 75% - with pleasure,
- 5% - without pleasure
- 3% - middle score

Macedonia:
- 90% - with pleasure,
- 2% - without pleasure
- 3% - middle score

On the question: “Do you feel you are under stress?”, the answers are shown graphically on figure 5 as follows:

Fig. 5
Bulgaria: 60% - Yes  40% - No
Macedonia: 35% - Yes  65% - No
Germany: 45% - Yes  55% - No

Conclusions

Almost half of all the respondents answer they feel under stress. It is considered that the consequences on the contemporary society reflect on the workplace in the form of increased mental load. The high percentage of the affected people is worrying because the stress has become of the serious workplace factors. According to the legal regulations about the risks of an activity, which are dangerous for the health, an evaluation must be done, the risk should be reduced and minimized until it has reached acceptable levels. The effects of new work habits and rates are expressed in reduced communication between people and lack of maintenance of interpersonal relationships. This is a counterbalance of our human nature and the expression of feelings often is seen as a weakness. Due to this a lot of people hide their emotions which sometimes can be connected with health problems. Not many are the people who have friends on their workplace with whom they can share personal themes. The orientation of the work world to high aims increases the daily dynamics. These requirements are often not in balance with our psychical and physical resources.

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The location of the Merawa dam is situated on the Cham I Daraban River, tributary of Qala Chuwalan River, which in its turn is tributary of the Lesser Zab River. From the administrative point of view, the dam site is located in Suleimaniyah Governorate, Sharbazer District, Iraq. The proposed works consist of a 38.50 meters high Dam and HPP which aims to provide a sturdy reserve of water for hydropower, irrigation and water supply for the residential areas in the downstream. Electric power is very important for the development of the area, as this war troubled zone lacks entirely electricity, moreover it is considered to be a strategic area as the Iran-Iraq border is nearby. The Dam and micro-HPP will be able to provide the area with base energy, with a sturdiness granted by the volume of the reservoir, as now the only power sources are isolated fossil-fueled generators. The energy produced by the 150 kW turbines might seem small, but the community will be able to rely on this source as its primary supplier.

**Keywords:** DAM, RIVER, PRODUCE ENERGY, IRRIGATION, WATER SUPPLY

1. **Introduction**

Water resources management in Kurdistan aims primarily to satisfy water demands, thus the best locations for hydrotechnical structures that are able to collect excess rainfall and flood water have been analyzed, as the regions are, mostly, dependent on underground water, with little or no storage capacity. A great importance is given by the Government of Kurdistan Region (KRG) for developing the Dam projects in order to transform the dry lands into perennial green fields, that subsequently also produce electricity for the local community and national power grid. Such a project is Merawa Dam.

2. **Location**

The location of the Merawa dam is situated on the Cham I Daraban River, tributary of Qala Chuwalan River, which in its turn is tributary of the Lesser Zab River.

From the administrative point of view, the dam site is located in Suleimaniyah Governorate, Sharbazer District. The proposed works consist in a dam on the river course which aims to provide water for electricity production, irrigation and to supply with water the residential areas, in a harsh climatic area.

3. **Description of works**

The hydrographical basin surface of the Cham I Daraban River in the Merawa storage reservoir section is of 48.03 km².

According to the survey made in the "Kurdistan Region Water Infrastructure Sector Master Plan" study prepared by SETEC Company in 2011, the Merawa River basin receives an influx specific flow to 8.3 l/sec/km².

The dam site is located approximately at 1230 m downstream of the existing bridge that is the main and only access point in Merawa village.

The dam crest was calculated in such matter that the tail reservoir water will not engage the bridge on the pressure even for maximum flood of 1:10 000 return period.

Minding the conditions mentioned above, the water storage volume at Normal Water Level (NWL) is 1.853.676 m³ from which the life storage 1.454.124 m³.

The main components of the hydrotechnical works are:

- The dam of 38.50 m elevation, crest length of 250 m, rockfill dam type;
- The normal water level is 1201 m.a.s.l.);
- The level of crown is 1205 m.a.s.l.);
- The spillway with side admission, placed on the right bank;
- The bottom outlet, situated within the dam body, in the gallery that is initially used as water diversion during the execution of the works.

The cross section of the dam body is trapezoidal shaped with the crest width of 6.00 m, upstream slope of 1:1.75, downstream slope 1:1.75 with 2 berms of 3.00 m width, maximum height from foundation is 38.50 m thus ensuring all the characteristics needed to consider Merawa dam is in the Large dam category. Merawa dam is designed as a Concrete Face Rockfill Dam. The inclination of the slopes is a result of the stability calculation taking into consideration the earthquake action. The first two layers represent the support layer for the reinforced concrete facing of dam. In the dam body it was provided a material zoning, as follow (fig. 4):

- Zone 1 – maximum 96 mm rockfill layer
- Zone 2 – maximum 250 mm rockfill layer
- Zone 3 - maximum 500 mm rockfill layer

The bottom outlet assembly works are placed in the central part of the dam body and has the following components:

- The intake tower
- The gallery

![Fig. 2 Render view of the Merawa Dam (after Aquaproiect Company (2014) Feasibility study and design for Merawa dam in Sulaimaniya Governorate / Mawat district.)](image)

The foundation sealing will be accomplished using a grout curtain by injecting pressurized cement grout, through two rows of injections, from vertically borehole-drillings posed at an inter-axial distance of 1.50 m between them and with a length of 25.00 m, measured in a horizontal plane on the plinth.
The intake tower is a reinforced concrete structure with horizontal section of 5.00 x 5.00 m and 21.85 m height.

The gallery that is initially used as water diversion during the construction of the works is a reinforced concrete box shaped structure, having the following characteristics:

- B x h: 5.15 x 5.15 m
- Wall thickness: 0.70 m
- Total length: 124.60 m

The bottom outlet is a steel pipe of 1000 mm diameter, consisting of an upstream penstock and downstream, in the valve chamber, with 2 gate valves. The bottom outlet allows emptying of the reservoir in 78 hours.

The spillway is placed on the right bank and has the following components:

- The side admission overflow
- The rapid chanel
- The constructions for energy dissipation

The side admission overflow high water diversion is located on the right bank and is a reinforced concrete structure, consisting of an ogee weir and a collecting channel with variable width (10.00 to 35.00 m) with a 1% longitudinal slope.

The construction continues with a rapid channel with increased roughness to limit the velocity at 7 m/s.

The total length of the channel is 124.50 m. The channel section is trapezoidal shape, base width is 35m. The structures for energy dissipation consist of: energy dissipater, rear apron of concrete blocks, and protection stone below dam. The energy dissipater is a reinforced concrete structure, with a total length of 25.0 m, this have a rectangular cross section, with the width of the base of 35 m.

Power is very important for the development, it is an important infrastructure parameter which aids the economic growth of any country.

There has been recently an ever increasing demand for greatest power generation in almost all countries of the world and especially in Iraq. Hydroelectric power generation is considered one of the most practical, clean (Environment Friendly) and economical nearly 30 % of the total power generation in the world is supplied by hydropower stations, and in some cases rising up close to 100%.

The hydrologic study of Merawa Dam project proved the possibility of power generation by releasing the water to Cham-I Daraban River through a Mini Hydro Station. The power plant is proposed separated from the dam body and will be constructed as a rectangular shape-top view- structure.

The access to the power plant will be provided with an access road along the downstream bottom outlet which will be achieved in the downstream regulated area. The power house is located about 100 m downstream from Dam longitudinal axis where the ground elevation ranges from 1167.5-1168.50 m. a. s. l. Merawa dam is proposed to be built in order to develop the adjacent area. Merawa village is made of 30 households and the village adjacent neighboring valley has a total of 20 households.

The population that lives here is approx. 200 inhabitants.

Villages do not have electricity in the area, with projects of National or Local Grid extension in the area at a halt, with small chances of accomplishment. For daily food preparation or heating, residents are using wood and fossil fuels. During the night they are not running lights, only lanterns and candles. Also due to lack of electricity they are completely isolated from the rest of territory information since they can`t use the radio or TV.

The operation rules for Merawa reservoir are to be fixed on the bases of the following factors:

- Power generation;
- Supply irrigation water;
- Supply water for population consumption;
- Facilitate the maintenance of recreational water areas;
- Regulate the flow downstream of the Merawa Dam.

Reservoir operation is necessary to be made in such a manner that it functions according to the respective purposes of its design.

Merawa Reservoir will use approx 1.5 Million Cubic Meters of the total storage capacity, between normal operation water level of 1201.00 m.a.s.l. and minimum operation water level of 1187.00 m.a.s.l, for power generation, and water supply.

The operation rules for Merawa Reservoir are to be fixed on the bases of the following factors:

- Irrigation and power generation are carried out within the range of the live storage capacity of 1.5 MCM.
- The power plant will use water from bottom outlet, from the steel pipe with ND 600 mm, designed for maximum discharge of 0.5m³/s.
In order to determine the amount of hydroelectric power that can be generated efficiently, it is necessary to estimate the quantity of water and head available at the site of turbines. The total available water is estimated below.

