Technological Safety and the Production System

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Abstract. Implementation of disease detection systems and technology safety management in the states is intended. The technique of defining the security center based on the linear programming problem solving and two-level system decision-making on technology safety assurance is presented. In the first level the safety center is defined, in the second level the process stability problem in the field of safe operation is solved.

Keywords: state assessment, safety of technologies, area of safety, center of safety, linear programming, preparation and decision-making.

I. INTRODUCTION

The methodological principles behind state-of-the-art system creation and safety management are based on mathematical models with final and final differences that are at the core of the US disease detection system [1]. Technological safety management decisions for manufacturing systems operating in semi-structured and highly regulated environments, based on diagnostic multilevel analysis taking into account the anticipated conditions of the technology process, information on external environmental conditions To be. And the mental ideas of production personnel about the conditions of technological situations [2].

II. FINDINGS

However, there is the following task: from the point of view of the systems concept to analyze and to accurately set correlations between all factors (variable) of a specific objective of the linear programming (LP) [5,6]. For systems and processes of destruction of chemical weapon it is especially relevant, considering the increased danger of such systems to the environment and people.

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There is a need for determination of numerical values of intervals of change of input variables of the linear model which do not lead to an essential deviation from the found optimum and at the same time provide stability of an optimal solution in case of changes of model parameters. Such researches received the name – the analysis of model of the task LP in case of the known optimal solution.

Method of obtaining the quasioptimal invariant solution of a problem of linear programming.

The idea of the offered method consists in the following. Optimal solutions of direct and dual symmetric problems of linear programming for the situation described by linear model are defined.

Let the direct problem of LP have an appearance:

$$W = \overline{C}^{T}\,\overline{X} \rightarrow \max, \qquad (24)$$

$$A\overline{X} \le \overline{B}$$
$$\overline{X} \ge \overline{0},$$

where $\overline{C}=\begin{pmatrix} c_1 \\ c_2 \\ \vdots \\ c_n \end{pmatrix}$, $\overline{B}=\begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_m \end{pmatrix}$,

$$\overline{X}=\begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{pmatrix}, A=\begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{pmatrix}.$$

Then the dual problem of LP will have an appearance:

$$F = \overline{B}^{T}\,\overline{Z} \rightarrow \min \qquad (25)$$

$$A^{T} \cdot \overline{Z} \ge \overline{C}$$
$$\overline{Z} \ge \overline{0}$$

Where $\overline{Z}=\begin{pmatrix} z_1 \\ z_2 \\ \vdots \\ z_m \end{pmatrix}$- vector column of dual variables z_i, $i=1,\dots,m$.

The theory of duality for problems of linear programming asserts that for optimal solutions of direct and dual tasks the condition of the supplementing not rigidity has to be satisfied:

$$\begin{cases} z_i^0 \cdot \left(\sum_{j=1}^{n} a_{ij}\, x_j^0 - b_i\right) = 0, i = 1, \dots, m, \\ x_i^0 \cdot \left(\sum_{i=1}^{m} a_{ij}\, z_i^0 - c_j\right) = 0, j = 1, \dots, n. \end{cases} \qquad (26)$$

Where
$\overline{x}^{0T} = \{x_1^0, x_2^0, \dots, x_n^0\}$- optimal solution of a direct task (a vector - a line);
$\overline{z}^{0T} = \{z_1^0, z_2^0, \dots, z_m^0\}$ – optimal solution of a dual task (vector-line).

Follows from a condition (26) that if any dual variable in an optimal solution of $z_k^0!! \neq 0$, residual of the resource $b_k^0 = 0$, it means that this value is exhausted, and this circumstance does not allow to increase more numerical value of target function of W. From the practical point of view, the research of behavior of an optimal solution $\overline{x}^{0T} = \{x_1^0, x_2^0, \dots, x_n^0\}$ is of great interest in case of possible uncontrollable changes of components of a vector of **X**. For bigger exemplariness and understanding we will continue reasonings on a numerical example.

We solve a problem a simple method.

