PART THREE

Strategic Support Equipment

Chapter 7

Development and Assessment of PLA's Electronic Reconnaissance Capability

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I. Introduction

Modern electronic warfare can be divided into electronic attacks (EAs), electronic support (ES), and electronic protection (EP). Electronic support consists of electronic intelligence (ELINT) and communication intelligence (COMINT). While the former is based on radar signals with a frequency range from 1.2 to 40 GHz, the latter usually covers 80 to 3,000 MHz used in radio communications. These two detect, intercept, identify, and position electromagnetic and radiation data and collect information about the characteristics of emission sources to facilitate further analysis. There is some overlap between signal intelligence (SIGNIT) and electronic support. However, electronic support emphasizes tactical applications. For example, the receipt and comparison of signals onsite are directly forwarded to Radar Warning Receiver (RWR) for radar early warning intelligence. Signal intelligence is more focused on long-standing surveillance, interception, and analysis for long-term strategic planning.[1]

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1 "Advanced Trigger Based Multichannel Pulse Analysis to Characterize Radar Warning Receivers," *Rohde and Schwarz*, https://www.rohde-schwarz.com/ph/applications/advanced-trigger-based-multichannel-pulse-analysis-to-characterize-radar-warning-receivers-application- card_56279-1039004.html; Mario LaMarche, "Electronic Support: An Overview of Electronic Warfare Part 3," *Mercury Systems Blogs & Podcasts*, November 2018, https://www.mrcy.com/ company/blogs/electronic-support-overview-electronic-warfare-part-3.

Analyses are performed on the electronic parameters and data collected from electronic surveillance ships, aerial reconnaissance aircraft, and ground reconnaissance vehicles for direction-finding. Electronic reconnaissance, which provides electronic protection and data required for attacks, is also part of electronic support. However, ships, aircraft, or vehicles are limited to platforms and usually cannot carry out large-scale and continued reconnaissance for long. Nonetheless, there is no limitation for electronic reconnaissance satellites/ ELINT satellites in outer space. Access to this intelligence source becomes the most critical element in common operating pictures of the C4ISR system.

During the Cold War, the U.S. and Russia embarked on many secret programs in the development of electronic reconnaissance satellites/ ELINT satellites to obtain electronic intelligence (ELINT). For example, the U.S. Naval Research Laboratory carried out the Galactic Radiation and Background (GRAB) experiment in the 1960s in the guise of observing solar radiation to obtain the Soviet Union's anti-aircraft radar information.[2] It is said that the Soviet Union launched over 200 electronic reconnaissance satellites/ ELINT satellites in 1967-1991 to stay on top of the U.S. Armed Forces and aircraft carriers of its allies. While there have been vibrant commercial activities by using signal intelligence in Europe and the U.S. from electronic reconnaissance satellites/ ELINT satellites in recent years, the development of the PLA's electronic reconnaissance capability has been relatively overlooked.

This report intended to examine the development, utilization, and R&D of the PLA's electronic reconnaissance equipment in order to assess the PLA's potential capability going forward. It also focuses on the influence of the increasing number of electronic reconnaissance satellites/ ELINT satellites.

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[2] John Pike, "Project Tattletale: GRAB Galactic Radiation Background Experiment," *Federation of American Scientists Space Policy Project*, February 20, 2000, https://fas.org/spp/military/program/sigint/grab.htm.

II. Development and Employment of PLA's Electronic Reconnaissance Equipment

In recent years, China has been keen to demonstrate its electronic reconnaissance on land, at sea, and over the air by aggressively developing electronic confrontation (i.e., electronic warfare) capabilities. On December 31, 2015, China formally established its Strategic Support Force (SSF) by including Technical Reconnaissance Department and Electronic Confrontation Department, previously under the General Staff Department. Meanwhile, China also set up the Network System Department and Aerospace System Department by including the Jiuquan Satellite Launch Centre (JSLC) and Satellite Maritime Monitoring & Control Department, previously under the General Equipment Department. The integration of functions on land, at sea, over the sky, and even in space into a single system speaks volumes about its ambition to expand electronic reconnaissance and enhance control over the electromagnetic environment.