Table 1. Estimate the quantity of water

<table>
<thead>
<tr>
<th>Months</th>
<th>Inflow (m³)</th>
<th>Area (m²)</th>
<th>E (mm)</th>
<th>P (mm)</th>
<th>(P-E)*A/1000 (m³)</th>
<th>Demand (m³)</th>
<th>Net inflow (m³)</th>
<th>Storage (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>240684</td>
<td>153100</td>
<td>132.4</td>
<td>89.2</td>
<td>-6614</td>
<td>4000</td>
<td>229470</td>
<td>1853676</td>
</tr>
<tr>
<td>May</td>
<td>747628</td>
<td>153100</td>
<td>203.9</td>
<td>34.8</td>
<td>25889</td>
<td>111082</td>
<td>610657</td>
<td>1853676</td>
</tr>
<tr>
<td>June</td>
<td>0</td>
<td>153100</td>
<td>325.6</td>
<td>0.4</td>
<td>-49788</td>
<td>230013</td>
<td>-279801</td>
<td>1573875</td>
</tr>
<tr>
<td>July</td>
<td>0</td>
<td>137111</td>
<td>343.9</td>
<td>0.0</td>
<td>-7152</td>
<td>297988</td>
<td>-345140</td>
<td>1228735</td>
</tr>
<tr>
<td>Aug</td>
<td>0</td>
<td>117641</td>
<td>311.9</td>
<td>0.3</td>
<td>-36657</td>
<td>316101</td>
<td>-352758</td>
<td>875977</td>
</tr>
<tr>
<td>Sept</td>
<td>0</td>
<td>95661</td>
<td>228.2</td>
<td>1.9</td>
<td>-21648</td>
<td>267494</td>
<td>-289142</td>
<td>586835</td>
</tr>
<tr>
<td>Oct</td>
<td>0</td>
<td>76801</td>
<td>153.7</td>
<td>33.1</td>
<td>-9262</td>
<td>243132</td>
<td>-252394</td>
<td>334441</td>
</tr>
<tr>
<td>Nov</td>
<td>165975</td>
<td>56224</td>
<td>94.3</td>
<td>56.2</td>
<td>-2142</td>
<td>36651</td>
<td>127182</td>
<td>461623</td>
</tr>
<tr>
<td>Dec</td>
<td>2330312</td>
<td>67282</td>
<td>50.2</td>
<td>99.2</td>
<td>3207</td>
<td>4000</td>
<td>2329609</td>
<td>1853676</td>
</tr>
<tr>
<td>Jan</td>
<td>2832539</td>
<td>153100</td>
<td>45.7</td>
<td>118.7</td>
<td>11176</td>
<td>4000</td>
<td>2839715</td>
<td>1853676</td>
</tr>
<tr>
<td>Feb</td>
<td>3058142</td>
<td>153100</td>
<td>56.3</td>
<td>123.8</td>
<td>10334</td>
<td>4000</td>
<td>3064476</td>
<td>1853676</td>
</tr>
<tr>
<td>Mar</td>
<td>2946078</td>
<td>153100</td>
<td>106.5</td>
<td>90.3</td>
<td>-2480</td>
<td>4000</td>
<td>2939598</td>
<td>1853676</td>
</tr>
</tbody>
</table>

![Fig. 6 2015 photo Merawa village (after Aquaproject Company (2014) Feasibility study and design for Merawa dam in Sulaimaniya Governate / Mawat district.)](image)

The power of the power plan is:

Pmax = 0.7 x 9.81 x 0.5 x 33.50 = 115.02 kW = 0.15 mW

The minimum power of the power plan is:

Pmin = 0.7 x 9.81 x 0.5 x 18.50 = 63.51 kW = 0.06 mW

Generator power range – from 60 -150 kW.

- Runner Diameter: 392 mm
- Net Head at Rated Discharge: 33.42 meters
- Unit Speed: 750.0 rpm
- Peak Efficiency: 91.8%

![Fig. 7 Energy requirements](image)

So considering there are 50 households, and the SHPP produces 150 kW and maximum consumption is 3 kW per household, we deduct that it can ensure the necessary electricity for the households neighboring Merawa dam. Irrigation corresponding Merawa dam, will take place both upstream and downstream of it.

The irrigation network was designed to ensure 20 ha upstream of the storage reservoir (Plot1).

Plot 1, a surface of 20 ha, will be supplied by pumping via a CP main pipe made of PEID 100, NP 10, with diameter 315 mm starting from the pumping station. The design capacity is 55,28 l/s.

For pumping the water for irrigation a group made of 2 centrifugal electro-pumps with following particularities and pump flow of 100 m³/h was designed. Plot 2, surface 8 ha, will be located downstream of the dam, on the right river bank (fig. 9).

This surface is located between the channel and the right river shore, where the flank is smaller in comparison to flanks of surrounding slopes. The water will flow gravitationally ensured via a main pipe with a length of 50 m and diameter or 315 mm, connected upstream to the vane chamber (split T). From the irrigation channel the necessary volumes of water for irrigating the agricultural crops will be provided. At the channel slope of 0.5 %, the channel transport capacity will be of maximum 31 l/s and the velocity v = 0.34 m/s.

Irrigation will usually be in June - October months, but if necessary can also be used and controlled in the other months depending on other necessities and on the water level in the reservoir.

![Fig. 9 Irrigation area](image)
4. Conclusion

Merawa dam is proposed to be built in order to develop the adjacent area.

The water reservoir volumes studied for this dam were limited and conditioned so that the artificial lakes will not affect the villages or other property and equipment located in the perimeter of the inhabited areas. The proposed works consist in a dam on river course which aims to provide water for electricity production, irrigation and water supply of the residential areas.

The Dam and micro-HPP will be able to provide the area with base energy, with a sturdiness granted by the volume of the reservoir, as now the only power sources are isolated fossil-fueled generators. The energy produced by the 60 - 150 kW turbines might seem small, but the community will be able to rely on this source as its primary supplier. All 50 households will have electrical energy.

This is a classical example of a Greenfield development that proves to be ecologically and economically viable in the given conditions. The purpose of the works, however costly they might be, is the only way to provide the village with necessary means of adequate living conditions for the inhabitants. The Power plant can be used 9 month per year (December, January, February, March, April, May, June, July, August) but it will provide most of the now almost non-existing power supply.

Irrigation surface is 28 ha, downstream and upstream of the dam, further supplying the community with the necessary means of self-sustainment.

In such remote places, with the high involvement of the local government, this example of design and works are a strong statement that hydrotechnical works are the stepping stone for both civilisation thriving and ecological durable development.

5. Acknowledgements

On this occasion, we would like to express our sincere and deep gratitude to Mr. Akram Ahmed Rasul - General Director of General Directorate of Dams & Reservoirs/ Kurdistan Region and Mr. Peshraw Omar - Technical Director, General of Dams & Reservoirs/ Kurdistan Region for their valuable support, interest and direct involvement as we are very much thankful for their acceptance regarding the presented paper.

Also, we cannot express enough thanks to AQUAPROJECT S.A. – Romania, for the completion of the project and the support data provided for the article that could not have been accomplished without the hard work of a great team of dedicated engineers. These acknowledgments must be credited to S.C. AquaProiect S.A. – Romania and all the team that participated to the supporting documents of this article.

6. References


2. SETEC Company (2011) Kurdistan Region Water Infrastructure Sector Master Plan
ANALYSIS OF RESIDUAL RISKS FOR LIFT

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Abstract: The paper analyses risk in the selected type of passenger lifts. The method of analysis is chosen according to standard EN 81-80, dealing with residual risks. It highlights the risks associated with the selected type of lift.
Keywords: PASSENGER LIFT RISKS, CLASSIFIED TECHNICAL EQUIPMENT, SAFETY, TECHNICAL CONDITION

1. Introduction

With specific technical equipment in the present day a great deal of attention is devoted to their use during work activities. It is therefore necessary to be familiar with legislation as well as safe use in order to avoid various risks, dangers and incorrect handling, which may lead to accidents and other dangerous situations. An example is electric traction passenger elevators, which are the subject of this contribution. Nearly every one of us uses such a lifting device every day for moving in different tall buildings, schools, hospitals, as well as residential buildings, etc. Therefore, it is necessary that passenger elevators be capable of safe and breakdown-free operation, given that they are used to transport a great many people.

Table 1: European legal framework for passenger lift [1]

<table>
<thead>
<tr>
<th>Standard labelling</th>
<th>Name of document</th>
</tr>
</thead>
<tbody>
<tr>
<td>STN EN 81-1+A3</td>
<td>Safety regulations for construction and assembly of lifts. Part 1: Electric elevators</td>
</tr>
<tr>
<td>STN EN 81-2+A3</td>
<td>Safety regulations for construction and assembly of lifts. Part 2: Hydraulic elevators</td>
</tr>
<tr>
<td>STN EN 81-21+A1</td>
<td>Safety regulations for construction and assembly of lifts. Lifts for carrying passengers and freight</td>
</tr>
<tr>
<td>STN EN 81-3+A1</td>
<td>Electric and hydraulic small freight lifts</td>
</tr>
<tr>
<td>STN EN 81-80</td>
<td>Safety regulations for construction and assembly of lifts. Existing lifts.</td>
</tr>
<tr>
<td>STN EN 13015+A1</td>
<td>Maintenance of elevators and escalators, rules of instructions for maintenance.</td>
</tr>
</tbody>
</table>

The basic division of passenger lifts according to driving mechanism is shown in the following Fig. no. 1.

Table 2: Overview of the main types of passenger lifts

<table>
<thead>
<tr>
<th>Electric drive</th>
<th>Hydraulic drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>chain</td>
<td>drum</td>
</tr>
<tr>
<td>motor</td>
<td>indirect</td>
</tr>
</tbody>
</table>

Fig. 2 Brief description of the electric driving mechanism of a passenger lift [2]

Several risks result in old elevators from the fact that they are designed to be as simple as possible from a construction point of view. The safety risks of these lifts are very high, and therefore it will be necessary to deal with them as soon as possible.

1.1 Standard STN EN 81-80

In 2004 standard STN EN 81-80, which sets the rules for increasing the safety of existing elevators intended for the transport of persons or persons and freight, was issued. It is a component of the group of EN 81 standards “Safety regulations for construction and assembly of elevators”. This standard compares the safety of an old elevator with a new one and proposes solutions for reducing or removing the risks found. It recommends that dangerous risks be removed immediately and less dangerous risks within 5 years. It also recommends reconstruction or replacement of equipment within 10 years in order to fully satisfy the level of safety required. The current situation of different levels of safety in elevators in Europe is causing increasingly more accidents. The reasons for introducing the STN EN 81-80 standards and its purposes are shown in Tab. 2.

Fig. 1 Basic division of passenger lifts according to driving mechanism [2]
Table 2: Reasons for introducing and the purpose of the standards STN EN 81-80 [4]

<table>
<thead>
<tr>
<th>Reason for introducing standard STN EN 81-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The majority of elevators are not designed for physically disabled persons</td>
</tr>
<tr>
<td>• More than 3 million elevators are in use in EU countries and 50% of them are more than 20 years old</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purpose of standard STN EN 81-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Categorizes various dangers and dangerous situations from which each assessed risk is analyzed</td>
</tr>
<tr>
<td>• Enables analysis to be performed on each elevator and safety measures to be set and gradually introduced</td>
</tr>
<tr>
<td>• Provides corrective measures for gradual and selected improvement, so that all lifts intended for transporting persons or freight are brought up to a current state of safety</td>
</tr>
</tbody>
</table>

Deficiencies perceived by users

| • Imprecise stopping of elevator car |
| • High noise level of elevator machinery |
| • High noise level of closing shaft doors |
| • Disadvantageous in energy use |
| • Frequent outages due to repairs |

Table 3: Parameters of the assessed lift

<table>
<thead>
<tr>
<th>Passenger lift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Manufacturer</td>
</tr>
<tr>
<td>Year of manufacturer</td>
</tr>
<tr>
<td>Loading capacity</td>
</tr>
<tr>
<td>Max. number of transported persons</td>
</tr>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>Number of load-bearing resources</td>
</tr>
<tr>
<td>Total length of load-bearing resources</td>
</tr>
<tr>
<td>Voltage</td>
</tr>
<tr>
<td>Type of driving electric motor</td>
</tr>
<tr>
<td>Number of stations/loading points</td>
</tr>
<tr>
<td>Labelling</td>
</tr>
</tbody>
</table>

For existing elevators approximately 82 so-called safety risks have been recorded.

