Improvements in Labour Safety Management: Efficiency of Industrial Control Organization and Implementation, Occupational Risks Assessment (by the Example of Food Industry Enterprise)

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Abstract. The labour safety management system (LSMS) at many enterprises is absent or does not work effectively, although it is an essential component of the safe work organization. In this connection, one of the basic mechanisms is the systematization of activities in the field of industrial control, as well as in the occupational risk management. This article proposes a methodological approach to improving labour protection at a food enterprise. In the implementation if this approach the following tasks have been completed: the most significant information elements of the LSMS have been identified and the least studied information element have been identified; identification of hazards and risks assessment based on production control data and special assessment of working conditions was carried out; the ranking of the assessment of the conditions of possible risk at workplaces was carried out; a risk management strategy for the enterprise was developed. The results of the proposed research support the effectiveness and prospects of the developed approach.

1. Introduction

1.1. Relevance of labor safety issues in food industry
One of the basic principles in the organization of production is providing of safe working conditions at all stages of the production cycle. The issues in the occupational safety at the food industry enterprise could be solved by an efficiently organized labor safety system (LSS) at the enterprises, which includes a set of measures to protect the life and health of workers, namely: legal, socio-economic, organizational and technical, sanitary and hygienic and others [1].

Correctly organized activities to ensure labor safety increases the discipline of workers, which in turn leads to an increase in labor productivity, a decrease in the number of accidents, equipment malfunctions and other emergency situations, which eventually results in increase of the efficiency of the production process [2-4].
1.2. Current state of labor safety

The functioning of the labor safety management system (LSMS) at enterprises (organizations) is the main component of the modern model for occupational health and safety management. One of the basic mechanisms in this system is the systematization of activities in the field of production control, as well as in the management of occupational risks [5,6].

Analysis of normative and legislative acts on these issues demonstrates that they are developed and presented in sufficient volume. Some of the documents in the Russian Federation have been developed based on international standards such as OHSAS 18001: 2007 and ILO-OSH2001 [7,8]. However, the studies show that at modern enterprises there is no a systematic approach to solving problems in the field of labor safety in particular industries, which does not make it possible to provide effective management in the safety of production processes [9, 16].

2. Statement of the goal

To determine the most significant components in the functioning and improvements in labor safety at food enterprises, an expert survey method was applied by use of the questionnaire. The survey was titled: "Organization of labor safety at enterprises: policy, goals, financing, current labor safety control, development of local documentation." The expert group included LS specialists and top managers of food enterprises [10].

Based on the data collected in the survey conducted, the following conclusions were made, namely:

- the expert assessment confirmed that the priority areas for creating safe working conditions at food enterprises are: conducting a special assessment of working conditions (SAWC) and development of the effective special system for labor safety management (LSMS). The development of documentation in these areas is carried out in accordance with the requirements of the legislation in the Russian Federation and is considered to be of a satisfactory level. The study has shown that the least developed element is the assessment of occupational risks and production control;
- the respondents stated as a negative factor: insufficient funding for all activities related to providing safe working conditions and the attention from supervisory authorities to the issues under consideration. In addition, in their opinion, the greatest finances are required for the SAWC and the assessment of professional risks;
- the experts consider the creation of an LSMS and conducting (carrying out) of an SAWC to be the most labor consuming in terms of organization and implementation. In their opinion, this is due to the insufficient level of qualification in specialists in the field of labor safety, especially for developing local documentation;
- it should be noted that the opinion of the respondents was practically the same in the following: the heads of enterprises lack motivation (smaller fines resulting in bigger inducement, etc.) and, at the same time, their low interest in creating safe working conditions for workers in the production process is observed.

Thus, the goal of the research is to study the current practice of organizing labor safety and develop methodological support to improve the functioning of an LSMS at an enterprise, taking into account the development of production control at workplaces. The object of the research is the food company Sibkor-N LLC in Novosibirsk, the main activity of which is the production of mayonnaise, marinades, sauces, as well as the production of containers and packages.

