

SIX SIGMA CONCEPT IN THE MAINTENANCE PROCESS OF TECHNICAL SYSTEMS

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Abstract. *Today, only those companies which are capable of permanent and fast adaptation to quickly-changing conditions can survive. The customer expects an excellent quality of products or services offered to him, and pays only those prices which are more favorable than the competition in the market. In order for a company to remain competitive and maintain maximal efficiency and availability of all its plants, what is needed is an approach different from the traditional concept of maintenance. The concept which enables maximal efficiency of plants must take into account the entire system, man-plant-environment; besides, it must apply continual measures to prevent all losses, whereby the maintenance process is permanently improved. This is possible to achieve by applying Total Productive Maintenance and Six Sigma concept in the maintenance of plants, which, through autonomous maintenance, places greater responsibility on operators concerning the state of the plant they are in charge of, which relieves maintainers, develops mutual confidence between operators and maintainers, increases the morals, and ensures greater commitment to work. All this ensures the achievement of a World-Class company through continual improvement of the maintenance process, with the ultimate goal of reaching the Six Sigma level.*

Key Words: *Six Sigma, TPM, Maintenance, Technical Systems, Improvement of Processes*

1. INTRODUCTION

It is well known that, in the market, only those companies with sufficient flexibility, i.e. ability to permanently and quickly adapt to the ever changing conditions, can survive. What permanently increases are mobility and output of companies, from whom the customer expects exceptional quality and prices lower than those of their competitors. Today,

a high degree of automation is typical of a majority of companies, whereby technical systems and the way in which they are used affect expenses, process quality, and product quality. In order for a company to remain competitive, what it needs are several concepts so that it may achieve and maintain maximal efficiency of its technical systems.

One of the concepts which cannot be avoided in reaching World-Class maintenance in a company is the application of Total Productive Maintenance - TPM. Those companies which have neither strength nor will to apply this approach of maintenance must define their mission, vision, goals, planned results, and operative strategies for realizing substantial improvement. On the contrary, it is only a matter of time when such companies will disappear from the market.

The process of maintenance becomes of increasing importance for companies, as it directly affects other relevant processes leading to customers' satisfaction or dissatisfaction. It is no longer possible for companies to uncontrollably spend their resources in the maintenance process (time, material means, money, etc.). Companies in Japan were the first to introduce this principle, and they went on to improve the maintenance process of technical systems, which led to their increased competitiveness in the global market. Special improvement in this field was made when it was realized that the maintenance of technical systems was, in fact, "a medical science on equipment", and when experience from other fields of improving maintenance processes was applied.

2. MODEL OF WORLD-CLASS MAINTENANCE PROCESS (WCMP)

The competition existing in today's market forces companies to eliminate all unrequired steps from their processes, i.e. all "trash" from processes. Only those companies doing the right thing (effectively) in the right way (efficiently), thus managing to eliminate the losses which occur in processes, can survive in the market. In this manner, they come closer to Best-in-Class processes, with a permanent tendency towards World-Class processes. World-Class processes represent the best among the best processes. Thus, for example, Six Sigma processes represent World-Class processes, as they allow only 3,4 errors per million chances for error.

When it comes to maintenance, a World-Class process means the best model of the maintenance process, which presupposes that it is comprehensible for all participants in the process, that it is easy to apply and requires minimal implementation costs as well as that it is universally applicable and increases overall efficiency of technical systems, which ultimately leads to a greater profit for the company.

The modern approach means application of known scientific methods in the field of maintenance, but also of knowledge of experienced operators and maintainers of technical systems. To reach a World-Class maintenance process, it is necessary to incorporate the experiences of TPM into process management, which results in a model which may be implemented in a majority of companies in different branches of industry.

To reach the Six Sigma level in the maintenance process, it is necessary to model a World-Class maintenance process, based on the concept of total productive maintenance, which would result in increased productivity, improvement of quality, reduction of expenses, and creation of better working conditions. Such effects are achieved through permanent improvement of maintenance activities, coupled with increased morals of employ-

ees and their motivation for work, which includes a radical change of culture of companies [4].

On the basis of some advantages which have been noticed, but also of shortcomings of the existing models and concepts of maintenance, and through overall analysis of the TPM concept, which was modified and adapted to process approach to maintenance, the new maintenance concept was modeled, based on applying the modern scientific-technological achievements.

The proposed model of World-Class Maintenance Process (WCMP) is created as a symbiosis of the existing maintenance concepts; it includes application of tools of quality and management, as well as of tools of Six Sigma concept. The model WCMP consists of algorithms of procedures in eight steps, which lead to the World-Class maintenance process through continual improvement (Fig. 1) [1]:

1. Making decision on introducing the World-Class Maintenance Process (WCMP);
2. Training of participants in implementing the WCMP in the company;
3. Recording the existing maintenance process;
4. Determining important processes in maintenance;
5. Defining the scope and phases in implementing the WCMP;
6. Application of the TPM concept in the company;
7. Standardization of maintenance procedures; and
8. Improvement of the maintenance process.