A safety risk is considered to be the difference between the technical equipping of an existing elevator made and installed according to previous provisions, with the requirements of contemporary standards, mainly with regard to the safety of operation. These risks are divided into several levels with regard to the number of dangerous situations occurring and the seriousness of the given safety risk. They can be found in each part of an elevator’s construction. It is first necessary to assess objectively and fairly the technical state of an elevator – to make a “diagnosis” and only afterwards begin with the “cure”. With old lifts other problems appear (e.g. unavailability of replacement parts), and therefore removing such risks is only a time-limited solution. The most realistic or most correct choice is to gradually remove safety risks – first those which directly endanger life and health, then less dangerous risks.

We call the activities which serve for the protection of persons and property certification activities for the operating capability of an lift.

They are performed:

• in the case of a breakdown or damage to an elevator,
• preventively and
• on the basis of results of checks, inspections, reviews and necessary tests.

Characteristics of the assessed lift and risk analysis of it

It is known that the lifespan of elevators versus the lifespan of other transport systems is significantly higher. The age of the installed lifts in Slovakia is more than 25 years and in some cases the age is even estimated at more than 30 years, which is already a very long period for making adequate replacement. These lifts, or more than 98% of them, are from the company Transporta, which anticipated their lifespan to be about 30 years.

2. Analysis of residual risks for the Passenger Lift TOV 250

For the analysis of residual risks according to standards STN EN 81-80 an lift of the type TOV 250 located in a concrete panel housing block was selected. This is an elevator which is among the most commonly used types of passenger lifts in panel housing blocks, installed during the times of Czechoslovakia. The assessed lift is located in a walled shaft. The parameters of the elevator are in the following table.

Table 3: Parameters of the assessed lift
Fig. no. 4 shows a view into the lift shaft – the suspension devices, the speed-limiter, the counterweights and the terminal switch are depicted.

![Image of lift shaft](image)

**Fig. 5 View to the shaft [1]**

Fig. 5 shows a view of the upper part of the car construction.

![Image of lift car](image)

**Fig. 6 Suspension carrier-beam**

The following is the analysis performed of residual risks on an existing lift of the type TOV 250:

**Table 2: A selection from the form of the assessed lift of the type TOV 250 [1]**

<table>
<thead>
<tr>
<th>3 Requirements for anti-vandalism measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure s against vandalism</td>
</tr>
<tr>
<td>Measures according to STN EN 81-71</td>
</tr>
<tr>
<td>[ ] yes</td>
</tr>
<tr>
<td>[ ] no</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4 Operation of elevator during a fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures for ensuring elevator activities</td>
</tr>
<tr>
<td>Measures according to STN EN 81-73</td>
</tr>
<tr>
<td>[ ] yes</td>
</tr>
<tr>
<td>[ ] no</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5 Shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perforated lining of the shaft</td>
</tr>
<tr>
<td>Modify lining of shaft according to:</td>
</tr>
<tr>
<td>- 5.2.1.2 STN EN 81-1+A3, or</td>
</tr>
<tr>
<td>- 5.2.1.2 STN EN 81-2+A3</td>
</tr>
<tr>
<td>[ ] yes</td>
</tr>
<tr>
<td>[ ] no</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 General requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment without harmful materials, e.g.</td>
</tr>
<tr>
<td>asbestos</td>
</tr>
<tr>
<td>5.1.4</td>
</tr>
<tr>
<td>[ ] not taken into account</td>
</tr>
<tr>
<td>[ ] high</td>
</tr>
<tr>
<td>1. Removal of asbestos which is dispersing (e.g. replacement with facing), 2. Asbestos is not removed – a warning board is placed there</td>
</tr>
<tr>
<td>[ ] yes</td>
</tr>
<tr>
<td>[ ] no</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2 Accessibility requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures for ensuring accessibility to persons with physical disabiliti es</td>
</tr>
<tr>
<td>5.1</td>
</tr>
<tr>
<td>[ ] not taken into account</td>
</tr>
<tr>
<td>[ ] high</td>
</tr>
<tr>
<td>1. Exchange for regular driving mechanism 2. Arrange for balancing equipment 3. Arrange for regulatory valve</td>
</tr>
<tr>
<td>[ ] yes</td>
</tr>
<tr>
<td>[ ] no</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Precision of balacing and stopping</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2</td>
</tr>
<tr>
<td>[ ] not taken into account</td>
</tr>
<tr>
<td>[ ] high</td>
</tr>
<tr>
<td>1. Construct solid pillar on solid ground, or</td>
</tr>
<tr>
<td>[ ] yes</td>
</tr>
<tr>
<td>[ ] no</td>
</tr>
</tbody>
</table>
### 7 Machine room and space for pulleys

<table>
<thead>
<tr>
<th>Section</th>
<th>Requirement</th>
<th>Checkmark</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Safe access to machine room and to the space for the pulleys</td>
<td>Yes/No</td>
<td>Arranged safe access with equipment satisfying: - 6.2 STN EN 81-1+A3, or - 6.2 STN EN 81-2+A3</td>
</tr>
<tr>
<td>7.2</td>
<td>Anti-slip floor in the machine room and in the spaces for the pulleys</td>
<td>Yes/No</td>
<td>Prepared anti-slip floor according to: - 6.3.2.2, 6.7.1.1.2 STN EN 81-1+A3, or - 6.3.2.2, 6.7.1.1.2 STN EN 81-2+A3 EN 81-2:1998</td>
</tr>
<tr>
<td>7.3</td>
<td>Horizontal distance in the machine room</td>
<td>Yes/No</td>
<td>Covered moving parts with a cover according to table 4 STN EN ISO 13857</td>
</tr>
</tbody>
</table>

### 8 Shaft and car doors

<table>
<thead>
<tr>
<th>Section</th>
<th>Requirement</th>
<th>Checkmark</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>Non-perforated shafts and doors</td>
<td>Yes/No</td>
<td>Supplement shaft and car doors according to: - 7.1, 8.6.1 STN EN 81-1+A3, or - 7.1, 8.6.1 STN EN 81-2+A3</td>
</tr>
<tr>
<td>8.2</td>
<td>Firmness of anchoring of shaft doors</td>
<td>Yes/No</td>
<td>Replaced anchors of shaft doors according to: - 7.2.3.1a 7.4.2.1 STN EN 81-1+A3, or - 7.2.3.1a 7.4.2.1 STN EN 81-2+A3</td>
</tr>
</tbody>
</table>

### 9 Car, counterweights and balancing weights

<table>
<thead>
<tr>
<th>Section</th>
<th>Requirement</th>
<th>Checkmark</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Shaft and cabin doors with glass</td>
<td>Yes/No</td>
<td>a) Replace glass according to: - 7.2.3.2, 7.2.3.3, 7.2.3.4, 8.6.7.2, 8.6.7.3 and 8.6.7.4 STN EN 81-1+A3, or - 7.2.3.2, 7.2.3.3, 7.2.3.4, 8.6.7.2, 8.6.7.3 and 8.6.7.4 STN EN 81-2+A3, or b) replace glass according to: - Annex J STN EN 81-1+A3, or - Annex J STN EN 81-2+A3, or c) reduce size of glass panels according to: - 7.6.2 STN EN 81-1+A3, or - 7.6.2 STN EN 81-2+A3, or d) remove glass panels and replace them with solid panels and supplement &quot;car at station&quot; signalization</td>
</tr>
<tr>
<td>9.2</td>
<td>Protection against dragging child's hand with horizontal movement of car and shaft doors with glass</td>
<td>Yes/No</td>
<td>Supplemented protection according to: - 7.2.3.6 and 8.6.7.5 STN EN 81-1+A3, or - 7.2.3.6 and 8.6.7.5 STN EN 81-2+A3</td>
</tr>
</tbody>
</table>

---

37
### 9.1 Safe ratio of floor space in car to loading-capacity

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Yes/No</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Safe ratio of floor space in car to loading-capacity</td>
<td>no</td>
<td>low</td>
</tr>
</tbody>
</table>

1. To reduce the usable floor space of the car, or 2. to limit use of the elevator only for trained users, or 3. to verify the intended use of the lift.

### 10 Load-bearing resources, counterweights and speed-limiters

#### 10.1 Protection against accidents with friction wheels, pulleys, chain wheels

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Yes/No</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>Protection against accidents with friction wheels, pulleys, chain wheels</td>
<td>8.91</td>
<td>medium</td>
</tr>
</tbody>
</table>

Supplement locking equipment of cover according to:
- 8.12.4.2 STN EN 81-1+A3, or
- 8.12.4.2 STN EN 81-2+A3

#### 10.2 Protection against falling of rope/chain from pulleys/chain wheels

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Yes/No</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2</td>
<td>Protection against falling of rope/chain from pulleys/chain wheels</td>
<td>5.91</td>
<td>medium</td>
</tr>
</tbody>
</table>

Supplement covers according to:
- 9.7 STN EN 81-1+A3, or
- 9.4 STN EN 81-2+A3

#### 10.3 Protection against objects getting between rope/chain from pulleys/chain wheels

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Yes/No</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.3</td>
<td>Protection against objects getting between rope/chain from pulleys/chain wheels</td>
<td>5.91</td>
<td>low</td>
</tr>
</tbody>
</table>

Supplement covers according to:
- 9.7 STN EN 81-1+A3, or
- 9.4 STN EN 81-2+A3

#### 10.4 Grippers controlled by suitable speed-limiters

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Yes/No</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.4</td>
<td>Grippers controlled by suitable speed-limiters</td>
<td>5.92</td>
<td>high</td>
</tr>
</tbody>
</table>

Supplement grippers controlled by a suitable speed-limiter according to:
- 9.8 and 9.9 STN EN 81-1+A3

### 9.3 Car doors

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Yes/No</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.3</td>
<td>Car doors</td>
<td>no</td>
<td>high</td>
</tr>
</tbody>
</table>

1. To reduce the usable floor space of the car, or 2. to limit use of the elevator only for trained users, or 3. to verify the intended use of the lift.

