

## PDCA APPROACH TO IMPROVE EQUIPMENT EMERGENCY MAINTENANCE SUPPORT: KEY STRATEGIES

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### **Abstract:**

*The PDCA (Plan-Do-Check-Action) cycle, a methodology encapsulating the essence of its four constituent phases, holds immense significance across diverse domains. To elucidate the omnipresence of this approach, it is imperative to first grasp the core concept of 'process' as defined within the GB/T19000 standard. A process, as per this standard, is construed as a nexus of interrelated or interactive activities that transform input into output, encompassing three pivotal elements: input, output, and activity. Irrespective of the objectives, organizations must meticulously plan and execute processes under controlled conditions to ensure success, with the realization of such objectives hinging on the effective management of the process itself. This fundamental principle underpins the universal applicability of the PDCA cycle method, extending its relevance to processes across diverse fields as per the GB/T 19001-2000 standard. The PDCA cycle method transcends boundaries, proving equally applicable to extensive, minute, or singular processes. Even in contexts where enhancing equipment emergency maintenance support capability is paramount, the PDCA cycle emerges as an indispensable tool for achieving high-level performance and continuous improvement.*

**Keywords:** PDCA Cycle, Process Management, Universal Applicability, Equipment Maintenance, Continuous Improvement

### **1. Introduction**

PDCA cycle is the abbreviation of the English words plan, do, check and action, and is composed of the initials of four words.

PDCA cycle method is widely used, but to clarify the universality of the use of PDCA cycle method, we must first clarify the meaning of the process. The process in GB / T19000 standard is interpreted as a group of interrelated or interactive activities that convert input into output. The process consists of three elements: input, output and activity. Generally speaking, in order to achieve specific objectives, any organization must plan the corresponding process and make it under controlled conditions, which must be realized through the process. PDCA cycle method can be applied to all processes in different fields (GB / T 19001-2000 standard). PDCA cycle method is applicable to large process, small process and even one process. In order to obtain a high level or continuous improvement of equipment emergency maintenance support capability, it also needs a process and follow the PDCA principle.

Cyclic application steps

PDCA is mainly divided into four stages, and its application steps are carried out in turn according to these four stages, and the process is managed in a continuous cycle. In order to facilitate the work, the four stages of PDCA cycle are usually subdivided into eight steps in Figure 1. However, in the specific application process, these steps should be flexibly applied in combination with the specific conditions of the process, and cannot be mechanically applied. The specific contents of the eight steps are as follows <sup>[1]</sup>: ①Analyze the current situation and find out the process of

existing problems; ②The process of diagnosing and analyzing various influencing factors of problems; ③The process of identifying the primary and secondary influencing factors and finding corresponding solutions; ④ The process of evaluating these solutions and making choices; ⑤The process of implementing established solutions; ⑥The process of measuring, verifying, analyzing and evaluating the implementation results; ⑦ Formally adopt the change, consolidate the achievements and eliminate the recurrence of similar problems; ⑧Deal with the unsolved problems in this cycle, and review the results if necessary to determine the process of further improvement opportunities.

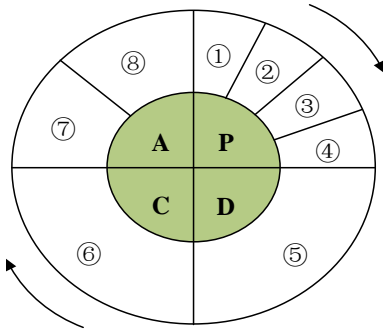


Figure 1: Application steps of PDCA cycle

Big rings and small rings promote each other

The PDCA cycle is the continuous rotation of a big ring within a small ring. The construction of the emergency maintenance support capability of equipment is a big PDCA cycle, emergency preparedness ability, emergency command ability and emergency support ability is relative to its small PDCA cycle, and emergency preparedness, often below the smaller set of PDCA cycle, interlocking, in addition to equipment emergency maintenance support capability of the size of the rings are relative. The cycle of the upper level is the basis of the cycle of the next level, and the cycle of the next level is the implementation of the cycle of the upper level. Each cycle coordinates and promotes each other to promote the continuous improvement of the construction of equipment emergency maintenance support capacity.