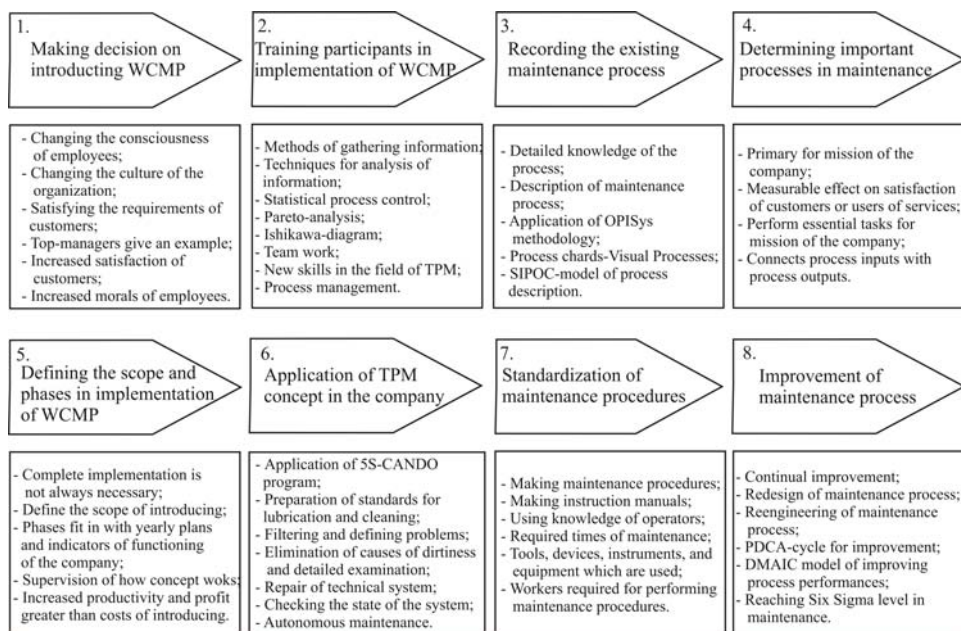


Fig. 1. Model of World-Class Maintenance Process (WCMP)

3. TOTAL PRODUCTIVE MAINTENANCE AND SIX SIGMA

A total-productive maintenance is a term describing the new philosophy and new approaches to design and management of the maintenance process. The point of this philosophy is how to radically reduce dissipation of resources and substantially increase the use made of plants and equipment, so that responsibility for proper operation and functioning of technical systems is shifted on the employees, which directly operate them. This led to the creation of autonomous maintenance, which broke down the barrier between specialists in maintenance services and direct operators, in control of equipment and machines.

Excellence is better than the best, which means that there is always something which can be better than the existing, i.e. that it is possible to achieve the vision of zero errors and zero interruptions, zero dissipation, etc. To achieve something better than the existing means to explore the possibilities of improving the existing models and concepts of maintenance, and to, on this basis, propose an improved model of the maintenance process, which will meet all requirements of the TPM philosophy, but also the requirements of Six Sigma concept.

Introducing the integrated TPM model and Six Sigma concept leads to an improved model of the maintenance process, which uses all advantages of the TPM approach, but also, through simultaneous application of Six Sigma concept, enables reduction of variations in the process, eliminates the occurrence of errors, and reduces the time cycle of the maintenance process.

Integration of Six Sigma concept in the TPM maintenance model was performed by using the DMAIC-model of improvement of performances, which improved the existing TMP approach to maintenance, and made it simpler and clearer for the users who wish to apply these new concepts in maintenance. The new model of World-Class maintenance process is illustrated by a clear graphic interpretation, which gives a clear picture of the new approach, and which is comprehensible for those experts already experienced in applying the TPM Six Sigma concept, but also for those who are yet to move in this direction.

4. REACHING SIX SIGMA MAINTENANCE PROCESS

Improvement of the maintenance process should not be the ultimate goal, but reaching Six Sigma maintenance process. Continual improvement of processes is based on the opinion that, however good something may be, it can always be better.

To improve the maintenance process Six Sigma concept may be used as a simple model of improving performances, based on PDCA-cycle, under the name DMAIC (Define-Measure-Analyze-Improve-Control). This model of improvement and design/redesign of processes enables reaching Six Sigma process performances, with planned result of 3,4 errors per million chances for error (Table 1).

Six Sigma is a system which combines tools for continual improvement, by focusing on processes, their analysis, and comparison. What is common to all various processes in a company is the defect, which causes extra work, reject, and increased costs. Six Sigma system measures defect in the process and normalizes them, so that it is possible to com-

pare the processes, which, in its turn, enables making a decision on arrangement of resources for better performances. As the ultimate goal of Six Sigma concept is work in the process with no errors, it is also necessary to trace the errors which occur in the process.