- a) Supplement self-acting car doors according to:
  - 8.6, 8.7, 8.8, 8.9 and 8.10 STN EN 81-1+A3, or
  - 8.6, 8.7, 8.8, 8.9 and 8.10 STN EN 81-2+A3,
  - b) Supplement manual car doors according to:
    - 8.6, 8.7, 8.8, 8.9 and 8.10 STN EN 81-1+A3, or
    - 8.6, 8.7, 8.8, 8.9 and 8.10 STN EN 81-2+A3
### 11 Guides, buffers and terminal switches

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Title</th>
<th>Section</th>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.1</td>
<td>Guides of counter weights or balancing weights</td>
<td>5.10.1</td>
<td>low</td>
<td>Countersweights or balancing weights: a) equip with firm guides according to EN 81-1+A3 or b) replace guides with four steel lines</td>
</tr>
<tr>
<td>11.2</td>
<td>Suitable buffers or other equipment</td>
<td>5.10.2</td>
<td>high</td>
<td>Supplement buffers according to: - 10.3 STN EN 81-1+A3, or - 10.3 STN EN 81-2+A3</td>
</tr>
<tr>
<td>11.3</td>
<td>Terminal switches</td>
<td>5.10.3</td>
<td>medium</td>
<td>Supplement terminal switches according to: - 10.5 STN EN 81-1+A3, or - 10.5 STN EN 81-2+A3</td>
</tr>
</tbody>
</table>

### 12 Distance between cars and shaft doors

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Title</th>
<th>Section</th>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.1</td>
<td>Horizontal distance between interior surface of wall and threshold, door frame of car or closed edge of car sliding doors</td>
<td>5.11.1</td>
<td>high</td>
<td>a) Reduce distance according to: - 11.2.1 STN EN 81-1+A3, or - 11.2.1 STN EN 81-2+A3 or b) equip car with security equipment according to: - 8.9.3 STN EN 81-1+A3, or - 8.9.3 STN EN 81-2+A3</td>
</tr>
</tbody>
</table>

### 13 Lifting machinery

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Title</th>
<th>Section</th>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.1</td>
<td>Emergency driving mechanism of electric elevator</td>
<td>5.11.2</td>
<td>high</td>
<td>Supplement emergency driving mechanism according to: - 11.2.3 or 11.2.4 STN EN 81-1+A3 or -11.2.3 or 11.2.4 STN EN 81-2+A3</td>
</tr>
<tr>
<td>13.2</td>
<td>Emergency driving mechanism of hydraulic elevator</td>
<td>5.11.2</td>
<td>high</td>
<td>Supplement emergency mechanism according to: - 12.5 and instructions given in 16.3.1 STN EN 81-1+A3 or - 12.9 and instructions given in 16.3.1 STN EN 81-2+A3</td>
</tr>
<tr>
<td>13.3</td>
<td>Closing valve (hydraulic elevator)</td>
<td>5.12.2</td>
<td>low</td>
<td>Supplement closing valve according to: - 11.2.3 or 11.2.4 STN EN 81-2+A3</td>
</tr>
<tr>
<td>13.4</td>
<td>Missing controlling of driving mechanism by independent contacts</td>
<td>5.12.4</td>
<td>high</td>
<td>Supplement stopping equipment according to: - 12.7 STN EN 81-1+A3 or - 12.4 STN EN 81-2+A3</td>
</tr>
</tbody>
</table>

### 14 Electrical equipment

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Title</th>
<th>Section</th>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Electro equipment</td>
<td>12.4 STN</td>
<td>high</td>
<td>- 12.7 STN EN 81-1+A3 or - 12.4 STN EN 81-2+A3</td>
</tr>
</tbody>
</table>
### Insufficient protection against injury by electric current (IP2X)

Protection and marking of electrical equipment.

<table>
<thead>
<tr>
<th>Section</th>
<th>Requirement</th>
<th>Level</th>
<th>Yes/No</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.1</td>
<td>Equip electrical equipment with covers according to: -13.1.2 STN EN 81-1+A3, or -13.1.2 STN EN 81-2+A3 with cover at least IP 2X.</td>
<td>High</td>
<td>Yes</td>
<td>-13.5.3.3 STN EN 81-1+A3, or -13.5.3.3 STN EN 81-2+A3, if voltage on the clamps is not greater than 50 V.</td>
</tr>
<tr>
<td>14.2</td>
<td>Supplement labelling set by: -13.5.3.3 STN EN 81-1+A3, or -13.5.3.3 STN EN 81-2+A3, if voltage on the clamps is not greater than 50 V.</td>
<td>Low</td>
<td>Yes</td>
<td>-13.5.3.3 STN EN 81-1+A3, or -13.5.3.3 STN EN 81-2+A3, if voltage on the clamps is not greater than 50 V.</td>
</tr>
</tbody>
</table>

### Protection of electric motor of lifting machine

<table>
<thead>
<tr>
<th>Section</th>
<th>Requirement</th>
<th>Level</th>
<th>Yes/No</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.1</td>
<td>Supplement protection against a change of phase for ensuring that the phase change cannot cause dangerous function of the elevator according to: -14.1.1.1 j) STN EN 81-1+A3, or -14.1.1.1 j) STN EN 81-2+A3</td>
<td>Low</td>
<td>Yes</td>
<td>-14.1.1.1 j) STN EN 81-1+A3, or -14.1.1.1 j) STN EN 81-2+A3</td>
</tr>
<tr>
<td>15.2</td>
<td>Equipment for inspection ride</td>
<td>High</td>
<td>Yes</td>
<td>-14.2.1.3 STN EN 81-1+A3, or -14.2.1.3 STN EN 81-2+A3</td>
</tr>
<tr>
<td>15.3</td>
<td>Supplement stopping equipment according to: -14.2.2 STN EN 81-1+A3, or -14.2.2 STN EN 81-2+A3</td>
<td>High</td>
<td>Yes</td>
<td>-14.2.2 STN EN 81-1+A3, or -14.2.2 STN EN 81-2+A3</td>
</tr>
</tbody>
</table>

### Lockable main switch in machine room

<table>
<thead>
<tr>
<th>Section</th>
<th>Requirement</th>
<th>Level</th>
<th>Yes/No</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.1</td>
<td>Supplement lockable main switch according to: -13.4.2 STN EN 81-1+A3, or -13.4.2 STN EN 81-2+A3</td>
<td>Medium</td>
<td>Yes</td>
<td>-15.2.1, 15.3, 15.4, 15.5.1, 15.5.3, 15.7, 15.11 and 15.15 STN EN 81-1+A3, or -15.2.1, 15.2.5, 15.3, 15.4, 15.5.1, 15.5.3, 15.7, 15.11, 15.15, 15.17 and 15.18 STN EN 81-2+A3</td>
</tr>
</tbody>
</table>

### Notes:

1. The examined case is crossed out – at present this risk is impossible to assess (the elevator is not equipped with these components).
2. A requirement “not taken into account” – this examined case does not apply in the elevator and probably will not be, or for other reasons will not be.

High level: the risk must be removed soon, medium level: the risk must be removed in a period together with greater modernization, low level: the risk may be removed in the long run together with modernization.
CONCLUSION

From the presented form for assessing the safety of an existing elevator it follows that the assessed elevator has risks which fall into the category of “high” – which need to be resolved as soon as possible – but there are also risks which, unfortunately, are not taken into account, so that it is not possible to resolve them. Namely because the elevator is not subject to current legislative provisions, and it is not possible to remove these risks. It is not possible to remove them because the elevator would need complete replacement or reconstruction, for which there is not financing, unfortunately. Such a complete replacement of an elevator costs approximately 30,000 – 40,000 €. It is necessary to note that given the fact that regular reviews, inspections, tests, controls, maintenance and all activities necessary for its safe operation, are conducted on this elevator, and that its age is relatively high, and it perhaps represents from its visual side a danger, it still ranks among the group considered to be “less dangerous”. It is recommended that the performed analysis of residual risks be given to building owners who are responsible for elevators. It then becomes their choice about how to deal with the results of the analysis. They may decide for gradual removal of defects, or for a radical solution – namely a complete replacement which, unfortunately, is financially demanding. It is necessary to keep in mind, however, that no small amount of money is spent annually on maintenance of this equipment. Therefore, it is suitable to consider reconstruction of the elevator, after which only essential service (review) would be performed.

Literature


The contribution was prepared in the scope of the grant project VEGA no. 1/0150/15 Development of methods of implementation and verification of integrated systems of safety for machines, machine systems and industrial technologies and Center for Research of control of technical, environmental and human risks for premanent development of productions and products in mechanical engineering” (ITMS 26220120060), supported by the Research & Development Operational Program funded by the ERDF.
ASSESSMENT OF ERGONOMIC RISKS OF THE SELECTED WORK ACTIVITY BY NIOSH METHOD

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Abstract: Diseases of the support-motor system are the most common reason for work disability. They cause not only personal suffering and loss of income but also represent considerable costs for businesses and the national economies of individual countries. One of the important indicators of the incidence of serious health damage from work is the occurrence of reported diseases from professions and other work-related health damage. Even though the mentioned diseases have a rising tendency, it is possible to avoid them by assessment of work activities, introducing preventive measures and controlling the effectiveness of measures taken. The article presents an example of ergonomic risk assessment for working with loads as a means of prevention.

Keywords: ERGONOMIC RISK, RISK ASSESSMENT, NIOSH

1. Introduction

“Ergonomy is an interdisciplinary science examining the mutual relationships of man and technology the work environment and monitoring the relationships within these subsystems with the aim of achieving a maximum degree of humanization and work safety, which a company and an individual can secure in a given stage of development” [1].

The aim of ergonomy is [1]:
• simplification of working conditions,
• to protect human health and to minimize the working of negative influences on a person during work activities,
• humanization of technology,
• designing of workplaces, instruments, machines, equipment, objects and aids such that it is possible to adjust their size and shape to the human body.

