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## COMBAT MEANS QUALITY TESTING SYSTEM DURING THEIR USAGE PROCESS

**Abstract:** An important indicator of combat readiness of military forces, it is possession of appropriately large stocks of safe and reliably functioning combat means (ammunition, rockets and others). Quality of stored stocks of combat means is becoming worse due to time of their storage. Quality changes occurring in combat means, come out from processes of their natural ageing and impact of usage conditions, as a result of which combat means change their physicochemical, ballistic and mechanical properties. Considerable part of combat means stocks which was not consumed during guarantee time of their technical suitability given by producer, saves longer their combat properties in high degree, so the combat means are still used for needs of military forces. Only need in this matter, it is to detect and eliminate these batches/lots of combat means and their elements which pose a threat for their safe usage. The tasks connected with this problem are realized in the frame of peaceful time system of tests and quality assessment of combat means.

## SYSTEM BADANIA JAKOŚCI ŚRODKÓW BOJOWYCH W PROCESIE EKSPLOATACJI

**Streszczenie:** Istotnym wskaźnikiem gotowości bojowej wojsk jest posiadanie odpowiednio dużych zasobów bezpiecznych i niezawodnie działających środków bojowych (amunicji, raket i in.). Jakość przechowywanych zasobów środków bojowych ulega pogorszeniu wraz z upływem czasu przechowywania. Występują w nich zmiany jakościowe wynikające z procesów naturalnego starzenia i warunków eksploatacji, w wyniku których środki bojowe zmieniają swoje właściwości fizykochemiczne, balistyczne i mechaniczne. Znaczna część zasobów środków bojowych, które nie zostały zużyte w gwarantowanym okresie przydatności technicznej, nadanym przez producenta, zachowuje w dużej mierze właściwości bojowe i są one nadal wykorzystywane do zabezpieczenia potrzeb wojsk. Należy tylko wykryć i wyeliminować te partie środków bojowych oraz ich elementy, które stwarzają zagrożenie bezpieczeństwa ich eksploatacji. Zadania z tym związane są realizowane w ramach pokojowego systemu badań i oceny jakości środków bojowych.

### 1. Introduction

Requirements dealing with maintenance of combat means in readiness for their usage/service to ensure continuous supply to armed forces, cause necessity of possession of quality and safety control/examination system for combat means. Combat means during their long-term life undergo processes which influence on their service properties. These are physicochemical processes (eg. corrosion, decomposition of smokeless propellants) and mechanical ones arising spontaneously (eg. relaxation of springs put under permanent

tension), defects arising during realization of loading and disloading works, and also during combat means movements. Course of destructive chemical and mechanical processes, in high degree is dependent on quality of raw materials used to production of combat means. Other mechanical defects come out from not respecting of safety and hygieny rules during works with combat means or come out from lack of knowledge in this subject and also come out from lack of knowledge on their constuction/design and operation. Combat means contain explosives which in the case of their not intended initiation can cause fatal lost for human life and materials. Due to above, in the frame of usage/service process, it is very important exact determination of their current technical state and prognosis of their maintainance. In order to assure quality and safety of combat means, there must be well/clearly and precisely determined rules of their usage and should be realised regular examinations of their quality. Stocks of combat means should be subjected to periodic inspection, technical services and diagnostic tests, assuring elimination of combat means not suitable for usage or dangerous ones. Considerably part of combat means which were not consumed in their guarantee period of suitability determined by producer, save in high degree their proper combat parameters, so such combat means are still used to satisfy needs of armed forces. Only thing to do, it is detection and elimination of such batches/lots of combat means and their elements which pose threat for their safe usage. Then, it is obvious to determine period of combat means storage during which, they are able to assure realization of task given to them and satisfactory safety level under conditions of their storage, transportation and service. After guarantee period of combat means technical suitability, responsibility for their quality and safety in the range of storage and usage, is under military management/administration. In conection with this, it arised need to posses in armed forces system elements/modules assuring assessment of safety and reliability functioning of combat means after their guarantee period (combat means with prolonged service time).