The model of World-Class maintenance process, as a specific "ticket" to Six Sigma maintenance processes, is related to the DMAIC-model for improving the performances of the maintenance process, advanced Six Sigma tools and quality tools, as shown in Fig. 2 [1].

Table 1 DMAIC-model of Improving the Maintenance Process

Six Sigma improvement processes		
Description of activity	Improvement of processes	Design/redesign of processes
1. Define goals of improvement activity.	<ul style="list-style-type: none"> • Determine requirements; • Set the planned result. 	<ul style="list-style-type: none"> • Identify problems; • Define the planned result;
2. Measure the existing system by setting reliable metrics for supervision of progress towards goal and use analysis of information.	<ul style="list-style-type: none"> • Confirm problem/process; • Filter problem/planned result; • Measure key steps. 	<ul style="list-style-type: none"> • Measure performances according to requirements; • Gather information on process efficiency.
3. Analyze the system to eliminate gaps between current system or process performances and the desired goal. Apply statistic tools to perform analysis.	<ul style="list-style-type: none"> • Develop hypotheses on causes; • Identify "vital minority" of the root of causes; • Confirm hypotheses. 	<ul style="list-style-type: none"> • Identify "the best practice"; • Assess process design; • Filter the requirements.
4. Improve the system, by using project management and other tools of management and planning, as well as statistic methods, to validate improvements.	<ul style="list-style-type: none"> • Develop ideas for removing the root of causes; • Test solutions; • Standardize solutions and measure results. 	<ul style="list-style-type: none"> • Design new process (check assumptions, apply creativity); • Implement new process, structures, systems.
5. Control the new system. Institutionalize the improved system by modifying the system of rewards, policies, procedures, budget, etc.	<ul style="list-style-type: none"> • Set standard measurements for maintenance of performances; • Correct problems as required. 	<ul style="list-style-type: none"> • Set and reexamine measurements to maintain performances; • Correct problems as required.