Having made two iterations, we will receive an optimal solution of a task:

$W_{max}^0 = 16$, at $x_1^0 = 9$; $x_2^0 = 7$, $y_1^0 = 23$; $y_2^0 = 47, y_3^0 = 0; y_4^0 = 0$.

In Fig. 2 presents a geometric interpretation of the solution of problem (27).

From the optimal solution of the direct problem (finite simplex table), we can determine the optimal solution of the dual problem:

$$F_{min}^0 = 16, \text{при } Z_1^0 = 0, Z_2^0 = 0, Z_3^0 = \frac{4}{15}, Z_4^0 = \frac{1}{15}.$$

Shadow price of a resource $b_3 : Z_3^0 = 4/15$, and resource $b_4 : Z_4^0 = 1/15$.

It demonstrates that the b_3 resource defitsitny, is more powerful than the b_4 resource four times and any deviation towards his reduction (for the different casual and nonrandom reasons) will lead to the fact that the received optimal solution of a direct task (27) will become not only non-optimal, but in general inadmissible. I.e. the point E in fig. 2 will appear outside the area of feasible solutions (AFS).

In contrast the approaches directed to prevention of reduction of W_{max}^0 in problems of linear programming [6-7] in the present article it is offered for the sake of achievement of acceptable level of safety at destruction of chemical weapon, to allow insignificant reduction of a prize of the operation W_{max}^0