Continuous cycle and continuous improvement

PDCA cycle around the target to do a spiraling movement, content and target real-time update. Because each loop, can solve some problems restricting equipment emergency maintenance support capability, also find or create new problems, of course, but the solved problem is always more than new problems, which makes equipment emergency repair work to a higher level every time and then implement appropriate capacity increasing, the concrete is shown in figure 2.

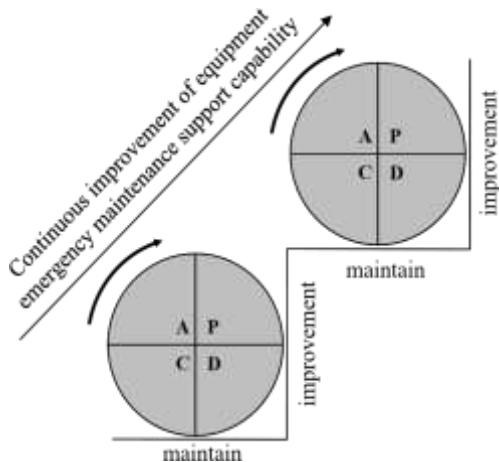


Figure 2: The rising process of PDCA cycle

Cyclic improvement, focusing on summary

The key to promoting the continuous improvement of PDCA cycle lies in the A (treatment and summary) stage. The so-called summary is to sum up experience, affirm achievements and overcome disadvantages. By summing up the experience and lessons and incorporating them into the new system, standards and regulations, it is beneficial to consolidate achievements, learn lessons and overcome disadvantages, and prevent the recurrence of similar problems. At the end of one cycle, part of the problems are overcome, and the next cycle continues to solve the remaining problems or new problems. In this way, the equipment emergency maintenance support capacity will continue to improve.

## 2. Equipment Emergency Maintenance Support Capability Improvement Process based on PDCA Cycle

The development of equipment emergency maintenance support capability is a spiral ascending process from low level to high level. The process is a continuous cycle, constantly reaching higher levels, rather than being done all at once or overnight. The process of equipment emergency maintenance support capability improvement based on PDCA cycle is shown in Figure 3. The cycle focuses on stage A, but its starting point is based on the formulation of capacity improvement plan. The formulation of the improvement plan requires sufficient understanding of each key link of the research object in the process of emergency response, as well as the content and approach of the integration of elements and resources required in each link. Among them, the problems exposed in the disposal process of new tasks or old tasks under the new environment and new conditions in the new period are the starting point for the study of PDCA cycle, and the specific improvement process is as follows:

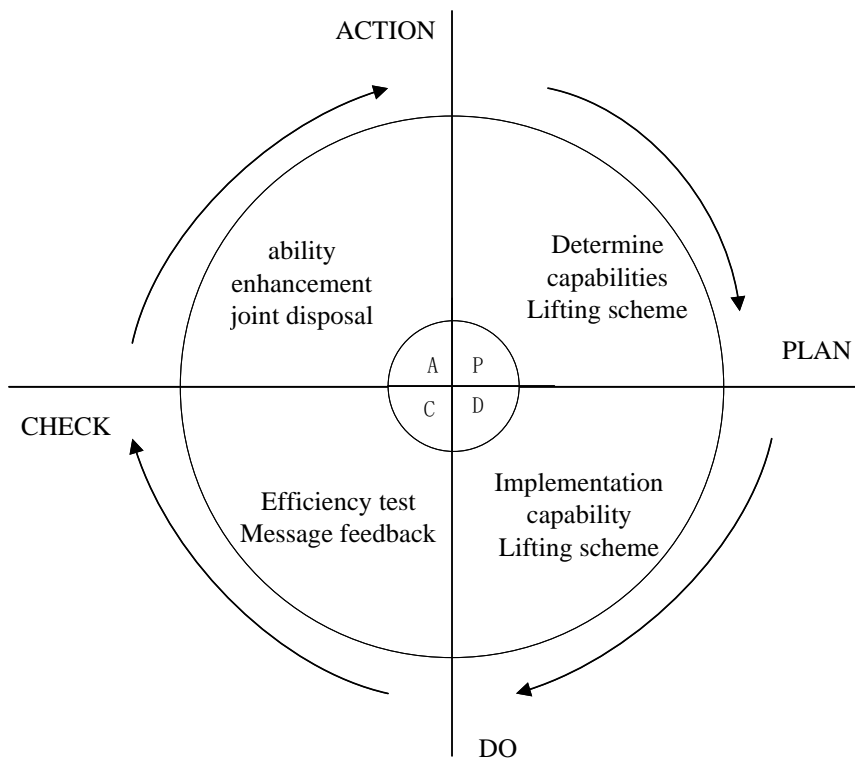


Figure 3: PDCA cycle flow for improving equipment emergency maintenance support capability

### 2.1. Determine the Promotion Plan for the Problem (PLAN)

The formulation of the upgrade plan is based on a clear understanding of the problem, which requires a comprehensive analysis of the problems that exist in the process of the equipment emergency maintenance support capability in the process of exerting its effectiveness. It is necessary to clarify the reasons for the existence of the problem, find out the key influencing factors, and grasp the connection between the various problems and the primary and secondary relationship, so as to improve the efficiency and effect of problem analysis. Based on the main reasons derived from the analysis, specific rectification and improvement measures are formulated and implemented in various departments and even members, and the results are summarized and analyzed regularly to further find out the existing problems and causes, and formulate corresponding measures. In this process, in order to improve the effectiveness of the measures or plans formulated, game theory can be used to make appropriate deductions or perform anticipatory management.

### 2.2. Implementation of the Promotion Plan (DO)

The execution stage is mainly to implement the corresponding rectification measures and plans for the emergency maintenance support capabilities of the equipment. This stage mainly completes the relevant measures or plans formulated in the PLAN stage of the previous step, and is also a stage in which the problems arising during the implementation of the plan are intervened. This stage is a crucial part of the PDCA cycle and is of great significance to the specific improvement of equipment emergency maintenance support capabilities. Therefore, relevant units must fully mobilize the enthusiasm of various departments and members to actively cooperate in finding and solving

problems. Among them, in order to ensure the implementation of the corresponding rectification measures in each link, the scope of responsibility of each department or member must be clearly delineated.

### **2.3. Ability evaluation and information feedback (CHECK)**

The core task of the inspection stage is to check the effects obtained after the implementation of the plan. Specifically, it is mainly to compare the results after the implementation of the plan with the goals set in the previous period, to find out the existing problems, and to check the results, and then to check the goals. The revision of the value provides a direct reference to pave the way for the new cycle.

### **2.4. Comprehensive Treatment for Capacity Improvement (ACTION)**

The main tasks of the comprehensive disposal stage of capacity improvement include: summary of the experience of the equipment emergency maintenance support capacity improvement process and the recycling and continuous improvement of the PDCA cycle. First of all, in terms of summing up experience, the problems arising from the implementation of the plan should be analyzed in detail, and the goal of improving equipment emergency maintenance support capability should be revised in accordance with the actual needs, and the good experience should be standardized and institutionalized in time to facilitate the efficient development of post-event work. , Especially for the existing unresolved problems, it is necessary to find out the reasons and take appropriate solutions. In addition, under normal circumstances, if there is no abnormality after the PDCA cycle ends, and the execution effect meets the previous goals, it can be transferred to the next cycle to continue to maintain. For the problems found in the summary of experience, you can also focus on robbing in the next cycle. This way, after continuous cycles, the equipment emergency maintenance and support capabilities will continue to improve. At the same time, the multi-level cycle of relevant departments should be strengthened, and indicators should be implemented to departments and individuals to improve the efficiency of the cycle.

