Implementation of Technosphere and Fire Safety Program (TFSP) to Increase Production Efficiency and Minimize Losses

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Abstract. Technosphere and Fire Safety Program (TFSP) is a production program whose main goal is to achieve maximum compliance with environmental laws, meet the requirements of safety standards and norms, maintain production equipment throughout its entire life cycle by engaging and motivating participation in this program throughout work force. The main three goals of the TFSP are: minimization of manufacturing defects, breakdowns and emergencies. According to this program, these goals can be achieved by taking measures aimed at improving the efficiency of equipment, creating an autonomous maintenance program, creating a planned maintenance system, organizing training courses for workers and developing an enterprise management system. The article considers the possibility of introducing technosphere and fire safety programs (TFSP) in industry. At the first stage, possible losses and factors contributing to these losses were determined. The general indicators of technosphere safety are affected by eight major production losses associated with equipment, which include equipment breakdowns, adjustment and commissioning, component replacement, production line start-up, idling, speed, manufacturing defects, and unplanned shutdowns. At the second stage of the introduction of the TFSP, a scheduled maintenance program was proposed with the aim of creating a smooth production process with minimizing technosphere risks.

1. Introduction
In any manufacturing industry, proper vigilance must be maintained for safe production, reducing the risk of accidents and disasters, reducing breakdowns and downtime of equipment, increasing the efficiency of personnel, the safe use of equipment and labor, and eliminating any type of emergency. TFSP is a new concept based on the goals of satisfying all these needs and creating a competitive production. It involves constantly conducting various environmental assessments, measuring the level of danger and predicting the development of the situation. One of the most important tasks of TFSP is to determine the degree of risk and its acceptable boundaries. Risk should be minimized both for humans and for nature. Any company can achieve production efficiency and other goals by successfully using the TFSP concept. The TFSP focuses on maintenance as a necessary and vital part of technosphere security. All this is no longer regarded as a non-profit activity.

TFSP is an innovative concept originating in Japan. Its occurrence can be dated to 1951, when the principle of preventive maintenance of equipment was introduced at several enterprises in Japan. The Japanese, based on a planned approach to servicing their devices, developed the concept of general
productive service. In mastering scientific works (1986), Nakajima describes how in 1953 20 Japanese companies formed a research group, and then sent their engineers for an internship in the United States to study equipment maintenance practices. In 1969, a specialized research institute was founded, and became the basis for the future creation of a research and development base for technical maintenance.

In 1969, the research institute began to work closely with the manufacturer of automotive components Nippondenso on the introduction of the principles of planned maintenance in their production. Tajiri and Gotah (1992) note that even though the principles of TFSP in the 90s were already distributed almost throughout Japan, only a number of enterprises were able to effectively apply them in practice. The catalyst for such a rapid spread was the difficult economic situation of the 1970s, when a number of large companies began to look for solutions to optimize their production. In the early 1990s, Western organizations began to show interest in TFSP as a result of the start of research in the field of quality management (IQA). In a number of publications: Suzuki (1994); Sekin and Arai (1998); Hartmann (1992); Wilmott (1994) conducted fairly extensive studies. Other scientific works, such as Maggard and Rhyne (1992), analyzed the area of specific application of TFSP principles in production and developed a strategy for checking, repairing or replacing equipment based on its specific reliability characteristics. However, even at that time we can identify the lag of the proposed theories from the trends that set the pace of modernization of production at that time. McKone and Weiss (1995) identify significant gaps between industry practice and academic research and emphasize the need to implement industrial and fire safety programs in large companies.

Since the goal of the TFSP program is to increase safety without compromising product quality, almost any company is interested in implementing this concept. Industry is one of the most promising sectors of the economy for the implementation of such practices. Thus, the prospects for introducing the principles of TFSP in order to increase the level of production safety without losing quality indicators are enormous.

2. Object of the study
The objective of the present work is to study a number of factors that impede the rapid implementation of TFSP, which can be applied in industry. This article attempts to identify the practical scope of TFSP and its implementation by calculating the cost-effectiveness of the organizational and technical security management system.

3. Analysis of the study
Although the costs of technosphere safety are often significant, companies that will use TFSP in the future will be able to get much higher revenues, due to minimizing the risks of technosphere accidents and disasters.

