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Research on the Present Situation and Development Characteristics of Missile Penetration Technology

Ziqi Li, Guiming Chen*, Chengqiang Gao, Zengji Wei and Quanmao Zhang

High-tech Institute of Xi'an, Xi'an, China
904544346@qq.com
**corresponding author*

Abstract: *From the traditional perspective, the conventional penetration technology of ballistic missile mainly includes anti identification, anti-interception and system penetration technology. With the development of missile defense system and information technology, the traditional penetration technology is based on digitization, automation and networking, and gradually enters the intelligent level. This paper mainly analyzes the current situation of military ballistic missile penetration technology, analyzes the multi warhead group intelligent penetration technology, intelligent mobility and intelligent stealth materials, and discusses the development direction of intelligent penetration technology of ballistic missile in the future.*

Keywords: *Ballistic missile penetration technology, intelligent maneuvering track change, intelligent stealth material*

1. Introduction to Ballistic Missile Penetration Technology

1.1. Main Features

Ballistic missile penetration technology mainly has the following two characteristics:

First, the technology is relatively complex, involving a wide range of basic technical fields such as electromagnetism, optics, materials and structures; second, it is more targeted and takes different penetration measures for different anti-missile defense systems and equipment [1].

1.2. Basic Classification of Ballistic Missile Penetration Technology

The penetration technology of ballistic missile can be divided into three categories: anti identification penetration technology, anti-interception penetration technology and system anti penetration technology.

Anti-identification penetration technology mainly includes stealth technology, jamming technology and deception technology; Anti interception and penetration technology mainly includes reinforcement technology, multi warhead technology and mobile orbit change technology; System anti penetration technology is to use system countermeasures to deal with the enemy's combat system and missile defense system, such as destroying the enemy's radar and so on.

2. Overview of Penetration Technology of Foreign Ballistic Missiles

Foreign military ballistic missile penetration technology, since the 1950s, with the confrontation between the nuclear forces of the United States and the Soviet Union, the missile defense system has been continuously improved, and the ballistic missile penetration technology has also developed rapidly. The most representative are the US "militia III" and Russia's "poplar m" ballistic missiles.

2.1. Analysis of American Militia Iii Missile Penetration Technology

"Militia III" rocket is the most important land-based strategic ballistic missile currently deployed in the United States. In order to improve its penetration, the following improvements have been made:

1) Mk12 multiple warheads were used.

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2) Penetration device: the warhead device adopts metal interference lines to complete high-altitude penetration, and each group of interference lines and warheads are released at the same time.

3) Strengthen the missile structure and control circuit. The new structure and control ring improve the dust-proof ability and enhance the ability to shield electromagnetic pulse and X-ray.

2.2. Analysis of Russian Poplar M Missile Penetration Technology

Poplar m missile is a single warhead strategic ballistic missile with the most advanced technical capability abroad. It is the great enemy of the U.S. national missile defense system. Its ability to penetrate defense technology is mainly reflected in the following points [2]:

1) New rocket engine. Effectively shorten the working time of booster section and engine shutdown height, and reduce the infrared radiation of rocket rear flame.

2) Special airway. The high-altitude maneuver orbit strategy can increase the flight time of the rocket under the horizon, so as to shorten the time that the defense detector can detect.

3) Stealth technology. Integration of radar and infrared stealth with special materials

3. Intelligent Development Trend of Penetration Technology

With the development of information technology and the optimization and improvement of anti-missile defense systems, on the basis of digitization, automation and networking, the penetration system of ballistic missile will also enter the intelligent stage, focusing on the development of the following functions [3]: cooperative operation, autonomous evasion maneuver, intelligent stealth, active electronic countermeasure, intelligent four-dimensional precision guidance, etc. Combined with the development of missile weapons, the following three points are introduced on the intelligent development trend of ballistic missile penetration technology in the future.

3.1. Multi Warhead Cluster Cooperative Penetration

3.1.1. Basic Concept of Cluster Cooperative Penetration

Cluster refers to a group of people with common goals. Multi warhead cooperative penetration means that multiple warheads of a missile cooperate with each other to form a complementary and tactical coordinated battle group [4]. Give full play to group advantages to attack the targets of missile defense system and enemy tasks, such as exploration, early warning, cover, attraction, attack and evaluation.

The cooperative penetration of multiple warhead clusters has the following four important characteristics:

1) Decentralization. This means that there are no bullets in the center of the lead. It can ensure that the function of each shot disappears or loses, but the purpose and function of the warhead are not affected and can still be realized.