2. Ergonomic risk as a part of safety analyses

This is a tool which is intended for examining certain aspects working on a person in a working environment. The aim is identification of deficiencies at the given workplace and then an effort to remove them then using appropriate measures. The measures may be technological, systemic or organizational. These measures subsequently enable adaptation of working conditions and thus the optimizing of the work load.

Working with loads is considered to be any activity during which human strength is used for lifting, carrying, pressing, pulling and placing loads. We recognize both living and non-living loads. When lifting heavy loads, the risk of muscular-skeletal diseases occurring is increased. The most frequently burdened parts of the body are the knee joints and the lower part of the spine. The incorrect handling of loads can lead to great pain and serious illnesses [2].

3. The NIOSH Lifting index method

Unsuitable working positions, which can lead to illness of the motor apparatus, are frequently found during work activities having the character of physical work at work stations that are poorly organized ergonomically. New methods which are used today for assessing physical burden enable, with the help of postural analysis, the identification and overall assessment of risks leading to damage to muscles and the spine. The NIOSH Lifting index method belongs among those methods which are used for assessing ergonomic risks that arise when working with loads [3].

This is a European standard for assessing the limit for handling loads which have a weight greater than 5 kg and handling them for a period of 8 hours. The values are derived from dependence of the weight of the handled load and pressure on the intervertebral discs.

Limit values relate to the pressure forces working at the transfer point of the lumbar and lower spine (between vertebrae L5 - S1) Fig. 1.

![Loading of the spine between vertebrae L5/S1](image)

Fig. 1: Loading of the spine between vertebrae L5/S1

We can use the NIOSH method, which is focused on analysis of lifting actions, if the following are provided:
• balanced lifting, using both hands,
• smooth movements,
• good conditions for transferring forces,
• freedom of movement (without limitation of position),
• a suitable work environment.

The method for calculation of the weight limit cannot be used if the lifting or stacking of loads involves:
• use of an aid,
• an unsuitable working environments,
• lasts longer than 8 hours,
• working when seated or kneeling,
• unstable objects,
• simultaneous carrying, pressing or pulling [4].

The equation for calculation of the recommended weight limit (RWL) is based on a multiplier model, which gives the weight for each of the variables. The weighted shares are expressed as coefficients, which lower the load constant (LC). This load constant expresses the maximum weight of a load which can be lifted under favourable (ideal) conditions.

The weight limit which is recommended represents the maximum weight of a load for approx. 75% of the female population and up to 99% of the male population. Each healthy worker with a calculated value of weight can handle during a whole...
work shift (8 hours) without increasing the risk of pain occurring in
the lumbar part of the spine.
Likewise, the measure of relative physical ease, the so-called
Load Index (LI), which is the ratio between the lifted weight and
the RWL, is set as:

\[ LI = \frac{L}{(\text{LI} \times \text{RWL})} \] (1)

The recommended calculation of the NIOSH method is defined
using the presented equation; explanations to the equation are in
Tab. 1, in which a brief description of the individual multipliers is
given, treated according to [15].

\[ \text{RWL} = \text{LC} \times \text{HM} \times \text{VM} \times \text{DM} \times \text{AM} \times \text{FM} \times \text{CM} \] (2)

If the value of the Load Index (LI) is lower than 1.0, this
indicates an inconsiderable risk of damaging health for the
employee. If this value is equal to or higher than 1.0 this means
high risk of damage to the spine, Tab. 2.

Table 1: Multipliers of the Load Limit

<table>
<thead>
<tr>
<th>Multiplier name</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC Load Constant</td>
<td>Load Constant (LC = 23kg)</td>
</tr>
<tr>
<td>HM Horizontal Multiplier factor</td>
<td>The Horizontal Multiplier (H = 25/4H)</td>
</tr>
<tr>
<td>VM Vertical Multiplier factor</td>
<td>The Vertical Multiplier (VM = 1 – 0.005 (V – 75))</td>
</tr>
<tr>
<td>DM Distance Multiplier factor</td>
<td>The Distance Multiplier (DM = 0.83 + 4.5D)</td>
</tr>
<tr>
<td>AM Asymmetric Multiplier factor</td>
<td>The Asymmetric Multiplier (AM = 1 – 0.0032.A)</td>
</tr>
<tr>
<td>FM Frequency Multiplier factor</td>
<td>The Frequency Multiplier gives the number of lifting actions/1 min</td>
</tr>
<tr>
<td>CM Coupling Multiplier factor</td>
<td>The Coupling Multiplier describes the relation between the hands and the grasped load</td>
</tr>
</tbody>
</table>

Table 2: Load Index LI

<table>
<thead>
<tr>
<th>LI &lt; 1</th>
<th>LI &gt; 1</th>
<th>LI &gt; 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal case</td>
<td>Increased risk of pain in lower spine</td>
<td>Probability of an injured spine increases</td>
</tr>
</tbody>
</table>

During long-term work with loads it is also essential to devote
attention to the calculation of the recommended load limit for
employees. In this way it is possible to avoid damage to health, the
occurrence of work injuries and work-related illnesses which are
linked with expenditures on the side of the employer. The
application of methods for assessing physical burden which are
focused on reducing risks of damage to the locomotive apparatus
can result in the easing of laborious work activities and thus also
help protect employee health at work.

4. Assessment of ergonomic risk during selected activities using the NIOSH method

With the given work activity the handler lifts a plastic container
full of metal components, which is stored in the lower part of the
rack on roller tracks, Fig. 2 and 3. He lifts it with both hands, which
he holds in front of the body, and puts in onto the transport wagon.
The plastic container has an optimal configuration, with handles on
both sides.

![Fig.2: Start of the action](image)

![Fig.3: Target position of the action](image)

![Fig.4: NIOSH Lifting index](image)

Horizontal coefficient (H) - the position of the hands at the
initial action is 40cm and the distance to the end action 28cm. This
position is measured as the distance between the ankles and the
centre of the load, Fig. 4.

Vertical coefficient (V) - the initial height of the lift (the lower
part of the rack) is 39cm and the target height of the lift (the
transport wagon) is 98cm. The vertical position depends on the
height of grasping the load.

Distance coefficient (D) - the difference between the starting
point and the target is 59 cm. The calculation is set by subtracting
the length of the lift in a vertical direction (V) at the start of the lift
from the length of the lift at the end of the action.

Asymmetrical coefficient (A) - is at the beginning by 10
degrees and at the intended place is zero. This depends on the angle
of asymmetry when lifting the load.

Coefficient of coupling (C) - is defined as “good”, describes the
relationship between the hands and the held load.

Frequency coefficient (F) - lifting in this way are 2 lifts/minute
for a period of 1-2 hours per day. This gives the number of lifting
actions/1 min.

Load constant (L) - is the weight of the plastic container with
the metal components; in the given case this is an average loading
of 6kg and maximally with a number of lifts 12 kg.

These entered coefficients were assessed using the NIOSH -
Excel method, see Tab. 3 and 4.

- H = 40 cm at the start of the action and 28 cm at the intended
  location
- V = 39 cm at the start and 98 cm at the intended location
- D = 59 cm
- A = 10° at the start and 0° at the intended location
- C = 1 (good – the plastic container has the optimal solution
  for handles)
- F = 2 lifts/minute
- L = 6 kg with average loading and 12 kg maximum loading
- Dur = 2 (activity lasts 1-2 hours daily at time of relaxation)
Summary at the start of the action – the average weight (6 kg) is smaller than RWL (9.3 kg) at the beginning of the action, and the maximum weight (12 kg) is greater than RWL and the FIRWL (11.1 kg). The LI is 0.64 and the FILI (1.08) is moderately over 1.0 which does not represent the total risk for the health of an employee and a small danger when lifting maximum load of 12 kg from the start.

Summary at the end of the action – the average weight (6 kg) is smaller than RWL (14.4 kg) at the target place. The maximum loading (12 kg) is smaller than RWL and FIRWL (17.1 kg). LI is 0.42 and FILI is 0.70, which testifies to the small risk for the employee in the target place.

Table 4: Calculation of loading of the support-motor system of a handler using the NIOSH method in the target position of the action

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5. Assessment of ergonomic risks with selected activities in the TECNOMATIX JACK software by the NIOSH method

5.1 Tecnomatix Jack

Tecnomatix is a product line of the company Siemens PLM Software, which includes several software tools for different areas of production that can be mutually connected. The tools in the Tecnomatix line enable industrial enterprises to use in practice the concept of a digital business, i.e. to plan and project production, design, verify and optimize processes and production resources in a digital environment, as well as to assess ergonomic risk.

This software package contains several modules focused on specific areas of design. One of them is also the module – Process Simulate Human – simulation and analysis of manual production operations from the viewpoint of feasibility, ergonomy and the loading of workers.

The measured coefficients were entered into the simulation in Tecnomatix, and after assessment by the NIOSH method in the module Process Simulate Human in the Tecnomatix software, the subsequent ergonomic risk of the selected activities was calculated, Fig. 5. The resulting values are in the “green numbers”, which means that the given activity is safe for workers in terms of ergonomy.

6. Comparison between the NIOSH – Excel method and NIOSH simulation in Tecnomatix

On the basis of the depicted values in NIOSH-Excel and the simulations in Tecnomatix, it is evident that there is only a small difference between them.

In the NIOSH-Excel table the resultant value of the load index is LI= 0.64 and the resultant value of the recommended weight limit is RWL= 9.3 kg, Tab. 8. These values are achieved after entering the measured coefficients into the table and with subsequent automatic calculation by the NIOSH Lifting index program. These same values for the coefficients were entered with the simulation in Tecnomatix. During the simulation it was possible to add physical dimensions, the sizes of the person, such as weight and height, which are important aspects with the assessment of ergonomic loading, which is also expressed in the result. The resultant value of the load index was LI = 0.830 and the resultant value of the recommended weight limit was RWL = 7.23 kg.

Since the load index is in both cases under 1 (LI < 1), this means that the given work activity indicates marginal risk of damage to worker health. But it should not be underestimated, because with everyday handling with loads during these work activities, sooner or later, damage to worker health could occur. Therefore, it is necessary in the future to continuously monitor and evaluate whether the worker is experiencing any health complications and propose effective measures for limiting such injuries.
Proposed measures:
- To use mechanical lifting equipment when working with loads,
- to store heavier materials at such a height in the rack where it will be more natural for a worker and where he will not have to exert himself,
- the training of employees for correct handling of loads,
- an employee should be sufficiently informed so that he takes seriously any first symptoms of over-loading and does not ignore symptoms of muscle pain,
- information and instructions should be repeated at regular intervals,
- to perform a check of whether employees are observing the prescribed principles and processes.