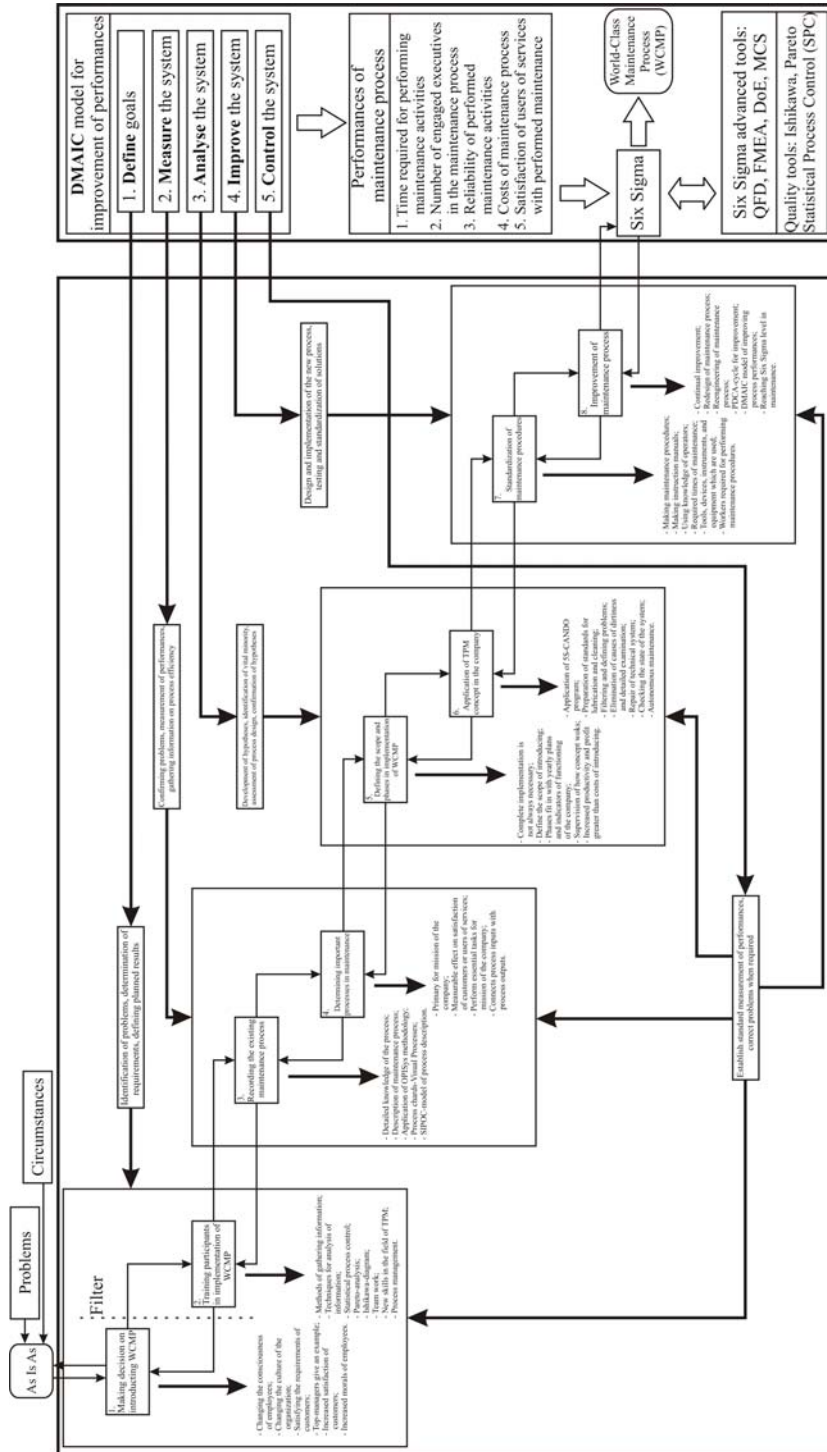


Fig. 2 Model of World-Class Maintenance Process integrated with Six Sigma concept

4.1 I phase of DMAIC-model: Define

In this phase of improving the performances of the maintenance process, which, in the model of World-Class maintenance (WCMP) relates to the first two steps (making decision on introducing WCMP and training users for implementation of WCMP), it is necessary to identify the problems which occur in processes, determine requirements, and define the planned result of improving the maintenance process.

The most responsible individuals for this phase are top-managers in the company, as they are the ones who can have the most complete view of all processes, how they are carried on, engaged resources, process documentation, relations with other processes, etc. About these procedures, they should consult maintenance experts, who have the knowledge and skills in the field of maintenance of technical systems, and are best acquainted with concrete maintenance processes of certain parts or the entire technical system.

This comprehensive analysis represents a sort of a filter, which determines the willingness and readiness of the company to implement the new maintenance concept.

Workers-direct executives in manufacture, and workers in maintenance, with their practical experience, may contribute to identifying problems, as they are directly faced with concrete problems in their field of work in their daily activities. They know in detail the technical systems they operate and maintain, and can recognize and solve the problems which are sometimes specific to a certain technical system, and need not coincide with technical-technological measures for correct functioning and maintenance of technical systems when they are in the state of "operation".

This phase of the concept usually includes participation of the already formed TPM-training teams, who enable participants in the process of implementing the WCMP for performing the activities from the TPM concept, and improve their work and decision-making in team work. Trained operators and maintainers of technical systems form multidisciplinary teams, which have the required knowledge and skills for performing the procedures of autonomous maintenance, and make coordinated decisions. These teams also actively participate in identifying problems and defining requirements, as they consist of participants in the process of implementing the new maintenance concept.

Defining the planned results of improving the maintenance process relates to achieving a maintenance process without errors and interruptions, and without accidents or injuries at work. As a consequence of these results of improvement, both direct and indirect costs of maintenance are reduced, reliability of technical system increases, product quality reaches a higher level, the lifetime of a technical system is prolonged, customers are more satisfied, and the company makes more profit in the market.

It can be freely said that the phase of defining is the most important phase in the process of improving the maintenance system performances and its path towards Six Sigma processes, as is the case in which consciousness is created and the need to change the existing concept of maintenance is confirmed, in order for the culture of a company to ultimately be changed. This change is achieved through education, as people should learn new skills, at the same time overcoming old modes of thinking.

Changing the culture of a company means a change in practice and protocols which people follow, as well as in values, which affect the way people react and their behavior when proposing changes of any type.

This phase must also include the application of planning of quality directed towards requirements of users (Quality Function Deployment-QFD), as one of the advanced tools of the Six Sigma concept.

4.2 II phase of DMAIC-model: Measure

This phase is applied when recording the existing maintenance process and determining the processes relevant for maintenance. Detailed knowledge of the existing maintenance process includes description of the maintenance process, drawing process charts, and completing the SIPOC-table. In doing this, possible existence of problems in the process is confirmed, the process is filtered and simplified, unnecessary and inefficient steps in the process are eliminated, and narrow points, which cause misuse of capacities of technical systems and transform serial activities into parallel, are eliminated, which reduces the time of waiting in the process.

Measurement in the process includes not only gathering information from the process, but also analysis of the existing information about the technical system, starting from its delivery, implementation, and putting into operation, to the moment of establishing a reliable way of measuring parameters and performances of the process. In charge of these activities should be teams for autonomous maintenance and improvement of maintenance processes, as they consist of people who are readily identify problems which occur in the process. At the same time, these teams gather and analyze information about efficiency of the process, reliability of certain parts or the entire technical systems, time required for the maintenance process, costs of maintenance, etc.

