



¹ František PETRÍK, ² Andrej ČERVEŇAN, ³ Marian KRÁLIK

IMPROVING THE MAINTENANCE SYSTEM OF THE MANUFACTURING ENTERPRISE

¹⁻³ Slovak University of Technology, Faculty of Mechanical Engineering, Institute of Manufacturing Systems, Environmental Technology and Quality Management, Námestie slobody 17, Bratislava, SLOVAKIA

Abstract: The article contains suggestions for improving maintenance systems, a specific proposal for standard maintenance, and both general and according to LOTO standard. Standardization is the biggest benefit for the improvement of a maintenance system; here at my work I have dealt with more areas, but this article will not deal with the categorization of faults, defects detection systems, analyses, calculations of MTTR, MTBF or indicators of availability machinery failure rates.

Keywords: maintenance, system of maintenance, standard of maintenance, disorders, machine

1. INTRODUCTION

“A frequent reason for losses and low productivity in businesses are the losses caused by the poor condition of the machinery and equipment”. It is therefore very important to deal with system maintenance of machinery and equipment and to find solutions for their improvement. Current maintenance systems are placing ever more demands on operators; the maintenance of machinery and equipment is no longer just a matter of maintenance staff, as was the case in the past. It is necessary to pay attention to the daily upkeep of the machinery and equipment which does not respond to breakdowns until after their occurrence. It follows that the main task of maintenance nowadays is not only to remove defects after their creation, but also to aim to prevent them. It is possible to achieve the involvement of operators of machinery and equipment in the maintenance system, because they are the first who are able to detect abnormalities in the machines in time for them to react to them. One of the main pillars of Total Productive Maintenance is autonomous maintenance, which is conditional on the successful implementation of the development standards of maintenance. In the description of the creation of such a standard, the 320 BHP surface-grinding machine will serve as the basis of the work. The standard, which will include a picture of the machine marked with a service description of the individual service operations which the operator performs on the machine, will be updated on a daily or weekly, etc. basis. The main purpose when creating the standard was the attainment of rapid availability of baseline data for the implementation of routine maintenance – who, what, when, and on which part of the machine repairs should be carried out. No system, however, can function without the cooperation of machinery and equipment operators and the maintenance department. The willingness of the operators to look after and maintain their machines so that not even the smallest fault occurs which could result in the emergence of more serious disorders which the maintenance department would have to attend to is of primary importance. “Workers will always be responsible for the good operation of the machinery”.

2. THE STANDARDIZATION OF MAINTENANCE

The current trend is to transfer as much as possible the number of maintenance operations to the maintenance worker handling the machine. The goal of standardization is to define precisely the responsibility for the individual steps or to establish who should perform the activity, so as to achieve the required quality. Service points are determined according to the documentation in an arranged form and transferred to the maintenance standards list. The standard should be prepared in summary, content, or visual form. In the transfer to the standard should be taken into account also breakdowns of a smaller scale, which should not be ignored but removed. The Maintenance Department should be instructed as regards modification or supplementation of the standard. Part of the standard should be the LOTO standard, which informs on the operation, maintenance, or the necessity to press the stop button to stop the machine either locally or by complete disconnection from the electric current. On the basis of the importance of the necessary data for the standard, I decided on the form of the standard as illustrated in Table 1. The picture in the standard operation allows or maintenance of the machine or a quick overview of the position of the service points. In the description of the service operations, the activity carried out by the worker or the

maintenance according to the responsibilities laid down in the standard is determined. The most common machine maintenance tasks include lubrication and cleaning of the machine, leakage of the hose, and control of mechanical damage. The mechanic’s maintenance tasks are for example replacing the hydraulics filter or inspection of the turning functions. Cleaning and tightening the connections fall under the responsibility of the electrical engineer. An important part of the standard is the inspection interval, which is daily, weekly, monthly, half-yearly or annually. Inspection of machines and equipment is mostly carried out by testing the functionality and by sight, in less frequent cases by listening. The company, before drawing up the standard, determines which defects are going to be recorded on it.

Table 1 – Overview contents of standard

Machine:	Tag	Service point	Description of the service work	Responsibility	Interval of inspection					Inspection method	Report	LOTO
					Daily	Weekly	Monthly	Half-yearly	Yearly			
Location of machine:												
Author of standard:												
Person who confirm standard:												
Instructions for maintenance staff in case of defects:										Revision:	Create:	
The decommissioning of the installation procedure:										Date:	Confirm:	

3. THE STANDARD OF MAINTENANCE BPH 320 SURFACE-GRINDING MACHINE

In the case of standard, I have applied the BPH 320 surface-grinding machine. Standards of maintenance should be placed in a conspicuous place on each machine in order to carry out activities in the maintenance intervals specified in the machine operation standard. The workers will make a record of the service intervention if it is stated in the standard: *make a record of the execution of the service operation*. Photo-documentation and a list of service operations, together with the responsibility for their implementation were drawn up on the basis of consultations with the Department of Machine Management and Maintenance and the workers themselves. A list of all service activities on the BPH 320 machine is referred to in Table 3, which forms the basis for defining the service points used in the standard. A sample completed standard maintenance for BPH 320 is shown in Figure 1.

