Innovation of Warfighting-oriented Inspection and Acceptance Method of Equipment Based on Cloud Model

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ABSTRACT

Inspection and acceptance is the last pass to control the quality of equipment. With the development of modern warfare, weapons and equipment are characterized by technical, informational, and systematic development, which puts forward higher requirements for equipment quality. How to conduct warfighting-oriented inspection and acceptance has become a new problem of equipment quality. This paper focuses on the new challenges faced by the inspection and acceptance of high-tech weapons and equipment under the new situation. By simulating the combat environment and designing the combat style, integrating the computer simulation technology, and comprehensively using the simulation inspection and cloud model to innovate the contents and methods of equipment warfighting-oriented inspection and acceptance, it effectively improves the inspection and acceptance effect and promotes the digital development of equipment quality supervision.

Keywords: *Equipment Inspection and Acceptance; Warfighting-oriented; Simulation Inspection; Cloud Model*

1. INTRODUCTION

In recent years, with the continuous enhancement of the warfighting-oriented training of the troops, the utilization rate of the troops' equipment has increased significantly, and higher requirements have been placed on the quality of the equipment. The original inspection and acceptance focused on meeting the tactical and technical indicators of equipment, the inspection process was single, and the inspection process was fixed, which could not meet the warfighting-oriented requirements [6]. Especially with the continuous development of weapons and equipment, how to realize the organic combination of equipment and people, and how to adapt to the development of new combat requirements, combat tasks and combat styles have become new issues in equipment quality management [3]. Inspection and acceptance is the last pass to control the quality of equipment, and it is also one of the most important links. Therefore, starting from equipment inspection and acceptance, this paper comprehensively uses computer simulation, virtual inspection, remote inspection and other technologies to explore how to use information technology to implement the warfighting-oriented requirements of equipment into inspection and acceptance.

2. NEW CHALLENGES FOR EQUIPMENT INSPECTION AND ACCEPTANCE

2.1 Pay attention to the combat effectiveness of equipment

Warfighting-oriented requires equipment to be grouped according to combat tasks, and to establish information fusion situation, target information analysis and damage effect assessment around command and control, intelligence reconnaissance, and fire strikes, and put forward new requirements for the comprehensive combat effectiveness of equipment [2]. To test the combat effectiveness of weapons and equipment, it mainly analyzes its target capability, realistic capability and core capability. Among them, the target capability is

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the design capability of the new weapons and equipment in the initial state of the mission, including information acquisition (reconnaissance detection or situational awareness) capability, information processing capability, information transmission (communication support) capability, command and decision-making capability, and combat control capability, command support capability, target adaptability, target strike capability, combat response capability and comprehensive support capability; realistic capability is the actual capability of new weapons and equipment to perform missions and tasks, which can be reflected by combat effects, and combat efficiency is such as the completion time of combat tasks, Effective mission duration, and combat costs such as risk, attrition, and battle damage ratio are represented; core capabilities are the ability of new weapons and equipment to maintain combat advantages within a certain period of time, mainly referring to information coordination capabilities, strike coordination capabilities, and the enemy's combat system. structural breaking capability.

2.2 Pay attention to the combat suitability of equipment

In the warfighting-oriented training in high-intensity and harsh environments, equipment quality problems frequently occur [5]. Combat applicability is an important indicator to measure whether equipment can fight wars, and it is an important indicator for the reliability, support, availability, compatibility and maintainability of weapons and equipment. and other non-combat capability factors. Combat suitability is the ability of equipment to be put into warfighting-oriented tasks and maintain the ability to complete combat tasks, that is, the degree to which it meets the needs of combat use. For example, whether the equipment can do fast maneuvering, coordinate in an ultra-distance range, and provide accurate, timely and reliable information services in the complex electromagnetic environment of the informationized battlefield fully reflects the applicability of the equipment in the warfighting-oriented environment.

The operational applicability of equipment is also reflected in the degree of adaptation between the equipment and the troops. On the one hand, it is reflected in the degree to which the equipment meets the requirements of troops training and operational application, that is, the availability, reliability, maintainability, support, compatibility, transportability, Human-machine adaptability, environmental adaptability and survival adaptability. On the other hand, it refers to the degree to which the establishment of equipment and related personnel meets the warfighting-oriented and training requirements of the troops. It is mainly reflected in whether the use and support of equipment meet the actual requirements of the troops' daily training and operations. Whether the equipment allocation is "in sync" with the current formation of the army, and whether the equipment can be "organically integrated" with the army's organizational setup, personnel allocation, and division of responsibilities is crucial, which directly affects the combat effectiveness of the army.