This phase of the DMAIC-model includes application of the following quality tools and advanced tools of Six Sigma concept:

- Statistical Process Control-SPC;
- Failure Mode and Effects Analysis-FMEA;
- Measuring Customer Satisfaction-MCS, etc.

4.3 III phase of DMAIC-model: Analyze

The purpose of analyzing the process of maintenance is to determine what is not good in the process, what the causes of its inefficiency are, as well as to propose how it can be improved. As is the case with the previous two phases, this phase for improving the maintenance process performances is also related the fifth and sixth steps of the model of World-Class maintenance process (defining the scope and phases in implementing the WCMP and application of the TPM concept in a company).

As in step three of the WCMP model (recording the existing maintenance process) the existing resources were already defined and the type of technological process was already recognized, the system is analyzed before making the decision on the scope and time interval needed for introducing the new maintenance concept. Assumptions on possible causes of problems are made, and "vital minorities" of the root of causes are identified, and these assumptions are confirmed or denied.

When applying the TPM concept in a company, experiences of other companies in implementing the TPM concept are used, it is assessed whether applied measures are satisfactory, leading towards planned results of improvement of process, and whether established requirements for improving the maintenance process are actually applicable, or

they need to be redefined and filtered. These activities are in charge of leaders of TPM-teams, as well as possible coordinators for implementing TPM, as they have the best knowledge of measures for carrying out the TPM concept.

Analysis also includes possible errors, which occur in the process the most frequently, and the causes of these errors. Application of adequate quality tools enables eliminating them in the following phases of the DMAIC-model.

This phase, as was the case with the previous one, requires application of quality tools and advanced tools of Six Sigma concept, such as:

- Pareto-analysis;
- Cause-effect diagram (Ishikawa-diagram);
- Design of Experiment-DoE).

4.4 IV phase of DMAIC-model: Improve

As from problem-solving teams in the sixth step of the WCMP (application of the TPM concept in a company) teams for improvement are made, composed of members trained for using problem-solving techniques, they propose corrective measures for improving the maintenance process. This phase of improving the maintenance process performances also includes standardization of procedures of maintenance, i.e. making procedures and instruction manuals, which define the duties of workers-operators, provide description of workplace and applied means of work, describe the procedure of work at workplace, set measures for protection of workers and the environment, etc.

Process improvement includes making a proposal for improving the process, defining a strategy of improvement, recording "to-be" process (whatever they should be), elimination of activities which do not create extra values, elimination of possible causes of variations in the process, assessment of risk, and testing.

Improvement of the maintenance process sometimes means redesign or re-engineering of the process, i.e. design and implementation of a completely new process, its testing, and standardizing the solution. In this case, the creativity of all employees is required. Process redesign represents the changes made inside the process, such as: adding new activities, introducing new documents, different procedures, etc. Process re-engineering represents radical changes which surpass the scope of a process.

Process improvement includes the following activities:

- Making an action plan;
- Measuring and tracking the efficiency of the improved process;
- Tracking the newly created values;
- Optimizing relations in the superordinate process;
- Process management; and,
- Continual improvement of process.

Through continual improvement, the maintenance process gradually reaches Six Sigma level.

4.5 V phase of DMAIC-model: Control

The control phase is very important, as it enables confirmation of introduced improvements. Control relates to all steps of the WCMP model, with establishing standard

measurements of maintenance process performances, and problems are corrected where required. This phase involves participation of all employees of the company, starting from top-managers, through teams for TPM-education and improvement, to workers-operators and maintainers, as they are in charge of activities from the TPM-concept.

Process of control includes the following activities:

- Making control charts;
- Management of processes of change;
- Documentation and standardization of the improved maintenance process;
- Supervision of the maintenance process through control charts;
- Checking stability and ability of the maintenance process;
- Proposing measures for further improvement of the maintenance process.

Control of the entire maintenance process is based on measuring process performances, which are continually tracked over time, with the goal to observe trends, the best and the worst practices, and possible fields for improvement. Each process has the possibility to get out of control and cause problems. For this reason, all participants in the process of implementation must be controlled effectively, while control must become part of everyday activities of all employees of the company.

However, relying solely on control to improve process (finding problems, errors, etc.) includes a high probability for the occurrence of an error or breakdown in the technical system. What is required instead is a continual effort to reduce or eradicate errors and breakdowns depending on the human factor. Control as the only means of process improvement can frequently come too late. A long-term process quality comes not only from control, but also from improving the process and the entire technical system. Practically, there are technical and financial constraints to process improvement, but the final goal is the Six Sigma maintenance process or performing the process completely without errors.