## **3. Ways and Measures to Improve Equipment Emergency Maintenance Support Capabilities**

### **3.1. Clear goals and always focus on the actual combat of equipment emergency maintenance support**

All kinds of military operations, especially non-war military operations, generally have no signs in advance, and the incidents happen suddenly and change rapidly. Once they happen, they tend to spread rapidly or even worsen. Therefore, in order to ensure the continuity of the combat effectiveness of the equipment, it is necessary to strengthen the emergency maintenance support capabilities of the equipment to restore the combat technical performance of the malfunctioning equipment in the shortest time, and achieve the effect of "preventing sudden emergencies quickly." In order to achieve this goal, under the condition of sufficient resource reserves, the "three fast" requirements of "maintenance elements are in place quickly, faults are found quickly, and the maintenance process is fast" are proposed for maintenance support work. The relevant departments should develop closely around the requirements in daily training and work.

#### **3.1.1. Emergency maintenance elements are in place quickly**

For equipment maintenance support tasks, maintenance support elements mainly include three aspects: maintenance personnel, maintenance parts, and maintenance resources. Safeguarding in place means safeguarding victory, which puts forward higher requirements for the rapid installation of maintenance guarantee elements. According to the goal, improve the talent training model. While paying attention to the scientific and proficient use of equipment by operators, it is necessary to strengthen their training in equipment maintenance to achieve the effect that equipment operators are maintenance personnel and achieve the goal of independent guarantee by the unit. Secondly, build a maintenance support information sharing platform, grasp the distribution of maintenance

elements in the entire domain and maintenance demand information (task location, time, and failure types, etc.) in real time, optimize and complete maintenance resources (maintenance personnel, accessories and equipment).

### **3.1.2. Emergency maintenance failures are found quickly**

The timely discovery of equipment failures is a prerequisite for troubleshooting, which directly affects the efficiency of equipment emergency maintenance support. According to the requirements of the "six characteristics" of equipment, the detectability and maintainability of equipment are as important as reliability. Especially in the equipment research and development stage, the design of testing equipment and methods should be ensured firstly to ensure that the user has rapid testing methods, equipment or tools of various newly equipped equipment, and if conditions permit, an intelligent detection system for equipment failures should be developed. Secondly, the operators of related equipment should master the "habits" of the equipment during the daily use, and at the same time collect and summarize the problem information and feed it back to the equipment R&D department. The R&D department appropriately develops a portable equipment problem quick-check system or manual to improve the design of the next generation. In addition, based on information-based communication remote video technology, it relies on maintenance support personnel or equipment design department "remote consultation" to timely and accurately determine faults and obtain maintenance strategy and method guidance.

### **3.1.3. The emergency repair process is fast**

The factors that affect the speed of the emergency maintenance process mainly include the scientific and reasonable level of equipment design, the operating proficiency of maintenance personnel, and the complete function of maintenance equipment, testing and monitoring equipment, etc. This requires that the equipment needs to consider the convenience and speed of maintenance at the beginning of the design, such as the rapid 3D printing of parts, the implementation of modular design of each component, and direct replacement on the spot when a failure occurs, and the failure of the module to be repaired based on base maintenance or fixed-point maintenance. Second, make full use of networked and simulated training resources to carry out synthetic joint training and comprehensive drills to improve the professional level of maintenance support personnel. In addition, according to different stages of action, different equipment support priorities are distinguished, and emergency maintenance support is flexibly performed. For example, during the mission deployment stage, the main task is to repair vehicles and other special equipment to ensure that the unit can quickly reach the predetermined location.