At the military parade on October 1, 2019 for the 70th Anniversary of the Founding of the People's Republic of China, four information operations parade formations drew out from the Strategic Support Force (SSF) and Electronic Confrontation Brigade of the Ground Force were inspected. One of the square formation from the Strategic Support Force emphasized: "system neutralization by breaking nodes, victory at the first strike". The other square formation from the Electronic Confrontation Brigade labeled itself for "integrated reconnaissance and strike operations, integrated network and electronic warfare, software and hardware integration, airland operations" by focusing on "battlefield network-electronic power" and joining by artillery units in the operations. These indicates that the two has distinctive roles.[3]

In the next year of the military parade, National Defense Channel of China Central Television (CCTV) showed the training images of the PLA Northern Theatre's 78th Group Army on May 10, 2020. In this footage, the two armored

[3] See *Chinese People's Liberation Army Daily*, October 2, 2019, http://www.81.cn/jfjbmap/content/2019-10/02/node_2.htm.

vehicles, remodeled from 6x6 Dongfeng Mengshi CSZ181, looked rather similar to the 2nd Information Warfare Formation in the military parade. One of the vehicles had two antenna. Judging by the appearance, it should be capable of monitoring and direction-finding over VHF/UHF/SHF; hence, it is likely to be an electronic reconnaissance vehicle. These training images also indicate that equipment displayed at the military parade has already been in service (Figure 7-1).

Figure 7-1 PLA's Electronic Reconnaissance Vehicle

Source: National Defense Channel of China Central Television (CCTV).

Electronic surveillance ships, such as Type 815 and follow-up models, have entered service since 2014 and carried out far-sea reconnaissance missions. There are currently nine known ships, with three each for East Sea Fleet, South Sea Fleet, and North Sea Fleet. It is worth noting that the Type 815 Series has been under continuous improvement during the construction process. Hence, it is known to come in two batches: the first to the fourth ships are the Type 815G (Figure 7-2); and the fifth one "Kaiyangxing" (Mizar, pennant number 856), which was launched in 2017, changed the radome in front of the mast into a cylinder. This subsequent batch is called the Type 815A for differentiation with the prior model (Figure 7-3).[4]

[4] "China's New Electronic Surveillance Ship Enters Service. U.S. Media Says It is World-class," *People's Daily*, February 22, 2017, http://military.people.com.cn/BIG5/n1/2017/0222/c1011-29099699.html; "Photo Feature Today's Chinese Warship," *Ships of the World*, 945, April 2021.

Figure 7-2 Types 815G Electronic Surveillance Ship "Uranus"

Figure 7-3 Type 815A Electronic Surveillance Ship "Zeta"

Source of photo: Global Times, Sina Military Section.

In addition, the public release from Japan's Joint Staff Office and the R.O.C. Ministry of National Defense provide timely information of PLA air activities. It reveals that the remodeled Y-8 and Y-9 electronic intelligence aircrafts, also known as GX Series, are not only participating training exercise over the East China Sea but also continue to violate Taiwan's southwestern air space. The J-16's electronic warfare model (J-16D) first showcased in 2021 China International Aviation & Aerospace Exhibition. It is equipped with a wingtip pod, with appearance like the AN/ALQ-218 radar warning/ electronic support (ES)/ electronic intelligence receiver (RWR/ESM/ELINT sensor) used by the U.S. Navy's EA-18G Growler, may possesses similar function. The payloads mounted beneath the intake on both undersides and the two stations for underwing pylon tanks may have the

same function as Growler's AN/ALQ-99 jamming pods. However, it is unclear whether China has overcome the technical challenge of AN/ALQ-99 in mitigating interference to the aircraft's own AESA radar for better operational effectiveness.

Figure 7-4 Static Display of J-16D at China International Aviation & Aerospace Exhibition

Source: The Paper.