## **2. System of combat means service and its tasks during peace time**

Term 'service of combat means' is understood as all activities connected with combat means starting from their transfer to armed forces. So, this term means usage of combat means during realization of combat tasks and in training process of armed forces, combat means storage under various conditions, their transportation, and also their technical examinations, diagnostic tests, as well as repairs and disposal of old and dangereous elements. In peace time, characteristic features of combat means service process, are combat means limited usage, their long-term storage, diagnosis, multiple cleaning, maintenance and repairs, frequent loadings on transportation means and on combat vehicles. Relatively small consumption of combat means and their large stocks caused growth of need of disposal of their old and dangerous elements. During realization of rules of usage and service in peacetime system of combat means service, military units, depots and amunition bases/stores, repair and disposal works/plants, supply ensuring field depots/stores, diagnostic laboratories and management of service mutually cooperate (Figure 1).

Important element of the system of combat means in terms of their service, is subsystem for tests and quality assessment which assures assessment and prognosis on safety and reliability functioning of combat means. In the frame of this subsystem there are carried out the following tasks:

- Collection, analysis and archiving information about structure, quantity and quality of combat means batches/lots and their elements and about their deployment;

- Control/examination, assessment and prognosis on safety and reliability functioning of combat means being in equipment of armed forces after guarantee period of their technical suitability;
- Delivery of information necessary for logistic authorities of armed forces to save safety of combat means during their service;
- Development of reports for logistic organs including assessment of safety and reliability functioning of combat means, prognosis of their suitability in terms of usage and storage, and conclusions and proposals of decisions dealing with storage, consumption, repair, disposal and destroying of combat means serviced in armed forces;
- Development of conclusions and proposal for decisions with technical and economical substantiations;
- Development of prognoses on suitability (due to established criteria), survivability and duration of individual – for the batch/lot of given type of element and aggregated prognoses– for the batches and collections, types of complete products, necessary to planning buying and supply of combat means to armed forces;
- Selection and adaptation of the most appropriate test methods and methods of quality assessment for the given combat mean (its type, nomenclature and so on);
- Development of new methods and also methodics and diagnostic tests procedures for combat means - new and being after guarantee term of their technical suitability, just introduced or being in equipment in armed forces;
- Indication, selection and sampling of combat means to diagnostic tests;
- Development of programs and carrying out of special tests on safety and reliability functioning of combat means and expertises explaining reasons of accidents with combat means or their incorrect functioning.

Block diagram of diagnostic tests of ammunition in its servicing process is presented in Figure 2.

Diagnostic tests of combat means consist of set of trials and examinations enabling development of diagnosis and prognosis on quality status of determined collection of combat means elements, and on their basis – on collection of complete combat means. Sounding tests of combat means confirmed assumptions that the least population of given type of ammunition which can be treated as uniform/homogeneous, it is production batch/lot i.e. limited in number collection of given type of combat means manufactured under strictly determined conditions from quality uniform modules, semi-finished products and materials which meet requirements included in technology documentation. Access of the production batch/lot to service/usage is realised on the basis of positive results of reception tests carried out most often by institutions and laboratories which are independent on the batch/lot producer.

Basis to undertake tests and assessment of quality of combat means stocks in service process, it is expiration of guarantee period of suitability given by manufacturer or given by research institution. For planning of tests there are used collections/files of information gathered and archived, consisted of:

- assortment – quantitative-qualitative files/records/register (batches/lots of complete products and their component elements) creating so called “data base about combat means” being in equipment in armed forces;
- protocols of receiving of batch/lots of elements and protocols of receiving of batch/lots of complete products, containing tests results of receiving tests, periodical ones and others (eg. qualification tests);

- tests results, assessments, prognoses and decisions on quality of combat means;
- reports about quality of combat means.

Combat means are diagnostically tested for which ended guarantee term of their technical suitability given by producer or testing laboratories. The test objects are samples drawn from batches/lots of complete combat means and from their elements. Firstly, the samples are drawn from “Central Storage” and then for repeated tests and special ones and so on, they are drawn from storage places in depots and magazines of military units. Types of tests and future terms of their suitability are established on the basis of obtained results.

In “Central Storage” there are stored basic collections of samples designated to safety assessment and reliability functioning of batches/los of combat means (their elements) stored in stocks of armed forces.

Tests and assessment of quality are carried out by scientific-reasearch institutes or laboratories engaged by ordering institution i.e. logistic authorities of armed forces. Reports from tests and about quality are used for system reclassification of combat means serviced in military forces after their acceptance by logistic authorities.

Tests are realised according to strictly determined, completely documented test methods guaranteeing repeatability, reliability and exactness of results.