History knows many technospheric disasters, the consequences of which are still felt:

1. Accident at the Deepwater Horizon oil platform. The explosion and fire occurred on April 20, 2010, 80 kilometers off the coast of Louisiana, at the Macondo Field. The oil spill became the largest in US history and actually ruined the Gulf of Mexico.
2. April 17, 2013 there was an explosion at a fertilizer plant in the Texas city of West. The explosion took place at 19:50 local time and it completely destroyed the plant, which belonged to the local company Adair Grain Inc. The explosion destroyed a school and a nursing home located next to the plant. About 75 buildings in the city of West were severely damaged. The explosion killed 15 people, about 200 people were injured. Initially, a fire occurred at the plant, and the explosion occurred at a time when firefighters tried to cope with the fire. At least 11 firefighters died.
3. The accident at the Sayano-Shushenskaya hydroelectric power station - an industrial technological disaster that occurred on August 17, 2009 - a "rainy day" of Russian hydropower. As a result of the accident, 75 people died, the equipment and premises of the station suffered serious damage, and electricity production was suspended. The consequences of the accident affected the environmental situation in the water area adjacent to the hydroelectric power station, in the social and economic spheres of the region.
4. An explosion at a chemical plant in Dzerzhinsk is a man-made disaster that occurred on June 1, 2019 at the Kristall chemical plant, located near the city of Dzerzhinsk, Nizhny Novgorod Region. At about 11:45 on June 1, two explosions occurred in the premises of the Crystal explosive storage facility. As a result, a fire broke out with an area of about 100 square meters. The blast wave knocked out 340 windows in buildings located at a distance of 3 km, including 70 kindergartens and 31 schools. 89 people were injured.

5. A fire in the shopping center “Zimnyaya vishnya” occurred on March 25–26, 2018 on an area of 1600 square meters, followed by the collapse of the roof and ceilings between the fourth and third floors. The fire was assigned the third difficulty number on a five-point scale, and a federal level emergency regime was introduced in the Kemerovo Region and a federal response level was announced. As a result of the fire, 60 people died, including 37 children. The fire became one of the two most significant in the history of modern Russia along with the fire in the Perm Lame Horse night club in 2009, in which 156 people died.

Among the systemic causes of technosphere accidents, the media cites the desire of the business to reduce its costs, the inefficiency of the fire control system in Russia and corruption.

Technospheric accidents and catastrophes every year take a large number of human lives, bring huge losses to companies, ruin organizations, and pollute the environment. Profits earned by saving on technosphere safety will never block losses resulting from accidents and disasters.

After identifying the main causes of production losses, we can proceed with the introduction of the TFSP concept. But for the full implementation of this stage, it is necessary to assess the general state of the level of technosphere production safety. The following is a scenario for introducing TFSP for industrial production in order to reduce the risks of technosphere safety.

3.1. The first basis of the TFSP - Implementing 5S System

The 5S international system stands for five steps. Some economists and propagandists of a new attitude to work explain the name with five Japanese postulates sequentially introduced in the 5S system: seiri, seiton, seiso, seiketsu and sitsuke. For us, closer and clearer are our native “5S” - five consecutive steps that must be completed in order to achieve the prosperity of industrial production. These are: 1. Sort. 2. Compliance with the order. 3. Keep clean. 4. Standardization. 5. Improvement. As you can see, the 5S system does not require anything supernatural in production. Perhaps this is why so far you can find distrust and a frivolous attitude towards her. According to the basics of Seyton, each item should have a specific place for storage. The workplace must be neat and clean. A manufacturing company strictly monitors its hygiene to maintain quality standards for its products. Rule 5S makes us think about maintaining a standard that ensures cleanliness in the workplace and throughout the organization, and a manufacturing company adheres to this rule in relation to human life in general. The funds that are spent to implement and maintain the 5S system at industrial enterprises require additional investments, which incurs additional costs, but it should be noted that these costs serve to reduce the risks of technological safety, and subsequently lead to higher profits.

3.2. The second basis of the TFSP

According to our observations, equipment operators occasionally clean equipment during production activities, while not having knowledge of the correct cleaning methods. They simply learn the procedures and necessary processes from senior managers, although specialized personnel should deal with this issue.

3.3. The 3rd basis of the TFSP

Continuous improvement of production conditions and equipment operability by identifying problems and malfunctions at zero level is a fundamental rule of lean production.
3.4. The 4th basis of the TFSP
Scheduled maintenance is necessary to maximize the efficiency of equipment and the production of a defect-free product. Employees must inspect and clean the equipment of machines in two stages: before the start of the working day and at the end of the working day. However, most companies do not have a planned equipment maintenance system, which significantly reduces the technosphere safety indicators.