III. R&D Capacity of China's Electronic Reconnaissance

Despite the limited information disclosed by China regarding the R&D of its electronic reconnaissance, the operational requirements should be identified by the Strategic Support Force (SSF). Based on the publicly available information, the PLA's research and validation in "electronic confrontation" (電子對抗) and "cyberspace security" (網絡空間安全) are in charged by Unit 32802 of SSF – which is also part of the Systems Engineering Research Institute of PLA Academy of Military Science in Beijing.[5] In addition, the Electronic Confrontation Institute under National University of Defense Technology in Hefei, Anhui, formerly known as Electronic Engineering Institute of PLA, was integrated into the National

[5] "Announcement (2021) No. 2 | PLA 32802 Brigade 2021 Announcement for Recruitment (Table of Positions Attached)," *hongshi81*, January 27, 2021, https://mp.weixin.qq.com/s?_biz=Mzg4ODA1ODE0NA=&mid=2247529640&idx=5&sn=b8771d32b5b7a025fe36ede84ca95b4d&chksm=cf82cce7f8f545f1f2b19b6c19b3781459d24611d00dd99742a3d73b2c032d68c73b5a61ad29&scene=21.

University of Defense Technology (NUDT) in Changsha since the military reforms in 2017. The latter is also a hub for technology R&D and the talent cultivation of senior experts in military technology. Further, the equipment testing was conducted at Luoyang Electronic Equipment Test Center of China in Luoyang City, Henan Province. This center is also know as the PLA's 33rd Experimental Training Base (Unit 63880).

In 2012, the Luoyang Electronic Equipment Test Center of China and Electric Engineering Institute of the National University of Defense Technology (presently Electronic Confrontation Institute) joined forces and established the State Key Laboratory of Complex Electromagnetic Environment Effects on Electronics and Information System (CEMEE). The complex electromagnetic environment refers to the aggregation of anthropogenic electromagnetic fields and multiple electromagnetic phenomena. All the electronic information systems are subject to the influence of different electromagnetic signals in the complex electromagnetic environment. Consequently, this affects the information links through many levels, such as acquisition, transmission, and utilization, and affects the normal functioning of electronic information systems. These changes are known as the complex electromagnetic environment effect. Understanding the complex electromagnetic environment effect is critical to the testing and validation of electronic warfare equipment. By working with the National University of Defense Technology, the Luoyang Electronic Equipment Test Center of China can establish and expand its own capabilities in equipment testing and validation.

According to recent publications, the Luoyang Electronic Equipment Test Center of China also has capacity to conduct original research while performing key mission in equipment testing and validation. For example, it followed the China-India conflicts in 2021 closely and performed analysis to such current event. The co-authorship also demonstrates its close cooperation with the military industry (Figure 7-5). China Aerospace Science & Industry Corp. Research Institute No. 8511 in Nanjing (known with role of "Headquarter for Information Confrontation" in China Aerospace Science & Industry Corp.) is focused on research of electronic engineering and specializes in field of "aeronautical electronic confrontation." It

is currently responsible of many national key engineering and related programs. According to the publicly available information, its R&D results have already become a series of products in electronic-infra red confrontation equipment and general electronic warfare equipment.[6]


節點文獻

印軍電子戰裝備及其山地作戰使用特點分析

Analysis on Indian army's EW equipment and the characteristics of its use in mountain warfare

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【摘要】電子戰貫穿現代戰爭的全過程,對戰局乃至戰爭結果影響巨大。中印加勒萬河谷沖突后,中印雙方雖然達成協議在沖突地區建立緩沖區,暫時完成"脫離接觸",但是印軍卻大幅增兵沖突地區,并將主戰武器裝備配置到相關區域,同時向美國、以色列、俄羅斯和歐洲國家大量購買先進武器,與各國進行聯合軍演,積極備戰,中印沖突升級的可能性一觸即發。簡要介紹了印三軍主要電子戰裝備,并對其山地作戰使用特點進行了歸納總結。

