sciendo International Conference KNOWLEDGE-BASED ORGANIZATION
Vol. XXV No 3 2019

CONTROL OF MALFUNCTIONS AND THEIR CONSEQUENCES IN THE OPERATION OF THE HEAVY ARTILLERY WEAPONS

Stelian POPESCU

"NicolaeBălcescu" Land Forces Academy, Sibiu, Romania
fam_popes@yahoo.com

Abstract: *At essential components in the composition of artillery weapons, it is important that during the manufacturing and repair processes, to identify, at an early stage, possible non-homogeneities / structural and joining discrepancies, which may lead to major defects and finally the occurrence of some damages in these weapons. Such phenomena can be traced and prevented by non-destructive control methods available to the actors involved. Suggestive in this regard are the methods of control with penetrating, electromagnetic, ultrasound and pressurizing liquids. Ignoring the consequences of the malfunctions can lead to a worsening of the technical condition of the artillery weapons and, implicitly, to their decommissioning.*

Keywords: testing, penetrating liquids, electromagnetic, ultrasound, pressurization, malfunctions, technical condition

1. Introduction

The control of the malfunctions of the heavy artillery weapons is visual or using the appropriate equipment and is designed to prevent the occurrence of nonconformities that can lead to the reset of the components, the increase of the manufacturing costs and the occurrence of the damages.

The visual possibilities are limited to observing wear and tear that can be detected with the naked eye, with an optical instrument (for example, a magnifying glass) or a surface analyser (generally used to explore the technical condition of the toothed wheels, grooves and threads).This category of checks also includes macrostructure control, which allows identification of internal failures after breaking by examining the shape and appearance of the surface, as shown in the breakage section. The macroscopic examination with a sample preparation makes it possible to identify macroscopic malfunctions, being executed in accordance with the provisions of STAS 4203-74 and STAS 5000-97.

Verification by means of measuring and control means it is possible to determine the dimensions of the parts by means of measurements. In this way the distribution of the dimensions on the interested areas is emphasized and the deformation, the out-of-roundness, the conicity, the deviation from flatness and concentricity, etc. can be determined. *The equipment commonly used includes: callipers (depth, outside, combined, for toothed wheels), micrometres (inside, outside, for threads, for toothed wheels), indicating snap gauges, comparators, angular and parallel planes, compasses, metallographic microscopes, angular measuring devices, internal tube measurement devices (micrometre*

DOI: 10.2478/kbo-2019-0132

screwdriver measuring device), piping measuring systems coupled to computer engineering etc.
Particularly important are non-destructive control procedures, which provide the possibility of identifying internal flaws in the structure of the material, to essential components in the structure of artillery weapons. In this respect, there will be presented some important methods, used for the realization and repair of components and subassemblies specific to these products.

2. Testing with penetrating liquids
Penetrating liquids testing is a non-destructive process that allows to highlight open discontinuities on the surface, based on the physical phenomenon of capillarity. For this purpose, the surfaces of the test pieces are cleaned and degreased, then the penetrating liquid is applied by spraying or immersion (the spraying variant is generally used), excess liquid is removed by liquid flushing or an organic degreaser and the developer is applied, which highlights the position, shape and size of surface defects. For the substance to penetrate all the defects and in all their depth, the penetration time will be on average about 15-20 minutes.
The developer is cleaned by washing with water and wiping, and if not removed completely degreasing and cleaning liquid is used.
The penetrating liquid process is frequently applied to the control of welded joints or welding cords performed in the manufacture or repair of artillery fire parts and subassemblies.
Penetrating liquids are used in accordance with STAS 10214-84, and for the examination of the elements of the elastic connection (pressurized installation), the provisions of the technical prescriptions CR 6-2003, the I.S.C.I.R. shall be complied with.
It is important to underline that penetrating liquids are delivered as defectoscopic sets (degreasing, penetrating, developing).

3. Electromagnetic testing
Electromagnetic testing is done with the device called magnetic defectoscope or ferrofluid, the principle of operation of these devices is based on the magnetization of steel weapon parts. Magnetic lines through the track are diverted to areas where there are cracks. For the identification of the deflection zones of the magnetic lines, the cracks are used for fine steel filing mixed in suspension in oil or diesel. The proportion of the mixture is 40 ... 50 g of filings per litre.
The testing pieces are immersed in the prepared suspension and then subjected to magnetization. Alloy and heat-treated pieces of steel are subjected to magnetization and then suspended for 1-2 minutes. The filler particles are deposited along the cracks, thus marking their presence.
The disadvantages of the method are that it can only be applied to ferromagnetic materials, it is limited to the detection of surface defects and in most cases requires several successive magnetisations in different directions in order to detect flaws having different directions.
When using fluorescent powders, the parts are controlled with ultraviolet light (the installation contains a UV lamp).
After control, the parts are washed and subjected to demagnetization by placing them in a field created by an alternating current or a direct current in the opposite direction to the magnetic field lines.
The process is mainly used to identify flaws occurring in the pipes and cylinders of the elastic connection of the artillery weapons.