Tests are conducted using in first order methods which are standardised, typical, published in standards or published in other standardised documents. On the basis of these documents, there are developed testing methodics, programs and procedures.

Institution conducting tests is fully responsible for application of own - not standardised test methods. Test methods dealing with combat means during their service time accepted as obligatory and sufficient ones to assessment and prognosis of their quality and for establishment of future terms of their technical suitability (terms of further tests) are presented in general form in “Tests Methodics”. In the case of singular test dealing with one type of combat mean (its element), there are developed tests programs.

### **3. Tests carried out in Military Institute of Armament Technology**

Military Institute of Armament Technology (MIAT) has been conducting tests of combat means for over 40 years. During this period MIAT has developed several proper and suitable test methods and methodices to assessment of quality for each assortment of combat means and their elements which come true in practical application enabling safe usage/service of combat means which obtained extended service life.

MIAT conducts diagnostic tests for the following types of combat means:

- small arms ammunition;
- grenade launcher ammunition;
- mortar ammunition;
- artillery ammunition;
- navy ammunition;
- aerial ammunition;
- naval ammunition;
- guided and unguided missiles;
- anti-aircraft and tactical missiles;
- mine and obstacle means;
- illuminating, signal and screening-smoke means;
- live/operational elements of above combat means.

Tested elements and substances used in combat means:

- high explosives;
- primary explosives;
- solid gun and rocket propellants – heterogeneous and homogeneous ones;
- pyrotechnic compositions;
- tracers;
- fuzes and igniters;
- primers, firing cups, detonating cups, boosters, detonators and delayers;
- mechanical elements, electric and electronic ones.

Test methods of combat means:

- physicochemical;
- ballistic;
- mechanical (rheological, strength tests);
- tests on safety and reliability functioning.

In particular, there are carried out the following tests dealing with:

- physicochemical stability of high explosives, solid gun and rocket propellants – heterogeneous and homogeneous ones, and pyrotechnic compositions;
- outer examinations before and after disassembling (examination of assembly correctness);
- examinations of technical state of packages (sealing, tightness, marking etc.);
- sensitivity to heat and to mechanical stimuli;
- properties, parameters, characteristics of substances and products i.e. articles, goods subjected/exposed to external inputs/impacts (eg. under conditions of heightened and low temperatures and humidity)
- determination of typical physicochemical parameters characteristic for given explosive (eg. melting point, cook off temperature, decomposition temperature, detonating parameters, initiation ability/output strength to initiate next element in firing/explosive train, water content);
- measurement of forces of ammunition disassembling;
- measurement of mechanical and electric parameters;
- determination of parameters of firing and explosive trains;
- service/usage parameters tested by firing tests realised in MIAT proving grounds.

Samples of fuzes as the most precise elements of projectiles, cartridges (rounds) are subjected to initial diagnostic, non-destructive tests with use of X-ray diagnostic system which is also used for detection of defects like inhomogenities, foreign matter in explosive materials filled in projectiles bodies/shells. Properties and parameters of pyrotechnic assemblies (delayers, fuse safety charges, augmenting charges etc.) which decide in critical degree about safety and reliability functioning of fuzes, are tested in test set-up equipped with laser with controlled energy of laser beam.

Tests of solid gun and rocket propellants carried out by DTA, TGA, DSC and FTIR analysis allowed for qualitative and quantitative determinations of substances evolving from propellants during their decomposition due to accelerated heating according to various temperature programmed regimes and it was possible to determine types of reactions going on during accelerated ageing. Combination of above laboratory, analytical techniques enabled in selected cases isolation of substances evolved from the propellants.

Application of chromatographic techniques such as HPLC and TLC in investigations of chemical changes of stabilizers (diphenylamine and ethylcentralite) in homogeneous single- and double-base propellants allowed to determine chemical stability of these propellants with

high precision and during early stages of their decomposition processes visible under natural conditions of their ageing. On the basis of above presented test methods there were also developed methods of analysis and identification of stabilizers (diphenylamine, ethylcentralite) and their daughter reaction products by HPLC and TLC combined with optical (UV, VIS) densitometry.

These investigations allowed for precise assessment of quality of homogeneous propellants especially in aspect of determination and prognosis of their chemical stability and for prolongation of their effective service period in military ammunition.