Table 2 – Overview of time required for performance of service operations

Responsibility Service point Time required for the performance of activities (min.)	worker						
	1	2	3	4	5	6	7
	1	0,5	0,5	0,5	0,5	4	2



Machine: BPH 320 surface grinder	Tag	Service point	Description of the service work	Responsibility	Interval of inspection					Inspection method	Report	LOTO	
					Daily	Weekly	Monthly	Half-yearly	Yearly				
Location of machine: Hall 1	1	dust exhaust	inspection of grinding dust level	worker	XR					visual	No	E1	
Author of standard:	2	lever	inspection of grinding dust level	worker	XV					functional	No	E1	
Person who confirm standard:	3	oil level indicator	inspection of oil level	worker	XR					visual	No	E1	
	4	sludge pan	inspection of function, cleaning	worker		X				visual	No	E1	
	5	dust exhaust hose	inspection of hose surface and tightness	worker	XR					visual	No		
	6	lubricators	inspection of lubrication	worker	XP					functional	No		
	7	magnet	inspection of clamping metal part	worker	XR					functional	Yes		
	8	hose	mechanical damage and tightness inspection	worker	XR					visual	Yes	E1	
Instructions for maintenance staff in case of defects: TO INFORM SUPERVISOR ABOUT FAILURE, ACTIVATE THE STOP BUTTON, ENSURE DISABLED STATUS PANEL, USE PROTECTIVE EQUIPMENT										Revision:	Create:		
The decommissioning of the installation procedure: TO ACTIVATE THE STOP BUTTON IF IT IS NOT STATED OTHERWISE										Date:	Confirm:		
 <p>Control may be performed only by trained personnel and maintenance workers for compliance with the safety regulations! Unauthorized person may not reside near the maintenance during the operations! The device must not be used during inspection and maintenance operation and there is a risk of injury! The device must not be clean with compressed air!</p>													

Figure 1 – Overview of standard maintenance of BPH 320 machine

The standard includes 22 service points; the other service points are stated in the appendix. The same maintenance standard of 320 BPH grinders was created, determining the maintenance times stated in Table 2, which will be available to the Maintenance Department for the purpose of production planning and calculation of MTBF, MTTR and availability indicators. One of the advantages is that we get an overview of how long the individual operations last, and so we are able to determine the total time necessary to perform the service tasks.


Table 3 – Overview list of all service activities on BPH 320 machine

Interval	Description of service work				
Daily	inspection of level of grinding dust	inspection of cleanliness of workplace	inspection of function, cleaning sludge pan	inspection of light status	inspection of tool settings
Weekly	inspection of concentrations and PH emulsion	Inspection that steel filings are separated from emulsions	inspection of mechanical damage to wedge belt	lubricate all guide areas	
Monthly	inspection of oil levels	inspection of lubrication			
Half - yearly	tightening of hydraulic hose				
Yearly	pressure setting of hydraulics	changing filter			

3.1. The partial standard of maintenance BPH 320 surface-grinding machine

Standard maintenance provides an overview of service points for the machine operator, using a picture image. However, a partial maintenance standard gives an overview of what specifically is to be performed on a given machine or what is its desired state or optimal value. The partial standard provides a detailed picture of the service point, activity and instructions and tools for the implementation of individual tasks. Just like the overall standard, the partial standard also provides an overview of the interval of the individual actions and the obligation to keep a record. A partial overview of the partial standard is stated in Table 4 and includes the work for which he is responsible. The Partial standards for other operations for which the mechanic and electro-mechanic are responsible shall be drawn up by analogy.

Table 4 – Overview of partial standard BPH 320 – the responsibility of worker

<i>Machine: BPH 320 surface grinder</i>												
<i>Location of machine: Hall 1</i>												
<i>Author of Standard:</i>												
<i>Person who confirm standard:</i>												
S.n.	Inspection	Detail of machine	Instructions/ Desired state	Responsibility	Used tools	Interval of inspections					Report	LOTO
						Daily	Weekly	Monthly	Half-yearly	Yearly		
1	inspection of grinding dust level		empty, if it is filled with a collection container	worker		X					No	E1
2	inspection of grinding dust level		10-times to thump	worker		XV					No	E1
3	inspection of oil level		add if it is less than 1/4 tank of oil	worker		XR					No	E1
4	inspection of function, cleaning		steel filings have to be separated from the emulsion	worker		X					No	
5	inspection of hose surface and tightness		nothing mechanical damage	worker		XR					No	