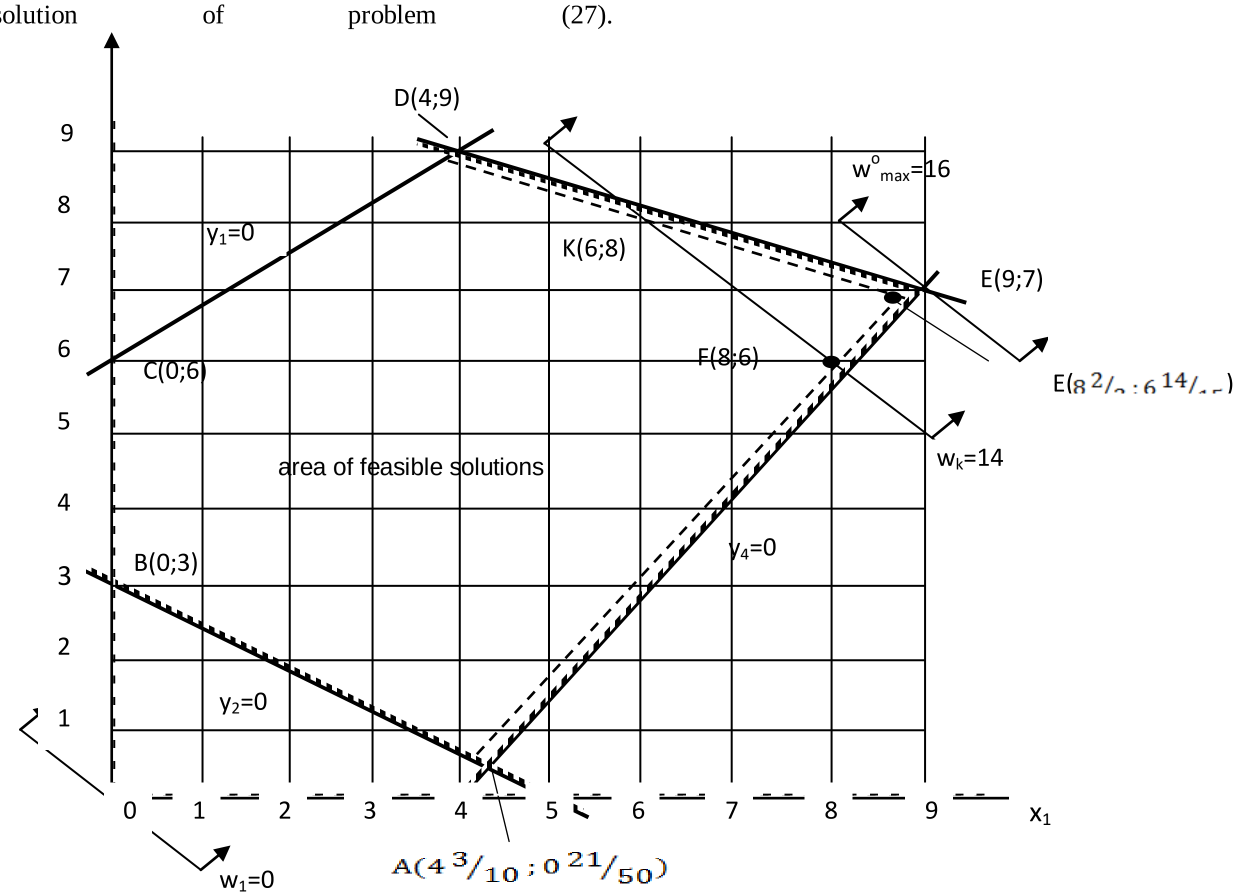

Figure 2. Geometrical interpretation of the solution of a problem of LP.

In other words, it is offered to reduce by a certain size AFS, to receive the quasioptimum, but steady (interval) decision, without resorting to the solution of a stochastic problem of linear programming which not always is correct for definition of the decision accepted for practice.

In a task (27) we will reduce a b_3 resource stock by 1 unit, i.e. we will put in the b_3=52 models, we will reduce a stock of the b_4 resource by 2 units, i.e. we will put b_4=26

Thus, in model (27):
$y_3^* = 52 - (2x_1 + 5x_2)$
$y_4^* = 26 - (7x_1 - 5x_2)$

It means that the AFS lines (fig. 2) of DE and AE in parallel will move inside the AFS.

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We will define a point of intersection of lines: y_3^ *=0 and y_4^ *=0, having solved for this purpose the system of the equations:

$$\begin{cases} 2x_1 + 5x_2 = 52 \\ 7x_1 - 5x_2 = 26 \end{cases} \quad (29)$$

$$x_1 = 8\,{}^{2}/_{3},\ x_2 = 6\frac{14}{15}.$$

Those in comparison with the optimal solution x^0=(9,7), point of intersection of straight lines: $y_3^* = y_4^0 = 0$ has moved inside AFS $x^* = \left(8\,{}^{2}/_{3}\,;6\,{}^{14}/_{15}\right)$.

We will reduce also value W to W=14. It means that the line of object function will cross edges the AFS: $y_3^* = 0$ и $y_4^* = 0$.

We will determine coordinates of these points of intersection of lines, having solved two systems of the linear equations:

$$\begin{cases} 2x_1 + 5x_2 = 52 \\ x_1 + x_2 = 14 \end{cases} \Rightarrow \begin{matrix} y_3^*=0 \\ W^*=14 \end{matrix} \quad (30)$$

$$\begin{cases} 7x_1 - 5x_2 = 26 \\ x_1 + x_2 = 14 \end{cases} \Rightarrow \begin{matrix} y_4^*=0 \\ W^*=14 \end{matrix} \quad (31)$$

For system (30):

$x_1^{**} = 6 > 0;\ x_2^{**} = 8 > 0.$

The point K is the intersection point of the lines of the objective function W and the constraint $y_3^* = 0$ has coordinates $x_1^{**} = 6, x_2^{**} = 8$, т.е. K[3;4].

For system (31): $x_1^{**} = 8, x_2^{**} = 6$.

That is, the intersection point H of the intersection W and the constraint $y_4^* = 0$ has the coordinates H [3; 4].

III. CONCLUSION

Thus, intervals of change of the variables $x_1 \in [3;4]$ and $x_2 \in [8;6]$ were defined, where target function of the task (26) is invariant (a segment of KH). From the practical point of view this circumstance allows to claim that in case of change of the x_1 variable in an interval [3; 4] and the x_2 variable in an interval [3; 4], the value of target function W=14 does not change. Doesn't play a role what indignations are imposed on x_1 and x_2, and what law of distribution they have. In the specified intervals the quasioptimal invariant value of criterion function of a problem of linear programming, so and stability of process of management of technological system in the field of safety is provided.

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5.An Alternative Approach for Solving Bi-Level Programming Problems

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