3. Theoretical base

A systematic approach to the development of an LSMS at enterprises (organizations) involves the implementation and providing the operation of all its elements as a whole [11]. For the effective functioning of this system, five main blocks have been identified, their list and content are presented in Table 1.
Table 1. List and content of the main components affecting the efficiency of the LSMS at the enterprise.

| N  | Main Blocks                      | LSMS Functional Elements | Labour Safety Procedures                                      |
|----|---------------------------------|--------------------------|---------------------------------------------------------------|
| 1  | Personnel policy                | Qualification and competence | - industrial training;                                      |
|    |                                 |                          | - teaching;                                                   |
|    |                                 |                          | - instructions.                                               |
|    |                                 | Staff turnover           | - payment;                                                    |
|    |                                 |                          | - benefits;                                                   |
|    |                                 | Equipment                | - work conditions;                                            |
|    |                                 |                          | - work-rest schedule;                                         |
|    |                                 |                          | - health inspection.                                          |
|    |                                 |                          | - safe operation.                                             |
| 2  | Technological process           | Raw materials            | - quality;                                                    |
|    |                                 |                          | - storage;                                                    |
|    |                                 | Monitoring and control   | - industrial control;                                         |
|    |                                 |                          | - multi-stage and other types of control;                    |
|    |                                 |                          | - internal audit.                                             |
|    |                                 |                          | - regulatory acts;                                            |
| 3  | Labour safety management        | Information collection   | - procedure for inspection of documents;                     |
|    |                                 |                          | - Posters and leaflets.                                      |
|    |                                 | LSMS documents management| - Development of LSMS;                                       |
|    |                                 |                          | - carrying out SAFC;                                          |
|    |                                 |                          | - identifying danger and risks assessment;                    |
| 4  | Identification of harmful factors| Constant control. Determination of labour conditions class | - questioning;                                                |
|    |                                 |                          | - providing collective and individual protection.             |
|    |                                 |                          | - LSMS control;                                               |
|    |                                 |                          | - procedures monitoring;                                      |
|    |                                 |                          | - occupational risks level assessment.                        |

Analysis of the current labour safety procedures at a food enterprise showed the absence of:
- local documentation on industrial control (IC);
- methodological support for assessing the level of occupational risks;
- a systematic (complete) LSMS system.

At the next stage of the research, the effectiveness of the industrial control (IC) functioning was assessed, which is one of the elements of the industrial safety management system. Production control is implemented through a set of measures aimed at ensuring the safe operation of the worker, compliance with the requirements of environmental legislation and compliance with sanitary rules, hygiene standards and the implementation of sanitary and anti-epidemic (preventive) measures in the organization. There are three main types of industrial control - sanitary and epidemiological, environmental and control at a hazardous production enterprise [12]. For each level of industrial control, a number of checklists is developed according to the type of production activity and the equipment used [6,13].

By various methods of system analysis, it is possible to build a model for the effectiveness of the IC [14]. By using the graphical method (Ishikawa diagram [15]), the analysis is made and the cause-effect relationships between the main elements for improving the IC system are determined. The following main (priority) blocks of IC implementation and working conditions control were identified:
- development and improvement of local regulatory documentation;
- safety and reliability of technological equipment;
- analysis of working conditions at workplaces based on the obtained reliable measurement results by accredited organizations;
- timely registration of accounting and reporting documentation;
- training of qualified and competent specialists.
Based on the described method, a local regulatory document “Regulation on industrial control in compliance with industrial safety requirements of Sibkor-N LLC” was developed and implemented, which made it possible to further identify and assess the hazards and risks at the workplaces of the enterprise under investigation.

The results of the hazards identification and working environment assessment as well as the labor process hazards are as follows [17]:

1) list of dangerous events;
2) description of the hazardous sources and harmful effects, risk factors, conditions for the occurrence and development of undesired events;
3) preliminary assessments of the hazards and possible risks of damage to the health of workers.

The list of identified hazards affecting all employees of the enterprise is presented in the form of a hazard register [18].

For the conditional ranking of the significance of possible risks at the workplace, an integral assessment of the risk level was used, calculated by the formula:

$$IAL_{or} = \sum (L_{Aor} \times N_{wwp})$$  \hspace{1cm} (1)

where,

- $IAL_{or}$ is an integral assessment of the level of occupational risk for a particular hazard;
- $L_{Aor}$ – level assessment of occupational risk for the corresponding hazard at a particular workplace;
- $N_{wwp}$ - the number of employees at a particular workplace.

Thus, the proposed methodological approach to improving the implementation of labour safety at the enterprise consists of the following stages:

- determination of the most significant information elements of the LSMS and identification of information elements that are least studied;
- identification of dangers and assessment of the risks level according to the results of SAWC and IC;
- ranking the assessment of possible risk conditions at the workplace;
- determination of the risk management strategy in the implementation of labour safety at the enterprise.

As a result of approbation and practical application of this methodological approach at Sibkor-N LLC in Novosibirsk, calculations were carried out and risk assessment maps were drawn up based on IC data. At the food enterprise, only 70 workplaces were examined (43 types of hazards were identified), in addition, 12 workplaces in the department for plastic packages thermal production (23 possible hazards).