2.3 Pay attention to equipment quality and reliability

Whether the quality level determined by the performance test and the combat test before the equipment leaves the factory can be well maintained during the equipment service stage is an important question that needs to be answered in the in-service assessment. Regarding the maintenance of equipment quality level, we need to focus on two aspects: First, whether the quality of equipment is maintained at a certain level after the production of equipment from small batches to large batches. Since there may be a gap in the quality of equipment produced in large batches and in small batches, it is necessary to make a limited comparison between the quality of equipment produced in large batches and the quality level of equipment operational test inspections to evaluate whether the equipment produced in large batches has quality degradation. question. The second is whether there is a rapid decline in the quality level of the troops equipped with large-scale installations and long-term service. During the equipment service stage, the overall quality level of the equipment should be tracked and monitored, the risk of equipment quality characteristics decline should be prevented in time, and the focus should be on the quality defects that affect the combat use of equipment [4].

3. EQUIPMENT WARFIGHTING-ORIENTED INSPECTION AND ACCEPTANCE METHOD

The warfighting-oriented inspection and acceptance of equipment is mainly to test the combat effectiveness of the equipment under similar warfighting-oriented conditions, and to identify and evaluate whether the tactical and technical performance of the equipment can adapt to the complex environment of the battlefield. Since different equipment plays different roles on the battlefield, the content of warfighting-oriented inspection and acceptance is also different. Therefore, this paper focuses on analyzing the content and methods of warfighting-oriented inspection and acceptance of several types of products.

The warfighting-oriented inspection of equipment is to build a real battlefield environment and state, test the performance of the equipment, cooperate with the troops, and adapt to the battlefield, etc., and find out the possible problems of the equipment, so as to meet the high standards and strict requirements for appearance. In terms

of warfighting-oriented inspection and acceptance methods, adversarial exercise inspection, simulation inspection, simulation inspection combining virtual and real, and integrated inspection and assessment are mainly used.

3.1 Adversarial exercise inspection and assessment

Adversarial exercise inspection and assessment refers to cooperating with the troops to implement confrontational exercises of actual equipment by constructing an approximate actual battlefield environment as a method of inspecting and assessing equipment. The biggest advantage of the adversarial exercise inspection and assessment is that the reliability of the inspection and assessment has been greatly improved, it is representative, it can truly reflect the efficiency and performance of the equipment under warfighting-oriented conditions, and basic data has been accumulated for the next simulation inspection. However, there are also three problems in the inspection of adversarial exercises: - The cost is high, and the inspection requires a large amount of infrastructure, troops, support personnel and actual equipment, and the loss and cost during the inspection and assessment process are relatively high. Second, the cycle is long, the preparation time is relatively long, and the annual plan of the army must be taken care of; third, the implementation process is complicated, mainly reflected in the many inspection and assessment items, involving a large area, and the equipment, personnel, organization, and management that need to be coordinated. It is relatively the most complex and requires a complete operational scenario before testing. For this method, it can be coordinated with the army's exercise plan in advance, and relevant exercises can be used to carry out inspection and acceptance work to improve the efficiency of inspection and acceptance.

3.2 Simulation inspection

Simulation inspection is to build a mathematical model of the combat environment and related equipment that is close to the real with the support of computer modeling and simulation technology. A method of collecting relevant inspection and acceptance data for inspection. The advantages of simulation inspection and assessment lie in its low cost, short cycle, high safety, easy to repeat, and can provide a large number of data samples. Simulation inspection and assessment also has obvious shortcomings, that is, the reliability is not high. The U.S. military also has "reservations" when using simulation tests for combat tests, and regards it as an "auxiliary means" for actual installation tests.

3.3 Simulation test and assessment of the combination of virtual and real

The simulation inspection and assessment of the combination of virtual and real is a method of combining the actual installation of the tested equipment and the simulation inspection of the accompanying test equipment according to the needs under the construction of a similar warfighting-oriented environment to form a personal-in-the-loop and real-in-the-loop test. A form of verification against simulation. The tested equipment adopts the form of actual installation to carry out inspection and assessment. The biggest advantage is that it has high reliability and can collect relatively real and reliable inspection data; the test equipment generally adopts the method of simulation, in order not to reduce the overall inspection effect. , which effectively improves the safety and economy of inspection and assessment, and shortens the inspection and assessment cycle. Using the combination of virtual and real simulation inspection and assessment, the advantages of actual installation and simulation are brought into play, and their shortcomings are avoided. However, this kind of inspection and assessment method still needs to break through the bottlenecks in theory and technology.