## **3.2. Highlight the key points and comprehensively build the infrastructure for equipment emergency maintenance support**

The basic construction of equipment emergency maintenance support is the foundation for the development of emergency maintenance support capabilities. If the foundation is firmly laid, the development and improvement of capabilities can be effectively implemented. Comprehensive construction does not mean "full bloom", that is, it cannot be simply regarded as average construction. Especially in the initial building stage of equipment emergency maintenance and support capacity, when various resources are obviously insufficient, it is necessary to carefully study the new requirements of military tasks in the new era, and make scientific overall planning and specific arrangements. In the process of various specific tasks, grasp the key points of construction, prioritize the priorities, and put the key issues that restrict the development of equipment emergency maintenance support capabilities in the first place. By doing a good job in key constructions, we will drive and promote all-round construction.

### **3.2.1. Improve the pre-plan system, with the word "full" in the lead**



Combining with the requirements of logistics support work to fully implement the "transformation of logistics to forward services", emergency equipment maintenance support work must firmly establish the view of "food and fodder should go ahead of troops and horses," and formulate various plans in advance. In addition, while pursuing advance plans, we should also pay more attention to the requirements of thoroughness, that is, to achieve the level of "multiple cases per sentiment, multiple policies per case, and multiple methods per policy". This requires focusing on the new characteristics, new requirements, new laws of current and future combat styles, as well as the types, scales and regions of various nonmilitary tasks performed, and closely focusing on the "three fast" requirements of equipment emergency maintenance support work, and based on the most urgent tasks, the most complex situations, the most severe situations and the worst environments, advance planning, strengthen management, take the initiative, make careful preparations, analyze new features of equipment use, maintenance and support, and conduct research on equipment emergency maintenance support issues. At the same time, timely organize training based on the safeguard plan to ensure the pertinence, scientifically, comprehensiveness and practicality of the safeguard plan. In this way, it actively adapts to the development and changes of future wars or non-military missions, meets the urgent needs of the emergency maintenance support preparation work when military tasks being performed, forms a fast and efficient equipment emergency maintenance support performance, and improves the unit's independent support capabilities.

### **3.2.2. Optimize the command mechanism and emphasize the word "fast"**

In the equipment emergency maintenance support activities, a rapid, efficient and scientific command mechanism can maximize the emergency maintenance support capabilities. At present, whether it is a local war under the conditions of informatization or a non-war military operation, the development of related support work involves all services, arms, and both sides. In the process of joint support, the establishment of an integrated support command system that integrates military and local forces and is the key to improving command efficiency. Secondly, simplify the command link, reasonably determine the command level, transform the command network from vertical to horizontal development, and standardize the tasks, command authority and coordination requirements of all levels and departments in different situations. Thirdly, improve the supporting construction of command means and continuously expand the functions of equipment support information acquisition, processing and transmission, so that the maintenance support command can communicate and interact with the commands of other departments to ensure that the maintenance support needs are known in real time, the maintenance support resources are transparent and visible, and the maintenance support actions are accurate and controllable. In addition, the development of auxiliary decision-making systems involving maintenance support force organization, support resource scheduling and equipment emergency repairs, etc., to help commanders conduct scientific and efficient command operations.

### **3.2.3. Pay close attention to training and preparation, start with "strict"**

To establish a new type of maintenance support force that responds quickly, guarantees efficient, and adapts to actual combat requirements, we must resolutely implement the principle of consistent combat and training, overcome chronic problems such as formalism and passive security, and use actual combat training to drive unit transformation and development. First of all, in response to the training needs of different equipment, actively research and development of scientific, comprehensive and realistic maintenance simulation training platform for different equipment to promote the improvement of training efficiency and quality [2,3]. Secondly, further strengthen the guidance on the use of equipment and the construction of the legal system. After the simulation training has

reached a certain level of proficiency, increase the intensity of actual combat training, resolutely put an end to the problem of some units "dare not move or use the new equipment", and prevent the problems caused by equipment repairing "not having enough food" leads to a decline in the quality of repair personnel and a decline in ability [4]. Thirdly, strictly set up assessment standards, regularly assess the training of grassroots departments and individuals, and formulate corresponding rewards, punishments and accountability mechanisms.