5. APPLICATION OF MAINTENANCE MODEL BASED ON THE TPM CONCEPT

Public (communal) companies have a very important role in the economy of each country, as their functioning affects vital needs of the population, such as provision of electrical energy, water, thermal energy, etc. Their technical systems have strictly defined tasks, which must be realized in keeping with certain criteria. Therefore, timely, effective, and efficient execution of the maintenance process is crucial for doing business successfully in public companies. Users of their services have very high requirements with respect of satisfying their needs, so that high availability, reliability, and optimal state of technical systems can be reached only through interaction of the people who directly operate them, and the technical systems themselves.

Absence of an adequate concept and quality approach to maintenance of technical systems in public communal companies may lead to:

- Low level of communal services;
- Increased costs of business;
- Low reliability of technical systems;
- Reduced exploitation properties of equipment;
- Inability to complete workplans;
- Reduction of planned income;

- Dissatisfaction of users of services; and,
- Creation of a bad working environment, etc.

Large communal systems with sizeable objects, equipment, and installations belong to large technical systems, whose maintenance must be covered carefully, in order to realize full efficiency of technical systems. Unpredictable, sudden breakdowns in parts of the system may cause breakdown of the entire system, which not only increases the costs of maintenance, but may also cause substantial damage in other respects. For this reason, the technical part of such systems must have a certain percent of backup capacities, used to alleviate or completely eliminate these unpredicted situations. The age of objects, equipment, and installations is also a very important factor to be reckoned with.

For all these reasons, management must treat the maintenance function as one of the strategic functions in the company, whereby the following facts must be born in mind:

1. Technical systems in public (communal) companies must reliably perform their tasks;
2. Their work must be efficient and rational;
3. Expenses must be within planned limits;
4. The use of maintenance resources must be optimal;
5. Maintenance tasks must be supported by modern scientific achievements (benchmarking, reengineering, TPM).

Therefore, if we want an efficient and rational functioning of public (communal) companies, maintenance of their technical systems must be systematic and planned. This systematic approach to maintenance includes a certain sequence of activities, which may enable quality maintenance in keeping with requirements of the technical systems. This approach includes:

1. Determining the concept of the maintenance program;
2. Planned development of the maintenance concept;
3. Sequence of activities of maintenance procedures;
4. Time normatives for maintenance activities;
5. Analysis of maintenance procedures-logistic support;
6. Analysis of the costs of maintenance;
7. Introducing an information system into maintenance;
8. Control of supplies, spare parts, and materials;
9. Planning modernization or reconstruction; and
10. Control of maintenance personnel [8].

5.1 Application of the model in PCC "City Heating Plant"-Niš

The described maintenance concept based on applying measures 5S-CANDO and autonomous maintenance, was applied in boiler house "Krivi vir" of PCC "City Heating Plant"-Niš. A six-member team of plant operators was formed. The steps of autonomous maintenance were applied, and they yielded expected results, primarily in the field of arranging the place of work, speed and efficiency of performing the activities of yearly overhaul, and increased motivation for work and morals.

The process of yearly overhaul includes: boilers, blowpipes, ventilator rooms, pump and masut stations, and external reservoirs [9].

Fig. 3 represents the chart of the process of yearly overhaul of thermal sources in the boiler room.

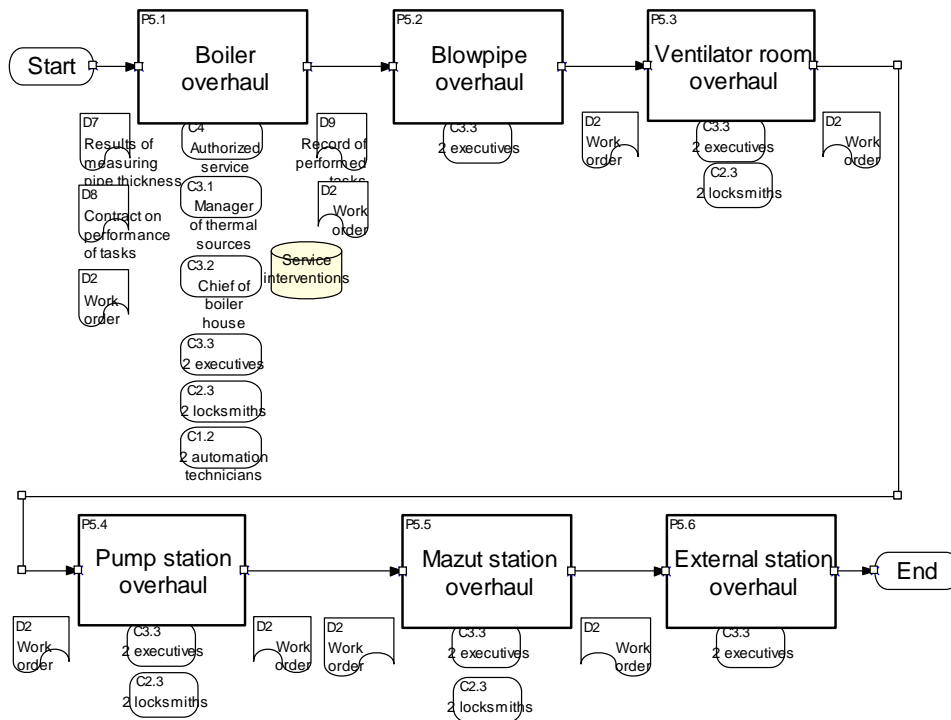


Fig. 3. Chard of the process of yearly overhaul of thermal sources

Fig. 4 represents the chard of the process of yearly overhaul of boilers, which consists of the following maintenance activities:

1. Visual checking of the boiler;
2. Determining the state of the boiler;
3. Mechanical cleaning, chemical washing, neutralization and conservation of the boiler;
4. Announcement of a public tender for performance of tasks;
5. Performance/control of tasks;
6. Chamotting of boilers (according to tender);
7. Conservation of smoke and water sides of boilers;
8. Chamotting of boilers;
9. Checking, cleaning, and lubrication of flue flaps;
10. Checking and changing all manometers and thermometers;
11. Checking safety valves;
12. Checking and pre-packing muck valves;
13. Checking the state and overhaul of electromotor and mechanical valves;
14. Checking all openings on boilers and changing asbestos; and
15. Checking, pre-packing and cleaning openings for observation of fire [1].

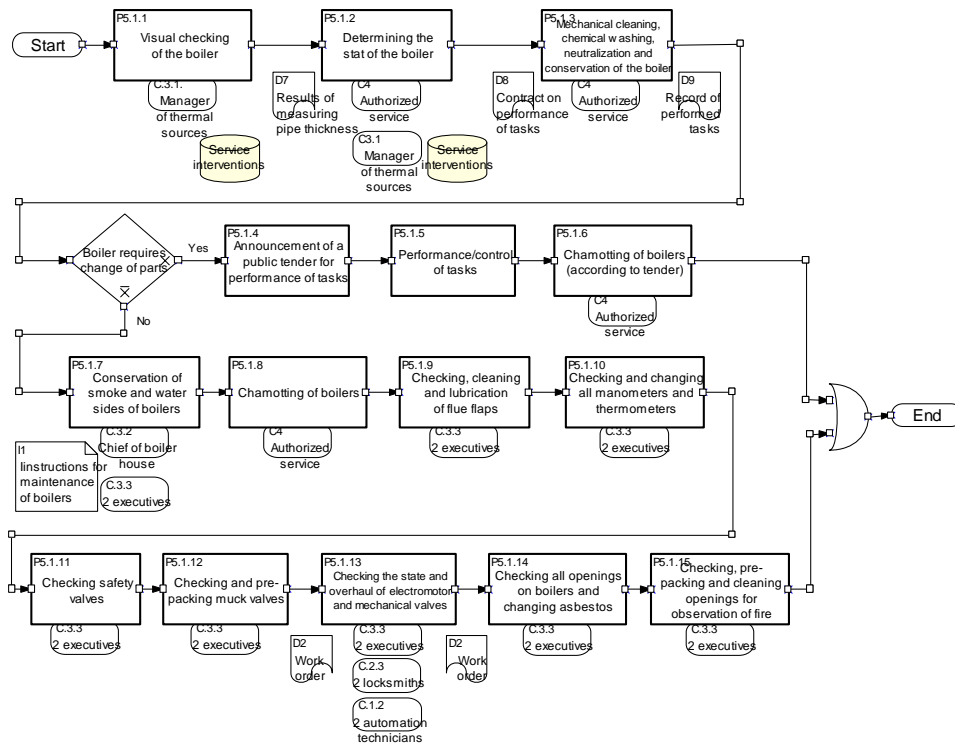


Fig. 4. Chard of the process of yearly overhaul of boilers



Fig. 5. Boiler with power 30 MW

Fig. 5 represents boiler number 1, power 30 MW, which works on masut (as is the case with boiler number 2), while Fig. 6 represents boiler number 3, power 58 MW, which works on natural gas or masut (yellow color marks ducts for natural gas, which lead to blowpipes).