3.4 Integrated inspection

Integrated test refers to a real-time linkage test that is based on the information network system of the shooting range, uses information technology to rationally plan the training resources of the shooting range, builds a distributed interactive test environment, and integrates test training ranges and facilities for different functional purposes. The integrated shooting range can comprehensively integrate various inspection and assessment resources, and comprehensively carry out a number of military inspection and assessment activities such as equipment development and testing, stereotyped inspection and assessment, and combat exercises.

4. CONTENTS OF WARFIGHTING-ORIENTED INSPECTION AND ACCEPTANCE OF EQUIPMENT

The warfighting-oriented inspection and acceptance is closely related to the accuracy of the inspection content, the combat style, and the fidelity of the constructed battlefield environment. However, in the actual inspection and acceptance process, it will be difficult to build a realistic battlefield environment. Therefore, the settings of the battlefield environment in this paper are mainly reflected in the complex electromagnetic environment and the fire strike environment.

4.1 Warfighting-oriented inspection and acceptance project settings

This paper takes a certain type of radar as an example to establish a practical inspection and acceptance evaluation system, as shown in Table 1.

Table 1 Radar warfighting-oriented inspection and acceptance

Inspection and acceptance content	Inspection and acceptance items	Inspection and acceptance index	Inspection and acceptance method
Suitability for combat use	Detection distance	Average maximum detection distance, average minimum action distance, average maximum recognition distance	Simulation test of the combination of virtual and real
	Detection coverage	Average Azimuth Coverage, Average Height Coverage	Simulation test of the combination of virtual and real
	Detection accuracy	Distance, azimuth, altitude detection accuracy	Simulation test of the combination of virtual and real
	Detection resolution	Range, Azimuth, Elevation Resolution	Simulation test of the combination of virtual and real
	Information transmission capability	Receiving ability of target information, information format coordinate conversion processing speed, information output speed, information ability to report air situation (working status, location)	Simulation test of the combination of virtual and real
	Timeliness of data processing	Transmission delay of data information	Simulation test
	Continuous working time	Average continuous working time	Simulation test
Adaptability to combat environment	Efficacy	Degree of combat effectiveness	Simulation test of the combination of virtual and real
	Adaptability to complex electromagnetic environment	The degree of performance in this environment	Simulation test of the combination of virtual and real
	Anti-interference ability	Emergency Support Capability, Interference Avoidance Capability, Interference Recovery Rate	Simulation test of the combination of virtual and real
Interconnectivity	Compatibility	Connection rate of each interface	Simulation test

	Quality of information exchanged	Validity of transmitted information	Simulation test
Ergonomics	Ease of operation	Ease of operation and comfort	Simulation test of the combination of virtual and real
	Safety	Operational Safety	Simulation test of the combination of virtual and real
Stability	Mean time to failure	Mean time to failure	Simulation test
	failure rate	Failure probability	Simulation test
Guaranteed	Mean time to repair	Mean time to repair	Simulation test
	Average maintenance cost	Average maintenance cost	Simulation test

The combat effectiveness assessment of radar mainly includes combat use adaptability and combat environment adaptability. It mainly assesses detection ability, information transmission ability and data processing ability. Different from the conventional fire strike ability assessment, the combat assessment of radar mainly focuses on complex electromagnetic performance in the environment. Therefore, in the warfighting-oriented environment, the natural environment of sea and mountains is simulated and set, and the background signal electromagnetic environment and the local electromagnetic interference signal environment are set in the complex electromagnetic environment. The test contents include detection ability under motion interference, data transmission processing between multi-level and multi-point, and performance under stop interference condition. According to the combat scenario, the enemy situation, the battlefield environment and the changes of the battlefield situation are set, and the ability of the radar in this process is simulated through the warfighting-oriented situation, and the detection distance, detection coverage, detection accuracy, detection resolution, intelligence transmission ability, and data processing timeliness , Continuous working time mean time to failure, failure rate, average maintenance time, average maintenance cost and other data measurement and recording.

For quantitative data, it can be tested according to the relevant data. In addition, the warfighting-oriented test of radar also includes qualitative indicators such as performance, adaptability to complex electromagnetic environments, anti-jamming capabilities, ease of operation, and safety. The cloud model is used to evaluate qualitative indicators.

4.2 Cloud Model Definition

Suppose U is a numerical domain, X is a qualitative concept on U, α is a specific value , $\alpha \in U$, α represents a random realization of the qualitative concept of X, then the degree of certainty of α to A is $\mu(\alpha) \in [0,1]$, then the distribution of α on U is Cloud model, referred to as cloud. Each α is called a cloud drop $(\alpha, \mu(\alpha)) \in [0,1]$.