MIAT as research-scientific institution, is enable to carry out comprehensive tests for all types of combat means (new and older types) under laboratory and field (proving ground) conditions in aspect of their overall quality assuring their safe and reliable usage.

## **4. Conclusions**

Quality testing system of combat means assures in each stage of their usage:

- detection and saving in stocks these combat means which still posses required combat properties although they extended guarantee period of their technical suitability;
- extension/prolongation of combat means service life and consumption/firing in first order such batches/lots of combat means which meet combat requirements (still possessing required combat/operational properties) but indicate symptoms of their natural ageing enabling predict terms of their lost of combat suitability;
- rational management of combat means stocks, control and survillance of their consumption order and their stocks restoring, carrying out of their repairs, removal and disposal of their old and dangerous elements.

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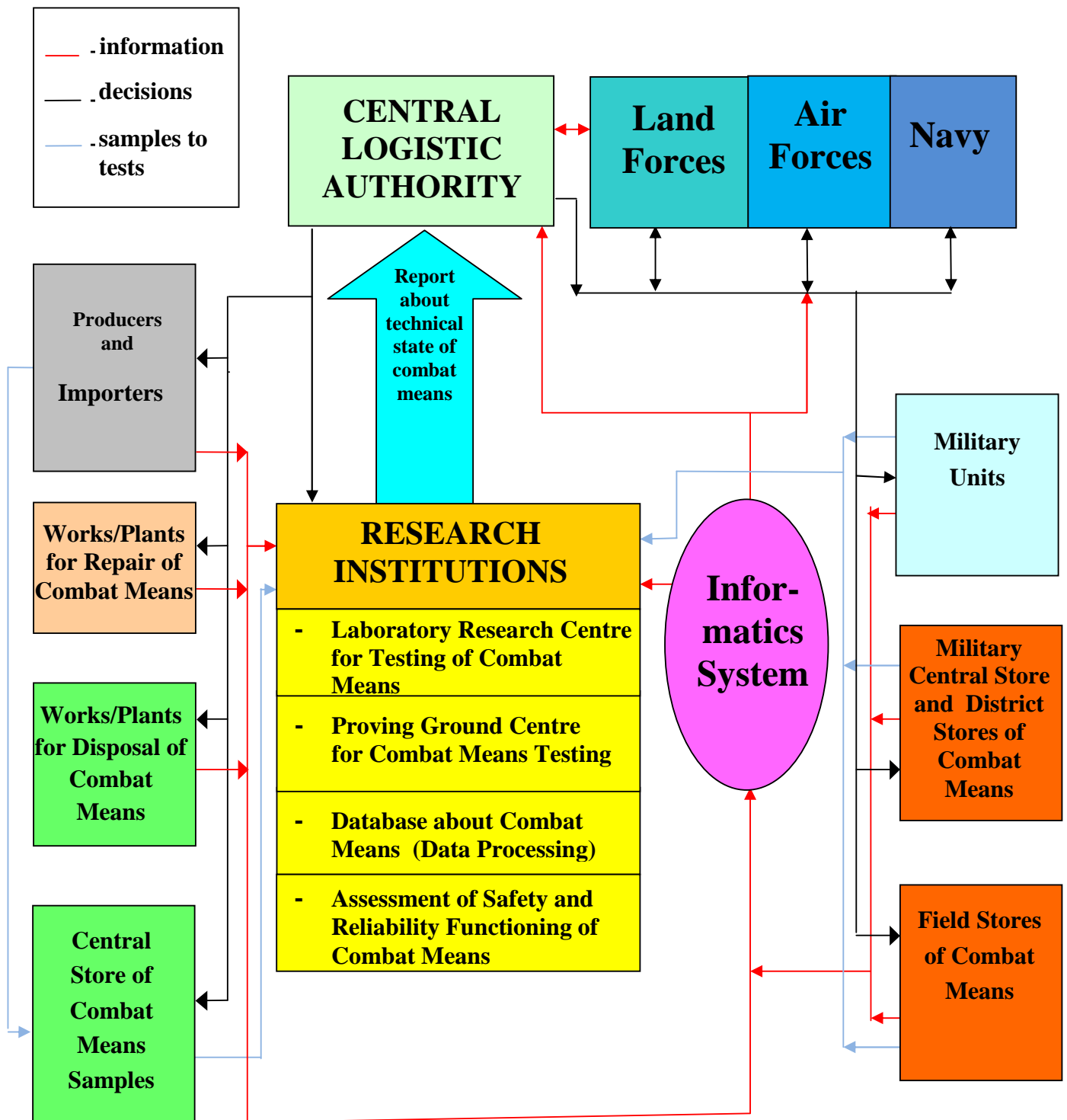
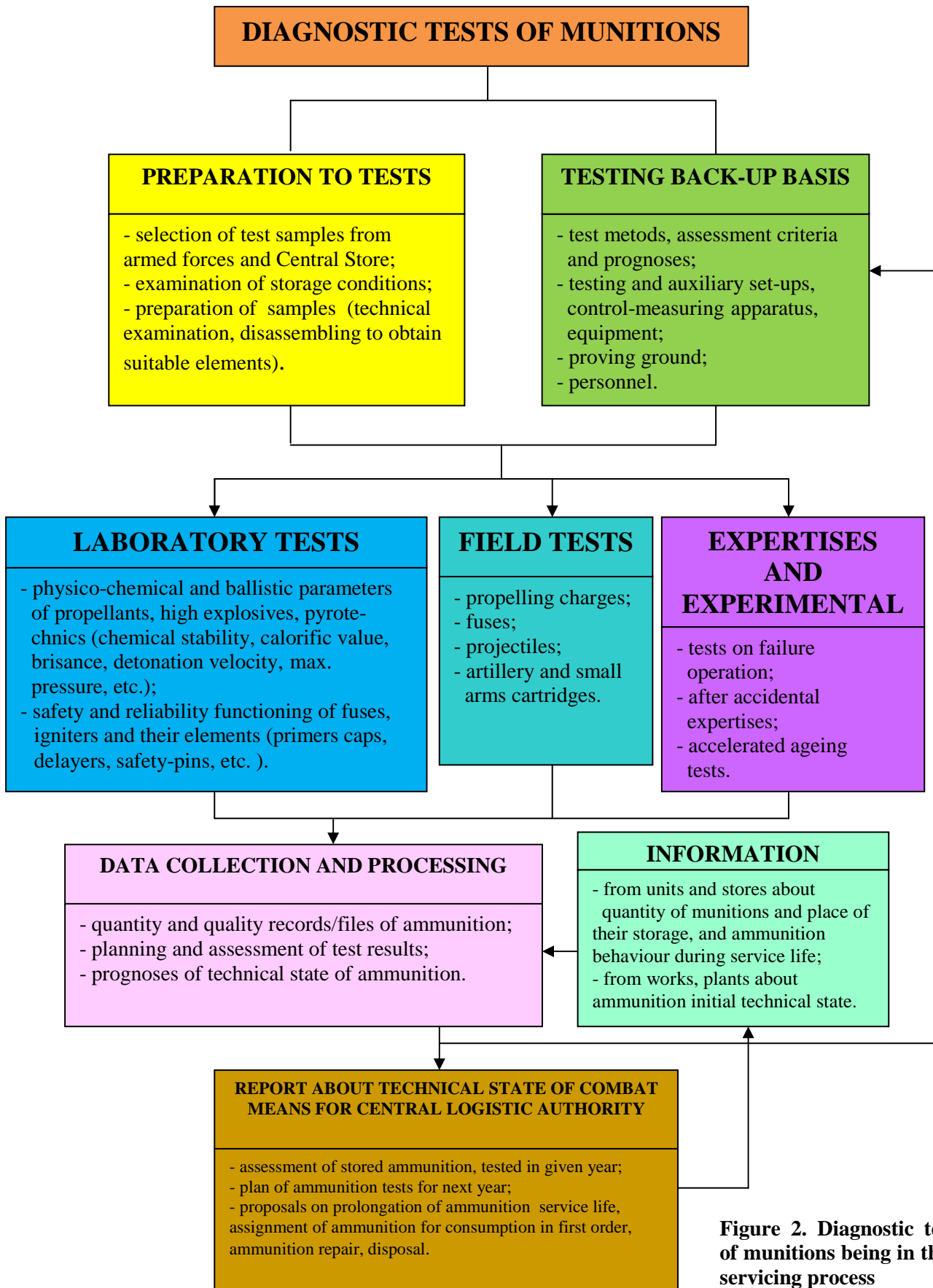


Figure 1. Servicing system of combat means including their quality and safety testing



**Figure 2. Diagnostic tests of munitions being in their servicing process**