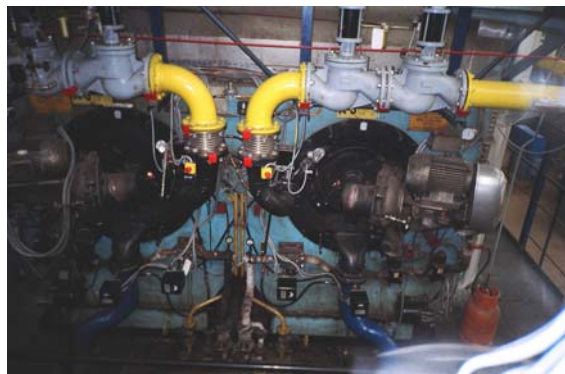


Fig. 6. Boiler with power 58 MW

CONCLUSION

1. The advantages of model of World-Class maintenance process (WCMP) in comparison with the existing concepts and models are the following:
2. It includes process organization of the company, i.e., its entire business, as well as maintenance, is to be seen as one of the processes of the entire business system of the company, with the goal of directing the process towards customers' requirements and increasing their satisfaction;
3. Requires application of methods TQL and TQM, as company strategy for continual improvement of the business of the entire company;
4. Functions exclusively through team work, which ensures high quality of work, with the help of talent, abilities, knowledge, skills, and experiences of team members, whose combination in team work has a synergic effect, which greatly increases available resources for problem solving;
5. Creates awareness of the need to change the existing maintenance concept by abandoning old modes of thinking, forgetting wrong and outdated things, which changes the culture of the company, new knowledge and skills are acquired, and the focus of the company shifts towards the market and purchaser or user of services;
6. Educates and trains all participants in the process of implementation not only in basic knowledge in the field of maintenance of technical systems, but also in special skills and strategies for problem solving, starting from top-managers, to workers-operators, which increases the morals and motivation of all employees of the company;
7. Enables detailed introduction to the entire maintenance process, through describing it by OPISys-methodology, using SIPOC-model, which creates clear possibilities for process improvement, as well as process visualization through process charts, which give a clear picture of the movement of all resources and documentation through the process;
8. Identifies important processes in maintenance, which as a "vital minority" have a decisive effect on the company's business, as they are crucial for its mission, and give measurable effects with respect of the requirements of customers or users of services;
9. Allows full use of available maintenance resources, by proper selection of the scope and time period of complete introduction, whereby the costs of education and adaptation of technical systems to the new concept are always compensated by the company's total profit;
10. Application of TPM-concept and autonomous maintenance, as its component part, makes all users in the maintenance process feel responsible for the state of the technical system they are in charge of, to feel it as something of their own, and take care of its functioning without breakdowns and interruptions;
11. Standardization of maintenance procedures gives the possibility to transfer experiences, knowledge, and skills of experienced operators and maintainers of technical systems, to other participants in the process, the most frequently in the form of figures or film recordings, to perform given tasks without unrequired effort and aberration from standard procedures and instructions;

12. Enables continual improvement of the maintenance process, which always results in increased effectiveness and efficiency of the company, reduced maintenance costs, increased profit and satisfaction of purchasers, and which always leads to Six Sigma maintenance processes;
13. Connects DMAIC-model for improvement of maintenance process performances with all required steps in the process of transferring the maintenance function in the company from "as-is-as" to "to-be" state;
14. Includes application of quality tools, such as: Pareto-analysis, Ishikawa-diagram, statistic process control (SPC), etc.;
15. Includes application of advanced tool of Six Sigma concept, such as: planning of quality oriented towards the requirements of purchasers/users (QFD), analysis of the effect and possibility of errors (FMEA), planning of experiment (DoE), measurement of customer satisfaction (MCS), etc.;
16. Gives the possibility of universal application in all technical systems, is simpler to understand, does not require high costs of training and implementation, gives palpable results within a very short period of time after introduction [1].

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SIX SIGMA KONCEPT U PROCESU ODRŽAVANJA TEHNIČKIH SISTEMA

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Danas na tržištu opstaju samo ona preduzeća koja su sposobna za stalno i brzo prilagođavanje uslovima koji se menjaju velikom brzinom. Kupac očekuje izuzetan kvalitet proizvoda ili usluga koje mu se pružaju, a plaća samo cene koje su povoljnije od konkurencije na tržištu. Da bi preduzeće ostalo konkurentno i održalo maksimalnu efikasnost i raspoloživost svojih postrojenja, potreban je pristup koji se razlikuje od tradicionalnog koncepta održavanja. Koncept

koji omogućuje maksimalnu efikasnost postrojenja mora da posmatra celokupni sistem: čovek-postrojenje-okruženje i primenjuje kontinualne mere za otklanjanje svih gubitaka, čime se proces održavanja stalno poboljšava. Ovo je moguće ostvariti primenom totalnog produktivnog održavanja i Six Sigma koncepta u održavanju postrojenja, koji preko autonomnog održavanja rukovaocima daje veću odgovornost za stanje postrojenja koje im je povereno, čime se rasterećuju održavaoci, razvija međusobno poverenje između rukovaoca i održavaoca, povećava moral i postiže veća privrženost poslu. Sve ovo omogućava postizanje World-Class preduzeća, kontinualnim unapređenjem i poboljšanjem procesa održavanja, sa konačnim ciljem dostizanja nivoa Six Sigma.

Ključne reči: Six Sigma, TPM, održavanje, tehnički sistemi, poboljšanje procesa.