For the package moulding thermal plant, where containers and packages for the food products are manufactured, the following indicators were obtained:

1. Identification of dangerous events. In Table 2, where the register of hazards and their integral assessment (fragment) are presented, the highest values of the risk levels of the $IAL_{or}$ are equal to 128, 112, 80 (low and medium) respectively, are caused by violations in the labour safety requirements for electrical safety, falling due to the loss of balance on slippery floors, hitting a person. The risk analysis conducted made it possible to modify the procedure of training the workers on electrical safety issues, to improve the requirements for materials and goods delivery and transportation and the movement of workers, the sanitary and hygienic maintenance of the production facilities.
Table 2. Register of possible hazards in the injection moulding plant and their integral assessment of the risk level (fragment).

| N | List of hazards                                                                 | Number of workers/working places | Risk Level | Integral risk level assessment (IAL) |
|---|--------------------------------------------------------------------------------|---------------------------------|------------|-------------------------------------|
| 1 | Electric shock due to contact with electrically active parts that are energized due to a faulty condition (indirect contact) up to 1000 V | 7/3                              | Low        | 0/0                                 | 7/3                              | 0/0                                 | 0/0                                 | 128                                 |
| 2 | Falls due to the loss of balance when stumbling, slipping, moving on slippery surfaces or wet floors | 7/3                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 112                                 |
| 3 | Accidents from moving machines                                                  | 7/3                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 80                                  |
| 4 | Injuries from falling transported goods/moving objects                          | 7/3                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 70                                  |
| 5 | Increased pressure in the system of compressed air supply                       | 7/3                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 56                                  |
| 6 | Exposure to open flames and inhalation of smoke, vapours of harmful gases and dust in a fire | 7/3                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 56                                  |
| 7 | Collision with a stationary object or structural element during movement        | 7/3                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 46                                  |
| 8 | Danger of winding or pulling hair, parts of clothing, personal protective equipment into moving parts of machines and mechanisms | 7/3                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 42                                  |
| 9 | Cut resulting from the impact of sharp edges and burrs, moving cutting parts of mechanisms, machines | 7/3                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 40                                  |
| 10 | Chemical hazards, respiratory injury from dust particles                         | 6/2                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 36                                  |
| 11 | Physical overloads from excessive physical efforts when moving objects and parts, as well as when the body of the worker is tilted more than 30 º | 6/2                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 32                                  |
| 12 | Burn from contact with hot surface                                              | 6/2                              | Low        | 0/0                                 | 0/0                                 | 0/0                                 | 0/0                                 | 24                                  |

2. Level assessment of occupational risks was carried out in accordance with State Standard GOST R 58771 [15] with a combination of the severity of damage to health and the likelihood of manifestation of the consequences from a hazardous event. The final assessment of occupational risk for workplaces in the injection moulding plant, taking into account all possible hazards (Table 2) is presented in Table 3.

Table 3. Levels of risk of damage to health and likelihood of manifestation of consequences in thermoplastic package moulding shop.

| Rating by matrix | Severity of health hazard | Likelihood of consequences manifestation | Frequency of hazards, % | Labour Safety Procedures                                                                 |
|------------------|---------------------------|------------------------------------------|------------------------|------------------------------------------------------------------------------------------|
| H2               | low                       | slight                                   | 29                     | Minor injuries that do not affect productivity and vital functions. Highly likely it will not happen - it is unlikely that the event will happen. |
|                  | slight                    | low                                      |                        |                                                                                         |
| H4               | high                      | slight                                   | 25                     | Injury or reversible harm to health with working disability up to 15 days                |
|                  | low                       | low                                      |                        |                                                                                         |
|                  | slight                    | high                                     |                        |                                                                                         |
| H6               | medium                    | low                                      | 38                     |                                                                                         |
The occupational risk in the thermoplastic molding shop, taking into account all the components, is characterized as “acceptable”, but the likelihood of a hazard in some areas exists. Due to this fact, there is a need for more effective risk management system.

4. Conclusion
The proposed methodological approach to assessing and managing risks for implementation of labor safety at a food enterprise is tested in practical implementation of improved LSMS and makes it possible to:
- use a risk management model for existing LSMS of the enterprise;
- carry out calculations and create risk assessment maps based on the results of LSMS and industrial control IC for structural divisions of the enterprise;
- develop a management strategy for each type of risk and thereby ensure an increase in the level of safety at workplace;
- to specify and plan labor safety measures for industries that have the highest level of risk, to invest finances effectively, to optimize the work of labor safety department.

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