4. Ultrasound testing
Ultrasound testing is based on the fundamental properties of the movement and is used to detect internal flaws in parts of the composition of fire guns, to which conventional procedures cannot be applied (STAS 6605-86, SR EN 12681-2003, SR EN 1714- 2000).
The process is successfully applied to

highlight internal defects occurring at the locks and breeches.
The ultrasonic method is usually based on the reflection of ultrasonic waves, when they encounter defects (cavities) in the depth of the material in which they propagate, on the measurement of the amplitude of the ultrasonic pulses and the time of passage (back and forth), Figure 1:

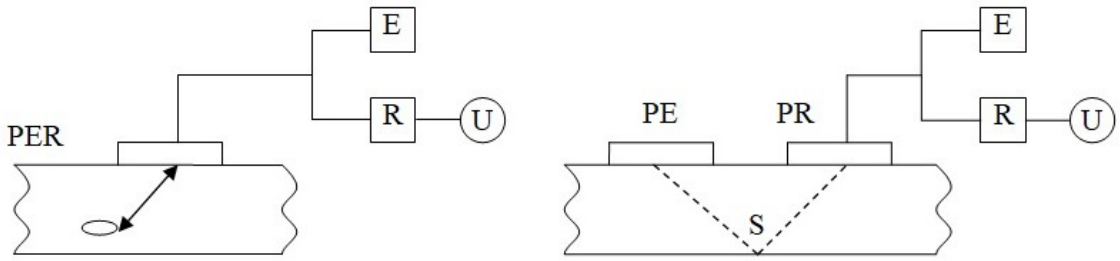

Figure 1: Ultrasound testing scheme
P – primary detector; E – transmitter; R - receiver

For proper application of the primary detector to the piece and, therefore, to ensure good transmission of the waves' beam, the part is cleaned in advance. For optimal contact between the primary detector and the component, a thick oil or grease is used. Signal processing is done with the built-in oscilloscope in the testing device structure.

5. Pressurisation testing
Pressurisation testing consists in checking with the pressurized liquids or air of the cylinders of the respective elastic coupling cylinder, respectively, of the balancing cylinders. The results of the checks shall be entered in the control records or registers of these parts, by type and by series. These documents serve for the sorting of the parts and the need for reconditioning, respectively the need for new parts in the weapon-maintenance process.

6. Consequences of malfunctions
Depending on their severity, the malfunctions (and defects implicitly) are grouped into three categories:

- **minor** (less serious - secondary) which does not impede the operation of the product, but its non-removal may subsequently have adverse consequences by aggravating the technical condition, thereby increasing the manufacturing costs and the cost of the repair;
- **major** (serious - primary), which do not substantially prevent the continued use of artillery material, but its technical and functional parameters are significantly affected. Exploitation is therefore subject to certain restrictions;
- **critical** (very serious - essential), generates significant damage to essential components and even to the weapon, the continued use of which may also affect the integrity of the service personnel or the surroundings. This time it is necessary to decommission the artillery piece in question.

Fault control can be done as described above, and evidence of malfunctions is made using the "Dashboard of the main quality nonconformities", the essential document drawn up for artillery weapons.

7. Conclusions

- The testing through the non-destructive procedures presented aims at eliminating additional costs and the risk of occurrence of damage to the sub-assemblies and finally to the weapon due

to nonconformities in the structure of the materials of their composition;

- Non-destructive testing processes can be applied to the artillery weapon production and repair flows;
- The costs of detecting non-conformities in the internal structure of the materials are insignificant compared to the realization of some essential components, respectively those that restore the technical condition of the artillery fire weapons due to a potential damage;
- Depending on their severity, the malfunctions can lead to worsening of the technical condition of the artillery weapons and, implicitly, to their decommissioning;
- Undetected faults generate additional manufacturing and repair costs to artillery firearm components / weapons.

References

[1] Kifor, C.V., Oprean, C., *Ingineria calităţii*, Editura Universităţii "Lucian Blaga", Sibiu, 2002.

[2] ASRO – *SR EN 12681 – 2003*, *Control nedistructiv acustic. Defectoscopie ultrasonic.*

[3] ASRO – SR EN 1435 – 2001, *Examinări nedistructive ale sudurilor. Examinarea radiografică a îmbinărilor sudate.*

[4] Institutul de Cercetări Metalurgice – *STAS 4203-74*, *Metalografie. Lucrarea şi pregătirea probelor metalografice*, Editura Institutului Român de Standardizare, Bucureşti, 1974.

[5] Institutul Român de Standarde – *STAS 10214-84*, *Detectoscopie cu lichide penetrante*, Editura Institutului Român de Standardizare, Bucureşti, 1984.

[6] Popescu, St. and Dascălu, V., *Tendinţe şi realizări constructive în dezvoltarea gurilor de foc de artilerie moderne*, Sesiunea de Comunicări Ştiinţifice, Academia Forţelor Terestre „Nicolae Bălcescu", Sibiu, 2002.

[7] Stelian Popescu, *Evaluarea resursei tehnice a gurilor de foc de artilerie de calibre mijlocii şi mari*, Editura Academiei Forţelor Terestre "Nicolae Bălcescu", Sibiu, 2015.