【Abstract】Electronic warfare runs through the whole process of modern war and has a great influence on the situation and even the result of war. After the conflict in the Kalwan valley between China and India,although the two sides reached an agreement to establish a buffer zone in the conflict area and temporarily complete the"disen-gagement",the Indian army has substantially increased its troops in the conflict area,deployed its main combat weapons and equipment to relevant areas,purchased a large number of advanced weapons from the United States,Israel,Russia and European countries,conducted joint military exercises with other countries,and active-ly prepared for the war. The possibility of escalation of Sino-Indian conflict is imminent. The main electronic war-fare equipment of the Indian army is briefly introduced,and its operational characteristics in mountainous areas are summarized. 還原

【關鍵詞】印軍；電子戰；山地作戰；無人機；

【Key words】Indian army；EW；mountain warfare；UAV；

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Figure 7-5 Recent Publication from Luoyang Electronic Equipment Test Center of China

Source: CNKI.

The 10th and 29th Research Institute are among the many other research institutions under China Electronic Technology Corp. (CETC). The 10th Research Institute, founded in Beijing on May 25, 1955, is China's first all-inclusive electronic technology research institute. It is also a National Tier-1 science and research organization in China. Meanwhile, 29th Research Institute is located in Chengdu City of Sichuan Province and widely known as Southwest Institute of Electronic Equipment. It is specialized in "electronic information control technology," R&D and production of related equipment. Furthermore, 29th

[6] "China Aerospace Science and Engineering Corp—Information Technology Research Institute," *Baidu Baike*, January 27, 2021, https://baike.baidu.hk/item/%E4%B8%AD%E5%9C%8B%E8%88%AA%E5%A4%A9%E7%A7%91%E5%B7%A5%E4%BF%A1%E6%81%AF%E6%8A%80%E8%A1%93%E7%A0%94%E7%A9%B6%E9%99%A2/1303764.

Institute offers master degrees in "signal and information processing," as well as in "electromagnetic fields and microwave technology." The affiliated company, Chengdu Tian'ao Electronics Co., Ltd., serves as a host for post-doctoral research.[7]

Judging by industrial corporations' immense collaboration between PLA, their actively recruiting efforts, and even offering postgraduate degrees, the PLA's development in electronic warfare equipment is an exemplification of the Military-Civil Fusion (MCF).

IV. Development of Electronic Reconnaissance Satellite/ ELINT Satellite

China's development of electronic reconnaissance satellites/ ELINT satellites is basically under the guise of scientific research program and civilian application. For instance, the first satellite, "ZH-1," from the China Seismo-electromagnetic Satellite (CSES), monitors the earth's outer electromagnetic fields, the ionosphere, the plasmasphere, and physical phenomena such as Energetic Particle Precipitation (ERP). The monitoring covers geophysics, the seismic mechanism, and the environment. The results suggest a significant correlation between electromagnetic disturbances and earthquakes hence, it is possible to explore new methods to predict earthquakes via electromagnetic monitoring.[8] While the ZH-1 claims to be primarily used for seismic observations, the detected data also provide key support to geophysics research. However, the establishment of the ZH-1 electromagnetic monitoring system suggests its electronic reconnaissance missions in space and value in military application.

This is particularly the case because geophysics research uses of ultra-low frequency (VLF, 3 kHz-30 kHz) radio waves . It can be transmitted to an extremely far distance via reflection from the ionosphere and penetrate seawater by at least 10 to 40 meters. This frequency is also used in the communications of nuclear

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7 China Electronic Technology Corp. (CETC) 29th Research Institute, http://www.cetc29hr.com/.