### **3.3. Take multiple measures simultaneously to continuously improve equipment emergency maintenance support capabilities**

#### **3.3.1. Improve the emergency maintenance support capability evaluation system**

The scientific and systematic evaluation system of equipment emergency maintenance support capability is the basis for the improvement of equipment emergency maintenance support capability. With the changes in military missions and the development of weapons and equipment, the requirements for equipment emergency maintenance support capabilities are not static. Therefore, equipment emergency maintenance support capabilities are dynamically changing and need to keep pace with the times. This requires that the corresponding emergency maintenance support capability evaluation system must be improved in accordance with the actual situation, so as to guide its improvement. For the improvement of the evaluation system, firstly, monitor and collect the results of training exercises and daily work of relevant maintenance support departments of the unit, and implement real-time optimization and improvement of related models, evaluation index types, and evaluation index weights involved in the evaluation system through big data. , And then revise and improve the preliminary evaluation system in time. Secondly, standardize the work content and requirements of the troops in various military operations, explore the commonalities in various content and requirements, and further improve the applicability of the emergency maintenance support capability evaluation system. In addition, improve the scientificity and accuracy of the evaluation methods in the evaluation system construction process, closely integrate the latest theoretical results on evaluation methods, and realize the transformation from the application of qualitative research methods to the application of quantitative research methods in the evaluation system construction process. Further improve the application value of the evaluation system.

#### **3.3.2. Improve the ability and quality of emergency maintenance support personnel**

The improvement of equipment emergency maintenance support ability is ultimately the improvement of the ability and quality of maintenance support personnel, that is, the improvement of the "combat power" of the talent team. With the change of maintenance support content and methods, maintenance support personnel will also change from physical to intellectual, and from a single role to a diverse role. At present, maintenance support personnel have considerable professional technical capabilities and experience, and they should continue to be trained. According to the "one, two, three" principle of "one subject, two knowledge, three knowledge", so that they can further expand their knowledge to achieve the effect of "multi-purpose soldiers, one specialization and many abilities" to meet the higher requirements of maintenance support. Secondly, strengthen the introduction of talents, and implement the treatment of the introduced talents. And establish talent files and the corresponding competition and reward mechanism, realize that those who are able to go above the mediocre, mobilize everyone's enthusiasm, and make outstanding talents stand out. In the end, we will build a maintenance support team with military-to-land linkage, excellent style and technology, and order and prohibition to ensure that it can be pulled out, topped off, repaired quickly, and maintained well at the critical moments.

#### **3.3.3. Improve the technical level of emergency maintenance support equipment**



With regard to equipment emergency maintenance support capabilities, we must insist on upgrading to technological innovation. First of all, focusing on changes in demand, focusing on key directions and research and development of maintenance support equipment for key equipment, in turn form the fist force of maintenance support. Secondly, build a maintenance support information resource sharing platform to create convenient conditions for "raising questions at the grassroots level, finding ideas for research departments, and improving the practicability of equipment", while improving the efficiency and economic benefits of equipment research and development. Thirdly, intensify military-civilian integration, give full play to the advantages of strong local scientific and technological strength, vigorous technological innovation, and great potential for national defense, and integrate it into the process of equipment technological innovation. At the same time, the corresponding laws and regulations are issued to enhance the spirit of the contract, and further regulate and promote the construction of military-civilian integration.

#### **4. Conclusion**

Based on the description of the application process of PDCA cycle theory, the article analyzes the specific implementation steps of each link of the PDCA cycle method in the construction and improvement of equipment emergency maintenance support capabilities, including: improvement plan determination, improvement plan implementation, capability evaluation and information feedback, and comprehensive disposal of capacity improvement. In accordance with the characteristics of equipment emergency maintenance support capabilities, strategies and measures that can be taken to improve the emergency maintenance support capabilities of individual equipment in the PDCA cycle are formulated.

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