3.5. The 5th basis of the TFSP
A manufacturing company needs to be very tough on the quality standards of its products. The quality control department should check the products after each new setup of the equipment. In addition, the quality control department must constantly monitor samples of manufactured products.

3.6. The 6th basis of the TFSP
The sixth basis is the need for training for equipment operators, so that they can find the cause of any problem and eliminate it as soon as possible. Today, unfortunately, not every company has the opportunity to train its staff.

3.7. The 7th basis of the TFSP
After introducing the six previous basics, you should start implementing the TFSP department in your enterprise. It is worth noting that this action is impossible or not profitable without the preliminary implementation of the above principles.

3.8. The 8th basis of the TFSP
The objective of this stage is to create a safe place to work. A manufacturing company must understand responsibility not only for human health, but also for the environment as a whole. Therefore, it becomes necessary to conduct the maximum “clean production”.

Based on the above basics, you can develop a development plan for the TFSP program:
Stage 1: Preparation:
Step 1: Announce top management about the enterprise TFSP;
Step 2: Actively promote the principles of TFSP in the enterprise;
Step 3: Create a TFSP promotion structure;
Step 4: Creating the foundations for the implementation of the program in the enterprise;
Step 5: Create a master plan for developing TFSP.
Stage 2: start:
Step 6: launch the TFSP program.
Stage 3: Implementation:
Step 7: Creating a system for achieving production efficiency;
Step 9: Creating a 5C system;
Step 10: Creating a performance management system in administrative departments;
Step 11: Creating a system of safety, hygiene and protection of the working environment.
Stage 4: Application:
Step 12: Implementing the TFSP Program

3.9. Realization of the TFSP
The aim of this step is to achieve maximum production efficiency, which can be achieved by four concepts. After identifying losses, it is necessary to identify the main causes, take measures to eliminate and prevent future production losses. There are various methods and tools for analyzing production losses. Four of these methods applicable in the production environment are presented in table 1.
Table 1. Loss analysis techniques.

| Analysis Technique                                      | Purposes                                      |
|--------------------------------------------------------|----------------------------------------------|
| Detection and Warning                                  | Simple breakdown                             |
| Detection and warning through logical analysis         | Repetitive & complicated breakdowns         |
| Physical analysis                                      | Chronic losses & quality defect              |
| Simplification and combination                          | Changeovers                                  |

Master Plan-Preventive Maintenance Master Plan is formed for some year forward undertaking a number of activities. These activities may be are as follows:

a. Evaluate equipment and understand current status
b. Restore basic condition of equipment
c. Establish information management system
d. Built periodic maintenance system
e. Built predictive maintenance system
f. Built spare parts management system
g. Built lubrication management system

The importance of safety, has long been the number one topic in many industries. In order for the production to be truly safe, it is necessary to conduct a survey of the technical condition of both the production premises and technical equipment. Also, do not forget about regular safety training.

The production process is associated with a considerable share of risk, because various unpleasant situations occur both during production and during non-working hours. What should be noted above everything else is the need for responsible personnel. It’s possible for every reasonably intelligent person to follow the rules and do their job, but not every person can achieve a real peak, and all because some are blindly enough to follow the rules, which, incidentally, often do not take into account small details, but the responsible one the employee will do his job not just as needed, but in a quality manner, while transferring the workplace in the same quality to another shift.

4. Conclusion

Every year, industrial accidents claim the lives of approximately 2.3 million people. Of these, about 350 thousand are victims of industrial accidents and more than 2 million die from occupational diseases. Another 313 million people become disabled annually as a result of work-related injuries. Such is the world statistics, voiced by Sandra Polaski, Deputy Director General for Political Affairs of the International Labor Organization (ILO), speaking at the first All-Russian Labor Protection Week in April 2015.

Modern production is constantly becoming more complex due to the continuous increase in productivity, profitability and maintaining global standards. To this end, the main task of manufacturers is to implement the principles of lean manufacturing and TFSP, in order to minimize production losses and reduce the high level of technosphere safety risks. The study confirms the relevance of the principles of TFSP in the production strategy for the implementation of organizational goals in manufacturing enterprises. In this work, a loss structure was developed to increase production efficiency. Determining various equipment losses during the production activity, the initial risks of the organization’s resources were calculated and the main production losses were identified, and a step-by-step plan was developed for introducing the TFSP program to the enterprise. The results of the study show that a successful TFSP implementation program can help the company achieve strategic goals and high performance.

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