3.2. LOTO standard of maintenance of BPH 320 surface-grinding machine

In this day and age businesses and their executives should focus not on the technical, but the human aspect, in particular, the safety of their workers, and to ensure that the standards of LOTO (Lockout /Tag out) form part of maintenance standards. The primary task of LOTO standards is to eliminate the incidence of work-related injuries resulting from unintended (unwanted) running of the machine or electric shock, ensure connection locations so that after disconnection and removal of residual energy uncontrolled starting of the machine cannot occur. The LOTO standard informs the operator of the machine and the maintenance worker on the necessity of pressing the stop button – stopping the spindle of the machine, or a complete shutdown of the machine from the electrical power supply. Another task of the LOTO standard is to warn the machine operator

or maintenance worker of the shutting down of the machine and of the device which performs this specific function. An example is a device that works with compressed air, where, even after turning off the equipment the air can threaten the safety of the operator. "LOTO standards include a set of instruction that must be followed by employees once a machine breaks down or begins to act up. Include on this set of instructions specific steps that must be taken. For instance, employees should notify all other people who use or operate that equipment that it is faulty. Include specific steps about how to do this (such as with signs or having the employee speak with people personally). Include instructions to shut down the equipment, disconnect the power and neutralize other energy sources – which could mean bleeding the air from hydraulic lines to remove pressure (since trapped air could harm the service worker.)". Therefore, my opinion is that, the LOTO standards are very important for maintenance.

Lockout Procedure – Lock

- ✓ The location of the special closure and padlock, which is critical for the release of the energy source, on the site.
- ✓ Information for other users that repair/decommissioning is taking place, and the equipment is therefore disconnected / disabled.
- ✓ Prevent undesired handling of the source of energy, which could lead to injury, death or damage to property.

Tag out Procedure – Mark

- ✓ The closure tag informs other users that repair/decommissioning is taking place and the equipment is therefore disconnected / disabled.
- ✓ Posting information regarding the disconnecting (responsible worker, date of completion). On the back side it is possible to place text describing the steps that must be performed by the operator before removing the device,
- ✓ The signature on the label confirms the performance of the task.

"The Lock Out and Tag Out procedure prevents the unexpected start up or release of stored energy that could cause injury to employees by placing a lock and/or warning tag on an energy isolation device".



LOTO						
Machine: BPH 320 surface grinder						
Location of machine: Hall 1						
Author:						
Confirmed:						
						
Point LOTO	E0	E1	E2	E3	E4	E5
Localization	Stop button	Machine main switch	Decommissioning spindle revolutions	Switching off suction and cooling	Turning off hydraulics	Turning off magnet
Work to ensure	Activate STOP button	Turn off, locked and store key	Turn off	Turn off	Turn off	Turn off
Security verification	Visual inspection and control of the motion of the machine listening	Visual inspection of the central control display	Visual inspection and control of the speed of the machine listening	Inspection of grinding dust	Inspection of oil level, changing the filter	Inspection magnet utility
Type of maintenance	preventive maintenance	preventive maintenance	preventive maintenance	preventive maintenance	preventive maintenance	preventive maintenance
Note: UNLESS IT IS STATED OTHERWISE, ACTIVATE THE STOP BUTTON!						

Figure 2 – Overview of BPH 320 LOTO standard

4. CONCLUSION

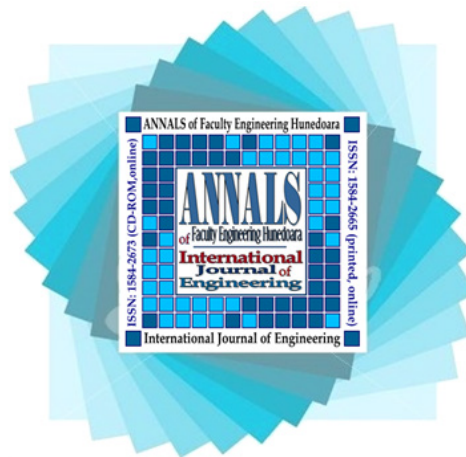
The issue of autonomous maintenance standards has been described in a number of publications, but the application of this theory in terms of a single company always represents a unique solution that takes into account the organization of production, maintenance, equipment used, etc. The article contains a proposal for the development of standards which I consider to be one of the main elements of the introduction of Total Productive Maintenance. Standardization of maintenance ensures that the machine operator will know the activities to be carried out before or during work on the device, so that there will be no failures on the device. At the same time I would like to note that this article may in the future serve as the basis for the development of standards and guidelines within the industry.

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