2) Autonomy. The battlefield situation is changing rapidly, and the specific situation of missile penetration may change from time to time. In order to avoid artificial decision-making, all operations in the flight process are carried out through independent evaluation and decision-making. All bullets only control their own flight and observe the position of other warheads, but will not affect other warheads [5].

3) High dynamic. Missiles must respond quickly to changes in the battlefield environment. The traditional method of setting parameters in the form of pre planning can not adapt to the rapidly changing situation of the battlefield in the future. Therefore, warhead clusters are required to receive battlefield situation information and make decisions quickly after battlefield information exchange.

4) Autonomy. All bullets form a stable cluster structure. When a specific warhead loses its function and leads to a vacancy in the cluster structure, the remaining warheads will quickly adjust the structure and take over all functions to restore a stable cluster structure.

3.1.2. Key Technologies of Cluster Cooperative Penetration

According to the process and possible problems of multi warhead group cooperative penetration,

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the key technologies to be solved are summarized, including spatial distribution of multi warheads, cluster situation and shared information [6], cluster dynamic task planning, cluster penetration and effect feedback.

1) Spatial distribution of multiple warheads. The cluster composed of a certain number of true and false multiple warheads, combined with its decentralization, autonomy, high dynamics and autonomy, as well as operational objectives and tasks, must meet the unique spatial distribution law in the process of cluster penetration coordination.

2) Cluster situation awareness and information sharing. In order to realize the cooperative operation of multiple groups of warheads, a high degree of consistency must be achieved on the basis of time and space. Under the assumption of consistent benchmark, multi warhead cluster must conduct all-round perception and data collection of battlefield situation information, such as battlefield, impact environment and the response and action of enemy missile defense system. Based on the data link, it realizes the exchange of situational awareness information, forms a unified operational view, and provides information basis for cluster cooperative operations.

3) Dynamic task planning in cluster. Under the condition of full coverage of battlefield information, formulate sub tasks to achieve the overall operational objectives, determine the formation and optimal trajectory, and allocate operational tasks according to the spatial position of each bullet.

4) Cluster penetration and effect feedback. Warheads are required to face complex battlefield regulations, maintain cluster coordination structure, perform combat tasks and effectively destroy targets. The damage effect feedback needs to evaluate whether the target has been destroyed, whether it needs to strike again, and whether it needs to redesign the operation plan according to the collected target state information.

3.1.3. Development Trend of Cluster Cooperative Penetration

The concept of cluster collaboration has been widely used in the research of UAV cluster operation in recent years. Some research achievements have been made in the projects of ELF and grey partridge of the U.S. Department of defense. The information society technology programme of the European Commission also funded research on the and real-time management and coordination of several heterogeneous spacecraft. Multi warhead cluster cooperative penetration can be learned and optimized from related technologies such as environment perception, mission planning, information interaction, UAV cluster cooperative combat formation flight and so on [7]. These improvements mainly include the following three points:

1) Ballistic missiles' perception of the environment is much more complex than UAVs. Firstly, the reentry height of the warhead is much higher than that of the UAV, and the space material environment faced by both sides is also different; Secondly, the enemy intercepts ballistic missiles and UAVs in different ways, resulting in different battlefield electromagnetic environment and different defense environment formed by the enemy defense system.

2) Ballistic missiles are used to achieve strategic objectives, which are more difficult, more relevant factors and more complex subtasks. Therefore, it is more difficult to formulate relevant tasks and task plans, and the plan preparation for possible accidents should be richer and more accurate.

3) The collaborative penetration of clusters puts forward high requirements for information interaction. Due to the high speed of ballistic missiles, information collection and interaction must be completed in a short time; otherwise the fighters will be delayed.

Generally speaking, the research on multi warhead group cooperative penetration technology is not mature at present. Due to the high requirements for autonomy, rich and complex tasks, and high requirements for response speed. However, with the strong support of hardware technology, some technologies can learn from UAV clusters. We still have a long way to go to achieve cooperative operations.

4. Conclusion

With the development of missile defense system and information technology, the intelligent penetration technology of ballistic missile has gradually become a reality. In the future war, there will be an era of confrontation with artificial intelligence. Therefore, we should overcome key technical problems as soon as possible, apply the latest technology to missile weapons and equipment, strengthen

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the strategic position of missile forces and win the future battlefield.

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