Each cloud is composed of many cloud droplets, each cloud droplet is a set of data, and cloud droplets combine vague language and quantitative values as the basis for evaluation. The cloud model expresses a language concept through the three eigenvalues of expected value E_{x} , entropy E_{n} and super entropy H_e , abbreviated as $U(E_x, E_n, H_e)$. These three values are called the digital eigenvalues of the cloud model, among which, $[E_x, \pm 3E_n]$ is the symmetrical region of action expressed by this concept. Among them, expectation E_{x} refers to the central position of all cloud droplets in the spatial distribution of the universe of discourse, which is also the point that best represents the qualitative concept X, and its membership degree is 1; entropy E_{n} represents the range of the distribution of all cloud droplets in the universe of discourse, the larger the entropy is. The wider the distribution range; the super-entropy H_e refers to the degree of dispersion of entropy. The cloud model transforms language concepts into numerical values through the three values of expectation, entropy and super-entropy, combines the randomness and ambiguity of language, and uses cloud images to express the qualitative language that needs to be explained. The cloud model can fully reflect human cognition, and can effectively weaken the ambiguity and uncertainty caused

by subjectivity, thereby improving the validity and reliability of the results.

4.3 Evaluation Model Construction

1.Determine evaluation factors and evaluation grades

According to the existing research results, this paper divides the evaluation of the warfighting-oriented inspection and acceptance method into five evaluation levels, namely: V={good (VH), better (H), average (M), poor (L), very poor (VL)} for semantic evaluation. In this paper, the cloud generation method of the golden section method is used. In the domain of discourse [0, 1] [1], the cloud model parameters of the intermediate evaluation state "general" are taken as $E_{x3}=0.5$, $H_{e3}=0.5$. The cloud model parameters of other evaluation states can be deduced by analogy. The range of cloud digital features of each evaluation level on the x-axis is shown in the following table, and the corresponding evaluation status cloud diagram of each evaluation level is shown in Figure 1 below, in which the range of each evaluation level on the x-axis is $[E_{xi}-3E_{ni}, E_{xi}+3E_{ni}]$, and is in [1, 0] range.

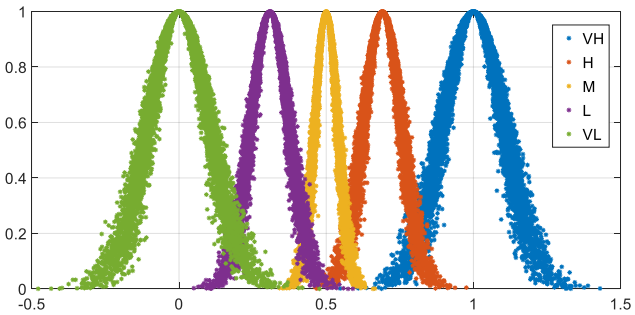

Figure 1 Cloud Model Evaluation Level Chart

2.Determine the evaluation cloud of each index

For the evaluation of the above evaluation index system, experts will conduct semantic evaluation of each qualitative index in the warfighting-oriented inspection and acceptance, and convert it into a graded evaluation according to the semantic evaluation. According to the comprehensive evaluation level, the cloud map of each index is generated by writing a program in the Matlab environment. According to the cloud map, the evaluation results of the warfighting-oriented inspection and acceptance indicators can be seen.

3. Comparative analysis

On the one hand, the inspection data are analyzed and compared, and the inspection results of the warfighting-oriented inspection and acceptance method are obtained. The inspection results are analyzed with the results of traditional inspection and acceptance, and the difference between the results is compared. On the other hand, the operability of the two methods is analyzed to examine their practicality.

Follow-up tracking of the selected equipment, tracking the stability and failure data after installation of the troops, and verifying the inspection efficiency of the warfighting-oriented method. At the same time, a survey is conducted on the equipment use, support and management personnel in the army to verify whether the method can effectively improve the satisfaction of the army equipment.

5. CONCLUSIONS

With the development of equipment, the actual combat inspection of equipment has become a new direction in the field of equipment quality. The warfighting-oriented inspection and acceptance method has changed the original inspection and acceptance method, integrated the battlefield environment, operational requirements, computer simulation technology, etc. into the inspection and acceptance process, and combined simulation data with cloud model evaluation to carry out inspection and acceptance from a system perspective, improving the reliability of equipment. From the research results, the inspection and acceptance method can be popularized and evaluated in the future, which can provide a reference for the follow-up equipment quality supervision.

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