People experience many consequences even into old age. It is therefore appropriate to also argue that even in youth one needs to think about old age.

7. Conclusion

An employer which does not exclude manual handling of loads is obligated to ensure that this handling is as safe as possible for employees, with the least amount of risk to health damage. In the interest of removing or reducing the effects of manual handling of loads on employee health, the employer is obligated before beginning such work:

a) to assess risk with each type of manual handling of loads,
b) to take relevant measures,
c) to ensure health oversight by which the health capabilities of employees for manual handling loads is assessed.

"This contribution is the result of the project implementation "Center for Research of control of technical, environmental a human risks for premanent development of productions and products in mechanical engineering" (ITMS 26220120060), supported by the Research & Development Operational Program funded by the ERDF."

“VEGA 1/0150/15 Development of methods of implementation and verification of integrated systems for safe machines, machine systems and industrial technologies”.

8. Literature


MODEL FOR ANALYSIS AND ASSESSMENT OF HAZARDOUS ENVIRONMENTS TO IMPROVE THE SECURITY OF THE POPULATION

1. Introduction

In 1976, an explosion in a small chemical plant outside the town of Meda, in Italy’s Lombardy region, 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.

The latest version of the Seveso Directive adopted in 2012 (Directive 2012/18/EU, effective 1 June 2015). 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 [1].

The Seveso Directive is also considered to be the European Union’s legal and technical instrument to fulfil the obligations, closely related with the UNECE Convention on the Transboundary Effects of Industrial Accidents [2].

With a view to strengthen Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) security, as well as to ensure protection of citizens, institutions and infrastructure against CBRNE incidents, in May 2014 was adopted a new EU approach for detection and mitigation of CBRNE risks [3]. 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.

Notwithstanding of the internationally accepted framework for prevention and countering accidents, involving hazardous substances, the related fields have not yet been developed: assessment of the vulnerability of various sectors of economy; improvement of the sustainability of buildings against CBRNE substances of concern; implementation of state-of-the-art systems for contamination of air, water, food and working environment 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.

2. 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. It is important to underline that this contemporary approach in advance has been discussed with the colleagues from different scientific and business organizations from Austria; Bulgaria; Cyprus; Greece; Italy; Lithuania; Portugal; Romania; Slovenia; Spain and United Kingdom.

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 are:

- Risks Assessment Methodology for multi-sectoral interdependencies, concerning Seveso type site/area related accidents;
- Measures to enhance the protection and reliability of buildings against explosive blast;
- Preparation of the requirements for the development of procedures and equipment for chemical and radiation protection of Seveso type site/area;
- Stationary and portable sensory unit models proposal, with high sensitivity and fast detection of contamination by chemical agents and radioactive materials for early warning;
- Localization of personnel in restricted areas (inside and outside of the buildings) and remote monitoring of their physiological health parameters;
- Personnel training and education model.

3. 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.

3.1 Risks Assessment Model for multi-sectoral interdependencies

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 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, which 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.

3.2 Measures to enhance protection and reliability of premises and buildings

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 [4] 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.

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 [5]:

• 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; no non-structural components such as fittings or installed equipment as a result of major deformation of the load-bearing construction and 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.

• 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.

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

• Materials and Systems [5]

Steel and reinforced concrete are the two materials often used in construction of the supporting structure of buildings.

• Steel

Steel structural systems should be detailed to take advantage of inherent ductility, and connections should be designed to provide continuity between elements. Steel should be 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 and 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; design for preventing progressive collapse should consider a scenario in which an exterior wall measuring vertically one floor height and laterally one bay width is lost.

• Methods of enhancing the sustainability of buildings [5]

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; Reinforced Concrete Masonry Units; Structural Retrofit; Building Envelope and Structural Load-Bearing Exterior Wall Systems.

• Increasing sustainability of windows [5]

• 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.
Proposed model for buildings’ sustainability against chemical or radiological attack is a natural result of the complexity of achieving protection against chemical, radioactive and explosive impact on a site during and after cleanup activities. Sensors would be useful for monitoring the level of contamination at the site/area, chemical agents or radiological materials can be used to preattack detection, as well as area monitoring of presumed target areas.

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 [6] 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.

3.4 Real-time analysis of air, food and water for chemical and radioactive contamination

Improvement “…the development and use of detection systems across the EU” [7] 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 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.

The abovementioned requirements will be met 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 refuinction. Smart sensor systems can be programmed to suggest alternatives, which will require integration and communication with the advanced analysis and decision support systems.
As a final result, the real time analysis of air, food and water for chemical and / or radioactive contamination will be achieved by portable and portable sensor system development.

3.5 Localization of personnel and remote monitoring of 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 [8].

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) for which sensory elements will be developed. 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.

3.6 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.

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 [3]:

• 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.

4. Conclusion

Expected impact and benefits of the proposed model developments is a better preparedness of society and all levels of stakeholders towards the "Seveso type site/area related accidents". 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.

Thus, will be enhanced understanding of policymakers and other stakeholders on how the multiple sectors, community, regions may be affected by Seveso type accidents, and what the total impact might be.

5. Literature


THE ATMOSPHERE AND SOLAR LIGHTNING INTERACTION

Metin Saltık, Adem Onat, Mustafa Denktaş

Abstract: In this study, the atmospheric electric charge changes were examined using an FET sensor. As is known, there are many resources that affect the global atmospheric cycle. The source is the sun in the most important of these resources. This study examined the effects of the sun on global atmospheric circuit.

KEYWORDS: LIGHTNING, ATMOSPHERE, FET, GLOBAL ELECTRIC CIRCUIT, AMPLIFIER, SENSOR,

1. Introduction

Earth’s atmosphere is electric structure. There are two important factors that influence the Earth’s atmosphere. These can be listed as follows.

a. Effects of lightning.
b. The effect of the sun.

Lightning effects, show the impact of the storm, especially at certain times. Lightning effects are the largest electrical currents affect the atmosphere. Lightning strikes, are very brief electrical current. In a short time, alter the power structure of the atmosphere. Seconds later revert to this duration. In other words, the immediate effects of lightning.

The effects of the sun, another effect is long-lasting. This effect continues as long as the sun. But the load changes in the atmosphere, especially at dusk and dawn when the sun reaches its maximum. This result is related to the formation of the charge layer in the atmosphere. Such as F and D layer formation. D and E of the night as the extinction layer. F layer is just to stay overnight. There are other electrical phenomena affecting the Earth’s atmosphere, but here it is effective, either.

3. Experimental work

To examine the electrical interactions in the atmosphere, we have developed an FET sensor. FETs as is known, are sensitive electrical circuit element that can detect load changes. The block diagram of the circuitry used in the experimental study are shown below. This circuit consists of five chapters. This section can be listed as follows.

1. Sensor
2. Filter
3. Amplifier
4. A/D
5. PC

The sensor consists of FET transistors. The amplifier is an amplifier consisting of several floors. Filter, band-pass and high-low is an electronic circuit. A / D is a circuit that converts analog signals to digital.

Figure 1. Block diagram of the measurement system used in the experiment.

The circuit block diagram shown above, 24-hour recordings are taken. These records are stored on the computer. We use my computer as a software for the seismic program. Because vibration is to record seismic program is able to record the results of the vibration load. Change the experimental setup is also capable of recording electrical load. 24-hour electricity load change records are shown below. Some of them are some effects of the sun lightning strokes. There appear to be major changes in the electrical charge of the lightning impulse. Sun effect is also weaker and longer. And that sun exposure usually consists of sunset and sunrise. This change also relates sunspots. These changes are seen in the charts in detail.
Figure 2. Changes in the electric field (Heavy rain and lightning two-hour recording)

Figure 3. 2015/08/01, 24 hours of recording
Figure 4. 2015/08/12, 24 hours of recording.

Figure 5. 2015/08/16, 24 hours of recording.
4. Result

It has reached significant results from experimental observations and data. These results give the same results with studies on global atmospheric cycle. 24-hour observation records of the results of all the factors affecting the structure of atmospheric electricity can be seen. These results are spread over a large area. For example, the effects of atmospheric electrical effects, all meteor to the effects of lightning shifts are recorded. In fact, 24-hour ionizing effect of the falling meteors were observed in the records. In another interesting record, load changes in the atmosphere before the earthquake is.

The observations and load changes from previous earthquakes were recorded in the records. This result is important in predicting earthquakes.

4. Conclusion

As in any scientific work that is open to debate. As is known, there is no certainty in science. Science debate. The results of this study can be discussed. The most important topic of discussion in lightning strikes are. Because lightning strikes are always obtained in the laboratory. But we've naturally by lightning strikes recorded.
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Abstract: First began to draw uranium in Bulgaria the Germans in 1938 in Buhovo. In the first year they draw 100 tons of metal. In 1939 they stopped. After the Second World War, uranium mining was renewed in secrecy, but this time by the Soviet-Bulgarian mining company. 48 mines have drawn uranium according to decree № 74 of the Council of Ministers in 1992, the government of Philip Dimitrov takes the decision to liquidate the uranium and another 30 were under investigation and trial operation. It is largely based in southern Bulgaria. Every year the world produces about 42,000 tons of uranium. One third of the yield is in Canada where deposits are 5 million tons. The control in the system of the Ministry of radiation status of the environment which is near former mines extracting uranium, includes field radiometric measurements and laboratory analyzes of soils, waste products in tailing ponds and landfills, sediments, groundwater and surface waters. A network of stations is built for monitoring of soil, groundwater and surface water and air, and produces agricultural products in the areas of uranium mining.

Keywords URANIUM MINES, URANIUM, CONTROL MONITORING, BUHOVO, RHODOPES, RADIATION CONTROL, RADIOLOGICAL RISK, LIQUIDATION, RADIONUCLIDES

1. Introduction

Many experts believe that the liquidation of uranium mining in the country in which they are finally exhausted, and even then there is extraction of uranium from old dumps. And no country liquidates its uranium production, if it has nuclear power plants. However, Bulgaria closed uranium mining in 1992 and threw over 50 million lev budget and a lot more under the PHARE 1991, was carried out hastily, with the result that in many areas are not realized complete technical solutions for this activity. Experience shows that no country in the world except Bulgaria's Remete mining, doesn't close its uranium deposits wrogram for the eradication of mines and land reclamation.