8 Guo-li Li and Hsiao-fan Li "China Successfully Launches Yaogan-32 01 Satellite," *Xinhua Net*, October 9, 2018, http://www.xinhuanet.com/politics/2018-10/09/c_1123533360.htm.

submarines. Further, such electromagnetic monitoring may enable tracking of submarines from different countries with satellite data. Chief Scientist of CSES Satellite mission, Sheng Xuhui Ph.D., is also involved in electromagnetic satellite working groups with France, Italy, and Europe, and the gravity satellite working groups with Europe by serving as China's team leader, thereby opening the door for China's improvement of its monitor system via international academic exchanges.[9]

The gradual completion of the Yaogan series satellites may expand China's exploration of the electromagnetic environment and assets in space. On October 9, 2018, Jiuquan Satellite Launch Centre (JSLC) successfully launched the Yaogan-32 Satellite 01 into the intended orbit with Chang Zheng 2C carrier rocket (along with YZ-1S carrier rocket). The Yaogan-32 Satellite 01 is produced and operated by the Aerospace Dongfanghong Satellite Company under China Aerospace Science and Technology Corp. (CASC) Fifth Academy (known as China Academy of Space Technology). It is primarily used to surveillance in electromagnetic environment and relevant technological experimentations.[10] In 2021, the Yaogan-31 Satellite 02, also developed by the Fifth Academy, was successfully launched with the CZ-4C Yao-40 carrier rocket on January 29 into the intended orbit.

The Yaogan-30 satellite series, developed by the Innovation Academy for Microsatellite of the Chinese Academy of Sciences, is based on the constellation model. From the released images, it is most likely to be a unit with three CubeSats. By calculating the time difference on arrival (TDOA) (Figure 7-6), it can obtain signal strength and therefore use for positioning. The Yaogan-30 Satellite 08 and Yaogan-30 Satellite 10 were also launched successfully on May 7 and July 19, respectively, into the orbits. According to the Chinese official media, the launch

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[9] Chu-ching Chao, "China Successfully Launches 'ZH-1', Its First Electromagnetic Aatellite for Monitoring and Testing," *people.cn*, February 2, 2018, http://scitech.people.com.cn/BIG5/n1/2018/0202/c1007-29803460.html; "National Institute of Natural Hazards' Chief Engineer Sheng Xuhui Invites to Make an Academic Report," Institute of Geology and Environment of Jiangxi Normal University, May 25, 2021, https://dlxy.jxnu.edu.cn/2021/0525/c1910a217802/page.htm.

[10] Huai-yu Liu, "Yaogan-32 Satellite 01 Successfully Launched," *Space China*, October 9, 2018, http://www.spacechina.com/n25/n2018089/n2018131/c2019368/content.html.

of Yaogan-30 Satellite 10 was described as the final stage of the current battle.[11] Based on the experience of the U.S. company Hawkeye 360 in providing signal intelligence services with CubeSats constellation, as each Yaogan-30 set consists of three CubeSats, it should be technically feasible to conduct around-the-clock radio frequency surveillance on specific regions in the world. This will help the vessel tracking of PLA in the region.[12]

Figure 7-6 Yaogan-30 Satellite 02

Source: China Central Television (CCTV) news channel.

V. Conclusion

In the preliminary introduction of the PLA's electronic reconnaissance capability from this chapter, it can be concluded that PLA already possess electronic reconnaissance capabilities at multiple temporal and spatial scale. Such capabilities continue to expand, with the goal of conducting 24/7 global surveillance. Therefore, these capabilities will greatly enhance their early warning capability and

[11] Chu-ching Chao, "China Successfully Launches Yaogan-30 Satellite 10 Tianqi to Complete the First Stage of the Internet-of-Things Constellation," *People's Daily*, July 19, 2021, http://finance.people.com.cn/BIG5/n1/2021/0719/c1004-32161846.html.

[12] Gunter Krebs, "Yaogan 30-01,..., 10-10 (CX 5), " *Gunter's Space Page*, August 3, 2021, https://space.skyrocket.de/doc_sdat/yaogan-30-01.htm.

complete the common operating picture for the C4ISR system with the final piece of puzzles. In the light of future great power competition, these will prepare PLA for the new "electromagnetic (operation) first" form of warfare.