First began to draw uranium in Bulgaria the Germans in 1938 in Buhovo. In the first year they draw 100 tons of metal. In 1939 they stopped. After the Second World War, uranium mining was renewed in secrecy, but this time by the Soviet-Bulgarian mining company. It existed until 1956, when as a cap uranium grouping is formed "Rare Metals", which is referred to as a "state within a state." It had 13 000 people-workers. It controlled the geological measures, mining, processing and export of the obtained uranium concentrate. Under his hat were the others: "Buhovo", "Trakia" - Plovdiv and "Rise" - Smolyan.

48 mines have drawn uranium according to decree № 74 of the Council of Ministers in 1992, the government of Philip Dimitrov takes the decision to liquidate the uranium and another 30 were under investigation and trial operation. It is largely based in southern Bulgaria. The most famous are Eleshnitsa Sirorhishte, White Water, Dolna Banya. Near Buhovo are made mining developments, near Sofia there is uranium in Seslavtsi and Kremikovzi ....

In the Rhodope mountain the areas are four: near Eleshnitsa / 15 km away from Bansko /, Dospat, Smolyan, Velingrad. In Thracian Valley - Stryama Rakovski and around Plovdiv, Yambol Municipality. There is uranium in Montana, Simitli, Sliven and Stara Zagora, Burgas, Veliko Tarnovo, Gabrovo, Lovech and Pleven, Targovishte, Shumen, Ruse, Razgrad, Silistra, Dobrich and Varna. In 1974 the output reached 400 tons per year. Before the decision to liquidate the industry in 1992, uranium mining reached 645 tons per year. Throughout the time till 1989 the yield is secret, while production is strategic. Export is entirely to the Soviet Union.

The Bulgarian product is named "triraniyevsmoomki" (or oxide-zakis).The classical technology of digging uranium ore is on loss. This is an expensive process, but that is because of the strategic production. The other scheme is geotechnological. It is clean and very cheap. Tailings have only two plants for processing uranium ore - "Eleshnitsa" and "Buhovo." Now technology enables the extraction of uranium from much poorer ores and tailings piles in both can still be extracted uranium. Yellow cake - commercial product uranium from 30% to 60% is obtained after processing at the plant in Eleshnitsa, and in Buhovo was firing extra and was received a concentrate containing uranium about 80%. From there it is transported in containers to the Soviet Union, where nuclear fuel was produced and was sent back to our Kozloduy NPP. Every year the world produces about 42,000 tons of uranium. One third of the yield is in Canada where deposits are 5 million tons. The richest deposits of uranium are in Australia and in the top ten are still Kazakhstan which declared its intentions by 2012 to become the largest producer of uranium, and South Africa. In Bulgaria uranium reserves are estimated at 20,000 tons. From them suitable for exploitation by geotechnological method are 12,000 tons and in practice can be extracted 6500 tons. However, they could secure our nuclear power for at least 20 years. Geotechnology is applicable for deposits in Plovdiv, Yambol, and the valley of Struma. Experts in the industry believe that Bulgaria is fully capable of pulling 300 tonnes of uranium per year. Only a small mine with no more than 100 people staff gave 600 thousand dollars a year profit at all deductions for taxes, transport, food, prevention of the workers export and further processing of the metal to the commercial product.

Until 1992 most of the minimum prices on the London stock exchange. the threeariumnine eightoxide costed $ 42 per kilogram. In regular supply the price jumped nearly doubled - to $ 70 per kilogram. Now the price is about $ 140 per kilo, which would bring 42 million dollars annual profit of Bulgaria in the resumption of uranium. However, the trend is the product to reach a price of 200 dollars per kilogram. That's what dictates the interest of Canadian and Russian producers to the revival of uranium mining in Bulgaria. The control in the system of the Ministry of radiation status of the environment which is near former mines extracting uranium, includes field radiometric measurements and laboratory analyzes of soils, waste products in tailing ponds and landfills, sediments, groundwater and surface waters. Radiological parameters of soil, bottom sediments and waste materials are evaluated by analysis of samples from the network of the EEA for the control of potential pollutants. Water samples are analyzed radiochemical regarding to the targets set out in BS 2823 "Drinking water" - total beta radioactivity, uranium and radium.
2. Materials for Production of Prototype Parts

With the entry into Decree №74/27.03.1998 on eliminating the consequences of the extraction and processing of uranium ores is assigned to the "Ecoengineering - RM" Ltd. to organize and supervise technical liquidation activities, technical and biological reclamation of scrubbing results and conduct a comprehensive departmental monitoring of environmental components. Despite the existence of a legal basis, not all sites are built and operated monitoring networks as approved by the Chairman of the Energy Committee “Instruction on organization of monitoring system design, construction and operation of networks for environmental monitoring in the affected by uranium industry development". The liquidation of every mine begins with closing the shafts and horizontal galleries. Blocking the entrances with concrete walls, parallel overhead bunkers and destroying buildings and then taking technical and biological reclamation of affected lands.

In the Phare project "Comprehensive Program for cleaning and monitoring areas affected by mining and processing of uranium in Buhovo" in March 1999 is built a local system for basic environmental monitoring in the area of Buhovo - Yana (LSBM). The system consists: two monitoring container located in Buhovo and in Yana, two reception centers - in "Rare Metals" Ltd Buhovo and EEA - MoEW and information board for continuous public information installed on the cultural center in Buhovo. The LBMS is intended to carry out continuous monitoring of indicators of environmental rehabilitation activities before, during and after the completion of restoration works in the area. Monitoring containers are equipped with measure instruments for continuous monitoring of total dust, radiological parameters power of gamma radiation dose, concentration of radon in ground-air meteorological parameters: direction and wind speed, temperature and humidity on the ground air, atmospheric pressure and precipitation.

A network of stations is built for monitoring of soil, groundwater and surface water and air, and produces agricultural products in the areas of uranium mining. Measurements show that there is no risk for people, animals and plant life, because values for heavy and toxic elements and radionuclides are below the limit concentrations. In 2001, after the closure of sites for uranium, in reference to the "NRA" Sofia were carried out radiation measurements for researching the radiation status of this region. The results of the measurements of background radiation are given in Table 1. In Table 2 are given the specific activity of soil samples from the surface layer 0 -10 cm, from places which are expected to have a lot of dirt.

<table>
<thead>
<tr>
<th>Measuring points</th>
<th>Coordinates</th>
<th>Background radiation * Sv / h</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Levels near “The breeding-pond”</td>
<td>N42 18 10.3 E24 54 39.5 204.0 m</td>
<td>0,23 - 0,28</td>
</tr>
<tr>
<td>2. Levels near the canal</td>
<td>N42 18 20.9 E24 54 08.2 204.2 m</td>
<td>0,18 - 0,20</td>
</tr>
<tr>
<td>3. Uranium mining site</td>
<td>N42 18 22.4 E24 53 55.1 183.7 m</td>
<td>0,24 - 0,31</td>
</tr>
<tr>
<td>4. Stock tubes “Rare metals”</td>
<td>N42 18 36.2 E24 53 44.3182.1 m</td>
<td>0,22 - 0,23</td>
</tr>
<tr>
<td>5. Road to Padarsko village</td>
<td>N42 19 11.9 E24 53 36.4 219.1 m</td>
<td>0,21 - 0,22</td>
</tr>
<tr>
<td>6. Village</td>
<td>N42 18 34.3 E24</td>
<td>0,20 - 0,22</td>
</tr>
</tbody>
</table>

Table 1. Results of measures of natural background radiation in the vicinity of Momino village.

<table>
<thead>
<tr>
<th>Place of samplers</th>
<th>U-238 [Bq/kg]</th>
<th>Th-232 [Bq/kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Momino village</td>
<td>90</td>
<td>67</td>
</tr>
<tr>
<td>“The cemetery”</td>
<td>72</td>
<td>83</td>
</tr>
<tr>
<td>“The breeding-pond”</td>
<td>37</td>
<td>44</td>
</tr>
<tr>
<td>To uranium mining site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rakovski city</td>
<td>73</td>
<td>68</td>
</tr>
<tr>
<td>Parvomay city</td>
<td>73</td>
<td>70</td>
</tr>
</tbody>
</table>

Table 2. Contents of radionuclides in soil samples, Momino village

The area, which has conducted uranium mining activities in the Rhodopes, starts not far from Asenovgrad and extends to the southern border. He is known as the center of tourism and recreation activities. Ongoing for decades uranium questioned the radiological purity, despite the talks of the liquidation events.

Receipt of uranium ore in these areas is done by digging pits / gallery /. For the transportation of ore are built roads and Mine excavated mass without industrial uranium forms a "mound" near the adit, which gradually overgrows. Open pits are walled, buried with earth and they are indistinguishable, but some of them are broken partitions. Given the radiological significance of the problem, the first studies were carried out in the upper stream of the Arda River in 1996 with a project funded by the MEST. Figure 1 shows the area of research and the points of samplers. Periodically conducted measurements showed that the level of background radiation does not exceed 0,28 Sv / h, v area. The content of radionuclides in the soil and water samples turned out to be within the average for the country [2].

The only point in which it was found to increase the background radiation (0,40 audits area but close to dysfunctional ramp for loading the uranium ore. This provokes taking radiation measurements in uranium indoor areas, which was funded in three consecutive years of NRA Sofia [3, 5, 6]. Object of research were three divisions - Gerzovica and Kiselchovo, Smolyan, Narechenski ore yield area, Belocherkovski rid, Plovdiv.
On the Fig. 1. Location of sampling from the closed uranium mines.

On figure 1. are reflected the points where samplers were made. These are the places that were open to the adit of closed mines and there is expected aggravated radiation situation. After inspection by the responsible institutions they have identified the following deficiencies in the former uranium mines, which must be removed with funding from PMS №№ 3 / 15.01.2014g. For allocating the funds on programs for technical liquidation and conservation of objects from the mining sector for 2014.

1. Government documents have been accepted to solve the problems of the consequences of priority liquidated uranium mines and uranium processing; 2. Some uranium mines and uranium processing are built without monitoring networks for radiation control and do not conduct departmental monitoring; 3. Compromised are already committed liquidation and reclamation works due to the poor quality of their design and / or implementation and insufficient maintenance of already built structures; 4. Radiological risk exists due to unresolved issues with management and complex purification of contaminated radionuclides natural water flowing from the mining sites.

1. Literature:

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4. Examination of the natural and technogenic radiation status of regions along the river Gorna Arda, the report is titled F-633/1996, fund "Research", MONT.
5. Setting the radiation status over the areas related by uranium yield in the region of Narechenski ore, report on the topic №552 / 2003 NRA Sofia.


8. PMS № № 3 / 15.01.2014g. For allocation of funds for programs under technical liquidation and conservation of objects from the mining sector for 2014.
Much of tritium and carbon-14 accumulates in ocean waters. Organic compounds, which enter as a component, are involved in photosynthesis, decomposition of organic matter, determine the age of stable isotopes, and it helps to learn a number of processes, such as the influence of magnetic fields on the planet.

Radioactive and biochemical researches prove that after big reactor breakdowns and nuclear explosions pastures and vegetation get polluted with radioactive iodine 131. High level of radioactive contamination has been established lucerne and other grasses, which required the prohibition of feeding farm animals with green fodder from the first slope. Milk is the most affected by the radioactive contamination of food of animal origin. Caught up in the human body radionuclides distributed in various organs, tissues and systems, they have complex kinetics, which depends on the nature of the metabolic processes. The distribution in the body depends on the manner of introduction of the radionuclide.

**Abstract:** Radioactive and biochemical researches prove that after big reactor breakdowns and nuclear explosions pastures and vegetation get polluted with radioactive iodine 131. High level of radioactive contamination has been established lucerne and other grasses, which required the prohibition of feeding farm animals with green fodder from the first slope. Milk is the most affected by the radioactive contamination of food of animal origin. Caught up in the human body radionuclides distributed in various organs, tissues and systems, they have complex kinetics, which depends on the nature of the metabolic processes. The distribution in the body depends on the manner of introduction of the radionuclide.

**Keywords:** RADIOACTIVE ELEMENTS, HUMAN, RADIATION EFFECT, RADIONUCLIDE, FOOD PRODUCT, ISOTOPES

**1. Introduction**

Cosmic rays that reach the Earth's surface can create radioisotopes decay but compared to other naturally occurring radionuclides is extremely low and not particularly important.

With the importance of biological standpoint are thus formed in the atmosphere of carbon-14 and tritium. Carbon-14 is formed by irradiation with neutrons, nitrogen-14, and the three - of hydrogen. Radio hydrocarbon included in the organic world, follows the path of stable isotope and it helps to learn a number of processes, such as photosynthesis, decomposition of organic matter, determine the age of organic formations and others. It passes in the coal, oil, etc., and also in the inorganic carbon compounds (carbonates) and others. Tritiated also be mixed with hydrogen into the water, and other organic compounds, which enter as a component and is involved in the circulation of the substances, but its half-life is much shorter. Much of tritium and carbon-14 accumulates in ocean waters.

It is believed that the content of radioactive elements is the result of nuclear reactions in the atmosphere and in recent years 1000 constantly present in it. Naturally there is no question of radionuclides as a result of the testing of nuclear weapons and other human activity, but natural cosmogeneous radionuclides. Interest is established depending on the content of radionuclides in the atmosphere not only by the altitude but also the latitude of the globe. It was found that with the distance from the equator to the north intensity of cosmic radiation is uvelichava. Tova binds to the influence of magnetic fields on the planet.

**2. Materials for Production of Prototype Parts**

Radioactive and biochemical researches prove that after big reactor breakdowns nuclear explosions pastures and vegetation get polluted with radioactive iodine 131. The most polluted this this isotope milk cannot be drank after that. In those occasions, milking animals must immediately be removed from pastures and fed only with provender from the warehouses. As in similar occasions, milk is the most affected product by radioactive pollution.

From all kinds of meat the one with highest levels of radioactive pollution is mutton. In other eatables from vegetarian and animal origin – tomatoes, pepper, cucumbers, potatoes, carrots, cabbage, beans, apples, pears, watermelons, mushrooms, cans, sausages, baby foods, etc...have been detected lower levels of radioactive pollution. This has served as reason to the Committee on the Peaceful Uses of Atomic Energy to state that main part of foods used within population doesn’t seem to be radioactive and to suppose risk to health is as its lower levels. Highest levels of pollution within researched plants have been detected with leaf vegetables – salads, lettuce, green onion, parsley.

High level of radioactive contamination has been established lucerne and other grasses, which required the prohibition of feeding farm animals with green fodder from the first slope. In straw cereals is measured several times higher activity than in the classes. In the measured activity was significant participation of radio-cesium.

Radioactive contamination of plants and plant products is associated mainly with air route of administration of radionuclides and their attachment on the soil and plant organs and a further shift in the chain - food for animals and humans. Milk is the most affected by the radioactive contamination of food of animal origin.

In some cases, it can be applied and biological decontamination of radioactively contaminated areas, ie extraction of radionuclides with plants that can accumulate and neutralize them.

Picture of the path of radioactive pollution in the human food chain gives us Fig.1. It appears that up to 80% of the calcium in the human body is obtained from foods of animal origin (Figure 1), but the most radioactive element strontium –90 (Sr90), is obtained in the radioactive contamination of the soil. The ratio of calcium and strontium in the bones of a person is equal to that of the elements in the soil.

From the figure it is clear that in terms of Sr-90 the most dangerous radioactive pollution is in the milk (a). The products of plant and animal origin have equal contribution to the pollution of the human body with Cs-137 (fig.1b). The ratio of Sr-90 / Ca is equal in the tissues of plants and soil. The organisms of animals use more quickly calcium than strontium, and this ratio is less than one. At the same time it should be noted that the contribution of Cs-137 in the food chain is extremely diverse. On one hand, plants extract more potassium from the soil than cesium, at the same time in animals the accumulation of cesium is more intense than calcium, and the ratio between their concentrations is above unity.
Fig. 1. Passage of Sr-90 and Cs-137 in the human food chain, the most sensitive to pollution with these radioactive elements (in Langkam, 1965).

The internal exposure of the human body is due to the radionuclides that have fallen into the (incorporated). Incorporation may be done in several ways, in which purposes of radioecology rights are the most important two:

- oral ingestion of food or water (oral incorporation);
- inhalation of radioactive gases and aerosols (inhalation incorporation).

Caught up in the human body radionuclides distributed in various organs, tissues and systems, they have complex kinetics, which depends on the nature of the metabolic processes. Some radionuclides have selective uptake, such as iodine in the thyroid gland, radium and strontium – in bones; others distributed more evenly, such as cesium and potassium muscle tissue, etc.

At some point, the body has a certain activity $A$ [Bq], which is distributed on the body mass $m$ [kg], determined with specific activity [Bq / kg]. But $C$ varies with time not only in body as a whole, but in different organs and tissues. This is due to the fact that the radionuclide is allocated in the body (especially in initial stages after arrival), but even is considered as a whole, $C$ is changing because that given radionuclide decays with a physical half-life $T_f$, but is also appears in the body to the strong of it is a chemical element that is involved in metabolic processes. That departure is a purely biological process and is characterized by the so-called biological half-life $T_b$.

The distribution in the body depends on the manner of introduction of the radionuclide. For example, after ingestion of plutonium-239 in the body is held only about 0,003%, whereas after inhalation retained part is 25%. It is seen and the complex distribution in various organs of the body. These organs, in which he goes and accumulates respective radionuclide are called critical organs.

Radioactive isotopes of any chemical element, which falls in the body are involved in the exchange of substances in the same way as the stable isotopes of an element. Biological activity of radioactive isotopes is determined by the parameters of ionizing radiation which they emit.

The radiotoxicity is called the property of radionuclides that cause various degrees pathological changes in their entry into the human body. Pure radiotoxicity cannot be separated from the chemical toxicity of a chemical element and compound and a typical example of this is uranium, which belongs to the so-called heavy metals.

Toxic effects of radionuclides caught up in the human body is determined by:

- solubility and absorption of the compounds in which they are found;
- The way of incorporation;
- character of the allocation in organs and tissues;
- speeds of input and output of the body;
- Physical characteristics of emitted ionizing radiation: type of radiation, energy, etc.;
- Age of the person, in which has fallen the radionuclide and other individual characteristics.

As a result of human exposure with large doses of some symptoms showing changes in normal physiology, may occur within days, hours or minutes. On the other hand, the body can react to irradiation of clinical events after years or decades. In this connection, radiation-induced effects in humans are divided into:

- Early somatic effects, with periods of manifestation from minutes to days. They are called acute and comprise a very wide range of phenomena, starting from the radiation erythema and lead to death of the organism. Somatic name comes from the Greek word soma, which means body.
- Late somatic or somatic-stochastic, with development period of years and decades. These include radiation the induced malignancies (commonly referred to as cancer).
- Inherited or genetic effects that occur in the progeny of exposed individuals: children, grandchildren, great-grandchildren, etc. In human radiobiology or otherwise, radiation in medicine, principally define two types of effects due to the effects of ionizing radiation on humans that medicine defined as diseases:
  - deterministic effects, as all of them are somatic and are characterized by a threshold of radiation impact (threshold dose of radiation), under which these effects were not observed, and above this threshold the severity (level) of the clinical expression of the effect depends on the dose;
  - stochastic effects, ie somatic (cancer) or hereditary (genetic) effects that occur in the irradiated person years after exposure or in subsequent generations. These effects (diseases) have a probability (stochastic) nature; for them it is assumed that there is no threshold on the radiation dose and the their gravity is independent of dose. Stochastic effects are not specific in nature, they can not be distinguished from other similar effects induced by other factors of non-radiation nature.
This principally separation of radiation the induced effects in humans is a result of multi-year study of the effects of ionizing radiation on both human and experimental animals (mainly mammals), starting from the molecular level through to level body as a whole and population level. On the other hand, a number of problems, both theoretical and practical, has a number of unclear incomplete data on specific patterns on the formation and progress of the corresponding radiation-induced effect.

3. Conclusions:

1. Radioactive contamination of plants and plant products is associated mainly with air route of administration of radionuclides and their attachment on the soil and plant organs and a further shift in the chain - food for animals and humans;
2. Milk is most affected by radioactive pollution food product of animal origin and flesh at high overlay of radioisotopes was observed in sheepmeat;
3. The highest contamination of vegetation is found in leafy vegetables - spinach, salads, lettuce, green onions, parsley, etc.;
4. The most widespread isotopes that have an impact on the human body are I-131, Sr-90 and Cs-137.

4. Literature: