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China Maritime Report No. 38: PLAN Anti-Submarine Warfare Aircraft - Sensors, Weapons, and Operational Concepts

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PLAN Anti-Submarine Warfare Aircraft

Sensors, Weapons, and Operational Concepts

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Summary

The PLA Navy recognizes the importance of a robust anti-submarine warfare (ASW) system to counter adversaries seeking undersea asymmetric advantages, and its aviation component is a key part of that system. This report discusses the PLAN's efforts to improve its airborne ASW platforms and equipment and describes how PLAN-affiliated sources discuss the employment of those assets. The PLAN's significant buildup and growing employment of fixed-wing maritime patrol aircraft in recent years are key indicators of the importance it attaches to the airborne ASW mission set, as is its push to acquire improved sensors on both fixed and rotary wing ASW platforms. PLAN-affiliated authors show that its academic and operational components are coordinating to explore best practices and maximize the effectiveness of these assets across a wide array of ASW scenarios.

Introduction

Over the past several years, the People's Liberation Army Navy (PLAN) has placed a priority on developing its anti-submarine warfare (ASW) capabilities and improving ASW training for both aviation assets and surface vessels. While the PLA often discusses ASW as a system composed of multiple assets, this report focuses solely on airborne components: namely, fixed-wing maritime patrol and reconnaissance aircraft (MPRA) and helicopters. It examines general platform capabilities, sensors, and weapons employed, research within the defense industrial base that supports these platforms, and common themes in PLA media and academic publications covering airborne ASW training, deployment, and future developments.

As ASW is highly sensitive, the available sources do not allow for a full exploration of this topic. However, authors affiliated with PLA academic institutions publish detailed theoretical discussions of the employment or means by which to improve processing of data collected by sensors, sometimes with input from the PLA operational community. While these authors do not necessarily represent the PLA, their writings can highlight research questions the PLA is seeking to answer and discussions within the PLA on these topics.

The PLAN recognizes that a robust combined-arms ASW system will be an indispensable part of any significant maritime operations it plans and views airborne ASW as an integral component of that system. The PLAN has acknowledged its limitations in this field and, in recent years, aggressively sought to address its quantitative gaps by rapidly expanding its fleet of fixed-wing MPRA. Its qualitative advancements are more difficult to capture with public information, but available data indicates at least some progress has been made on sensors and weapons. PLAN-affiliated researchers are focused on improving tactics, techniques, and procedures (TTPs) to make the best use of these new systems.

Rotary-Wing Anti-Submarine Warfare Platforms

The PLAN currently operates four helicopter types for shipborne ASW: the Z-18F, Z-9C, Z-9DF, and Ka-28. China reportedly tested early ASW equipment on imported French SA 321 Super Frelons and their Chinese derivative, the Z-8, but these helicopters were too large for use from PLAN combatants at the time.

The Z-18F's size limits the PLAN to operating it on larger combatants such as the Type 001 and 002 CVs, Type 075 LHAs, Type 071 LPDs, and possibly Type 055 CGs (however the dimensions of the helicopter decks on Type 055 CGs would require precise operation of Z-18 airframes to avoid collisions).[1]

China purchased a total of fourteen Ka-28 Helix-A ASW helicopters from Russia in the late 1990s and early 2000s.[2] These Helix variants are smaller than the Z-18F, allowing the PLAN to operate them from more combatants such as 054 FFs, 054A FFGs, and 052D DDGs. Notably, the PLAN operates Ka-28s only in the Eastern Theater Command.[3] The PLAN began receiving the Z-9C naval variant of the Z-9 in 2004. The Z-9C is operable from all helicopter-capable PLAN combatants, but it lacks some key ASW equipment such as magnetic anomaly detector (MAD) and sonobuoys, likely due to size and weight constraints. In recent years, the PLAN has also fielded an ASW version of its upgraded Z-9D, known as the Z-9DF, but this version would be subject to the same constraints and sensor limitations. The Z-20F naval variant of the Z-20 has not yet been fielded, but it is expected to provide the PLAN an indigenous option that is small enough to be compatible with most surface combatants but large enough to employ significant ASW capabilities.

Table 1: PLAN ASW Helicopter Size and Sensors[4]

Platform	Fuselage Length	Maximum Weight	MAD	Dipping Sonar	Sonobuoys	Surface Search Radar	EO/IR
Z-18F	23 m	13.8 tons	N	Y	Y	Y	Y
Ka-28	11.3 m	12.1 tons	Y	Y	Y	Y	Y
Z-9C/DF	12.11 m	4.5 tons	N	Y	N	Y	N**
Z-20*	20 m	10 tons	?	Y	?	Y	Y
*Naval variant not yet fielded ** Some Z-9Cs have been observed with EO/IR turrets							

Magnetic Anomaly Detectors

The only MAD-equipped helicopters currently operated by the PLAN are Ka-28s, which have APM-73V (АПМ-73В) towed magnetometers mounted under their tails. These systems consist of a magnetically sensitive component, measurement system, positioning system, power source, and a control and recording instrument.[5] The magnetically sensitive portion is towed on up to 80 meters of non-magnetic cable during operation.

[1] U.S. Army Training and Doctrine Command, Worldwide Equipment Guide (WEG), accessed 18 December 2022, https://odin.tradoc.army.mil/WEG/Asset/Z-18_ (White_Heron)_Chinese_Medium_Transport_Helicopter.

[2] *PLA Aerospace Power: A Primer on Trends in China's Military Air, Space, and Missile Forces* (Montgomery, AL: China Aerospace Studies Institute, 2022), 3rd ed., p. 145, https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Other-Topics/2022-08-15%20PLA%20Primer%203rd%20edition.pdf.

[3] *The Military Balance 2021* (London: The International Institute for Strategic Studies (IISS), February 2020).

[4] U.S. Army Training and Doctrine Command, Worldwide Equipment Guide (WEG), accessed 24 February 2023, https://odin.tradoc.army.mil/.

[5] 孙明太 [Sun Mingtai], ed., 航空反潜装备 [*Aviation Antisubmarine Equipment*], (Beijing: National Defense Industry Press, 2012), p. 236.

One Chinese ASW expert reported that the system could detect targets at a maximum of 400 meters, but its actual maximum use range was between 250 and 400 meters.[6]

Search Radar

China Electronics Technology Group Corporation's (CETC) 14th Research Institute (RI), the premier state-owned developer of military radar systems in China, manufactures the indigenous systems employed by the PLAN's fixed and rotary-wing ASW assets. Z-9Cs have been outfitted with the KLC-1 surface search radar for some time, with newer Z-9D/DFs being equipped with the KLC-3B.[7] The KLC-3B represents an iterative step forward in the adoption of a more capable surface search system to be employed by future vertical lift systems of the PLAN. CETC-14th RI advertising indicates the KLC-3B is more capable of identifying small targets in conditions with heavy sea clutter, indicating steps to improve the processing of radar signals that reduce the false alarm rate.[8] Despite this, the exact performance of this system is unknown.

Dipping Sonar

The PLAN has imported dipping sonars such as the French HS-12 and the Russian VGS-3 (ВГС-3). It reportedly purchased five Thomson Sintra HS-12 dipping sonar systems from France in the mid-1980s for use on previously imported SA 321 Super Frelon helicopters.[9] The HS-12 is an omnidirectional 12-beam dipping sonar with active modes between 12.4 and 15.2 kHZ and passive modes between 7-20 kHZ.[10] China also purchased several AS 565 ASW helicopters from France in the 1980s that were likely equipped with additional HS-12 systems.[11] One source claims the PLAN used the original five HS-12s on larger SA 321s and variants HS-12H or HS-12C-H on the smaller AS 565s, but provides no significant details about these variants.[12]

China acquired Russian VGS-3 (ВГС-3) dipping sonars with the fourteen Ka-28 ASW helicopters from Russia in the late 1990s and early 2000s. The VGS-3 operates in five channels between 9 and 11 kHz, has both passive and multiple active modes, and can reportedly detect targets as far as 20 kilometers away.[13] These sonars do not appear to have been used in any other Chinese helicopters.

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[6] Ibid., p. 236.

[7] 图文：国产 KLC-1 直升机搜索雷达 ["Photo: Domestic KLC-1 helicopter search radar"], 新浪军事 [Sina Military], 3 April 2008, http://mil.news.sina.com.cn/p/2008-04-03/0934493302.html; Anh Nguyễn Đăng, "Radar hàng không KLC -7 cho máy bay AWACS tiên tiến của Trung Quốc," https://www.youtube.com/watch?v=GbN62q6g9gQ&t=80s, 21 November 2018; 瞄准蔡小姐的沱江舰! 中国直 9D 的雷达性能逆天 ["Aim at Miss Cai's Tuojiang ship! The Radar Performance of China Z-9d Is Against the Sky"], 新浪军事 [Sina Military], 10 April 2017, http://slide.mil.news.sina.com.cn/h/slide_8_203_49613.html#p=1.

[8] Anh Nguyễn Đăng, "Radar hàng không KLC -7 cho máy bay AWACS tiên tiến của Trung Quốc," Youtube, 21 November 2018, https://www.youtube.com/watch?v=GbN62q6g9gQ&t=80s.

[9] 马景峰 [Ma Jingfeng], 航空吊放声纳接收阵收扩系统设计与分析 ["Design and Testing of Aviation Dipping Sonar Receiving Array Retraction/Protraction System"], Master's Thesis, 哈尔滨工程大学 [Harbin Engineering University], 2018, p. 9.

[10] Sun, *Aviation Antisubmarine Equipment*, p. 163.

[11] "AS 565 PANTHER / Z-9C NAVAL HELICOPTER," SinoDefence.com, 11 June 2006, https://web.archive.org/web/20070225085300/http://www.sinodefence.com/airforce/helicopter/z9c.asp.

[12] Ma, "Design and Testing of Aviation Dipping Sonar Receiving Array Retraction/Protraction System," p. 9.

[13] Sun, *Aviation Antisubmarine Equipment*, p. 172.

Figure 1: VGS-3 Dipping Sonar on Ka-28[14]

Authoritative details on indigenous Chinese dipping sonars are limited, but various sources credit several advancements to marine acoustics expert Ma Yuanliang (马远良), who reportedly helped develop dipping sonars such as the HDS-1, SKD-41/41A, H/SKD-143, and H/SKD-144.[15] The PLAN reportedly sent Ma to France in the late 1970s to study French dipping sonars and air-dropped torpedoes, after which he returned to China and developed the SKD-41A.[16] This sonar was a significant improvement on the earlier SKD-41, featuring a greatly reduced working frequency, 360-degree search, precise localization, and preprocessing capabilities.[17]

In the 1990s, Ma Yuanliang was reportedly involved in developing two dipping sonars for “an imported model of ASW helicopter,” presumably the AS 565 and/or Z-9. The systems were tested at Northwestern Polytechnical University (西北工业大学) in Xi’an, an acoustic testing range at Qiandao Lake (千岛湖) in Zhejiang Province, a Hefei helicopter testing site, and sea testing ranges at Qingdao and Dalian before being delivered to the PLAN in 1997 and 1999, respectively.[18] While the exact sonars are not named, they are likely the H/SKD-143 and H/SKD-144. Other sources associate Ma with these systems, and his Baidu Baike entry claims he won an award in the year 2000 for the “X/XX-144 dipping sonar.”[19]

A 2018 Harbin Engineering University (哈尔滨工程大学) master’s thesis on dipping sonars details the H/SKD-143, which it claims is also known as the H/SKD-3.[20] The thesis implies the author’s employer, China Shipbuilding Industry Corporation (中国船舶重工股份有限公司/CSIC) subsidiary Shenyang Liaohai Equipment Co. LLC (沈阳辽海装备有限责任公司), was involved in research on the system.

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[14] "Helicopters II,” Chinese Military Aviation, updated 4 February 2023, http://chinese-military-aviation.blogspot.com/p/helicopters-ii.html.

[15] 马远良 [“Ma Yuanliang”] *Shaanxi Provincial Library*, 1 June 2017, https://www.sxlib.org.cn/dfzy/gczy/sqwxn/dfrw/ys/201706/t20170601_770836.htm.

[16] 马远良院士-大智大勇书写水声世界的传奇 [“Academician Ma Yuanliang—Wise and Brave Legend in the Marine Acoustics World”] Wisdom Blue Oceanographic Engineering Institute, 23 August 2019, http://www.i3smot.com/academician/47.html.

[17] Ma, “Design and Testing of Aviation Dipping Sonar Receiving Array Retraction/Protraction System,” p. 8.

[18] “Academician Ma Yuanliang—Wise and Brave Legend in the Marine Acoustics World”

[19] “Ma Yuanliang,” Baidu, https://baike.baidu.com/item/马远良/2732332.

[20] Ma, “Design and Testing of Aviation Dipping Sonar Receiving Array Retraction/Protraction System,” p. 11.

According to the thesis, the system weighs 260 kg in total, features 16 horizontal beams, and operates between 2.73 kHz and 3.28 kHz in active mode and between 0.1 and 4.0 kHz in passive mode. It also features a photo of the system that appears identical to systems seen in use on PLAN Z-9Cs during training in the mid-2010s.[21] A similar system may also have been seen on the Z-9 ASW helicopter in March of 2021.[22] The H/SKD-143 bears some resemblance to the Cormorant dipping sonar developed by the British Plessey Naval Systems in the 1980s, but more substantive comparisons are limited by the lack of publicly available specifications.

Figure 2: H/SKD-143 Dipping Sonar (left)[23] and similar system on PLAN Z-9C (right)[24]

The thesis briefly mentions additional dipping sonar models but does not elaborate other than associating them with other systems, listed by generation. See Table 2 below. The thesis does not mention the HDS-1, which other sources claim as China's first dipping sonar.

[21] "Helicopters I," Chinese Military Aviation, updated 24 May 2021, http://chinese-military-aviation.blogspot.com/p/helicopters-i.html.

[22] "Helicopters I," Chinese Military Aviation, updated 3 March 2023, http://chinese-military-aviation.blogspot.com/p/helicopters-i.html.

[23] Ma, "Design and Testing of Aviation Dipping Sonar Receiving Array Retraction/Protraction System," p. 12.

[24] "Helicopters I," updated May 24, 2021.

Table 2: Reportedly Indigenous PRC Dipping Sonars

Generation[25]	Model
Not Listed	HDS-1
First	H/SKD-41
Second	H/SKD-41A
	H/SKD-42*
Third	H/SKD-95*
	H/SKD-143
	H/SKD-144
*No additional information provided on these systems.	

The Harbin Engineering University thesis was focused on improving the retractable arm mechanisms for dipping sonars and briefly discussed testing an unnamed prototype dipping sonar in late 2017 at both the "721 Testing Station" at Qiandao Lake and from a PLAN vessel in the Yellow Sea.[26] The at-sea testing reportedly included a PLAN submarine, which was prepositioned and had cut off communications the night before the test. The testing was mostly acoustic in nature, but the paper only discussed retractable arm tests, such as opening and closing in air, on the surface, and underwater. Both lake and sea testing were reportedly successful, but revealed a need for stronger, higher quality materials for the arm mechanisms. The paper showed digital models and photos of the prototype, which included eight arms with two sensors each, for a total of 16 sensors.

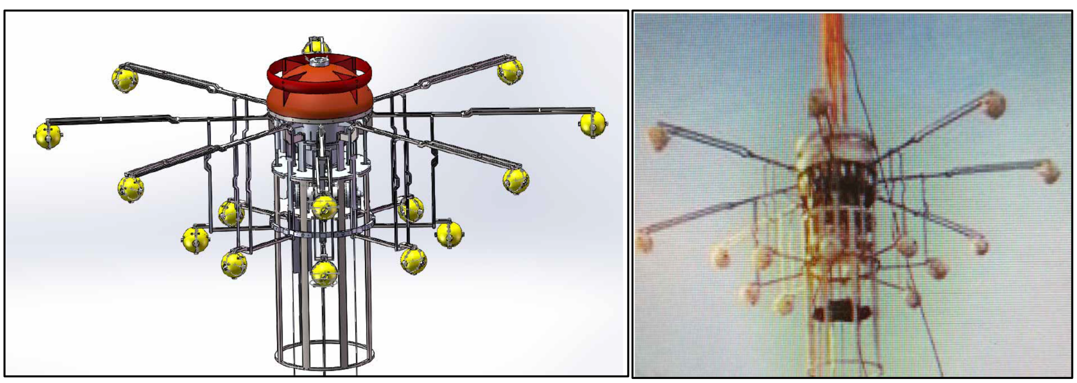

Figure 3: Unidentified Dipping Sonar Tested with PLAN in 2017[27]

A 2003 master's thesis from Northwestern Polytechnical University (where Ma Yuanliang reportedly researched several dipping sonars) describes in detail a system for emulating target signals for the H/SKD-144 for maintenance or training, but it also provides some details on the H/SKD-144 itself.[28]

[25] Ma, "Design and Testing of Aviation Dipping Sonar Receiving Array Retraction/Protraction System," p 8.

[26] Ibid., p. 51.

[27] Ibid., pp. 14, 51.

[28] 郑琨 [Zheng Kun] SI-144 目标模拟器研制 ["Development of SI-144 Target Emulator",] Master's Thesis, 西北工业大学 [Northwestern Polytechnical University], 2003.

According to the thesis, the system includes a 12-hydrophone transducer array with submerged pre-processer and is operable in four modes: active, passive, passive pinger, and “B-T.”[29]

A section that outlines specifications for target signals indicates several parameters that are identical to those of the HS-12, such as both active and passing working frequencies, pulse width, etc.[30] It is not clear whether this was a type of obfuscation or if the system actually shares those characteristics with the HS-12. If accurate, the H/SKD-144 seems unimpressive for its time, especially compared with the H/SKD-143, which was reportedly developed simultaneously.

Sonobuoys

PLAN Z-18F and Ka-28 helicopters employ sonobuoys as key ASW equipment, but Z-9Cs have not been observed using them, presumably due to space and weight limitations. As with dipping sonar, the PLAN likely uses both imported and domestically produced sonobuoys and processing systems, but details on Chinese indigenous models are limited.

Figure 4: Z-18F Search Radar, Dipping Sonar, and Sonobuoy Tubes[31]

[29] This abbreviation is not elaborated on but may be a reference to bathythermograph functionality.

[30] Zheng, “Development of SI-144 Target Emulator,” p. 4.

[31] "Helicopters III,” Chinese Military Aviation, updated 17 March 2022, http://chinese-military-aviation.blogspot.com/p/helicopters-iii.html.

China reportedly purchased five Thomson Sintra LAMPARO sonobuoy processing and control systems from France in the mid-1980s along with the HS-12 dipping sonars mentioned above,[32] possibly as an integrated set known as the HS312S or TSM8241 system.[33] It is not clear whether this purchase included sonobuoys themselves, but the LAMPARO system is compatible with a variety of U.S. and French sonobuoys.[34] If sonobuoys were provided, they would presumably have been French-produced models such as the DSTV-7, DSTV-4M/N, and DSTA-3.

The five Ka-28 ASW helicopters China purchased from Russia in the late 1990s (and likely the additional nine the following decade) were equipped with the Izumrud (Emerald) search system.[35] The Izumrud system uses RGB-16 passive omnidirectional sonobuoys, but it is not clear whether China obtained these in the purchase as well. An undated catalogue from Ukrainian state-owned arms trading company Ukrspecexport claims the RGB-16 operates in the 2-5 kHz frequency range.[36]

The Aviation Industry Corporation of China (AVIC) has reportedly developed at least two sonobuoys, the SQ-4 and SQ-5.[37] A series of images of what appear to be these models on display at an unknown event show the two are of similar diameter but the SQ-5 is slightly taller and labeled a bathythermograph buoy.[38] According to a 2021 PLA news article on sonobuoys, bathythermograph buoys are usually dropped before search buoys to determine ocean conditions, such as salinity and temperature conditions at different depths, and ideal search buoy arrays.[39] Although more often associated with the PLAN's KQ-200 fixed-wing ASW platform, SQ-4 and SQ-5 sonobuoys are reportedly also used on Z-18F helicopters.[40]

AVIC's Luoyang Electro-optical Equipment Research Institute (洛阳电光设备研究所) has filed for several patents in recent years related to sonobuoy technology, including for an improved outer body, a better buoy management system (discussed in the Fixed-Wing Sonobuoy section below), improved localization methods, and multimodal buoy-to-aircraft communications.[41] However, these patents do not specify exact sonobuoy system or model numbers associated with these patent applications.

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32 Ma, "Design and Testing of Aviation Dipping Sonar Receiving Array Retraction/Protraction System," p. 9.

33 Sun, *Aviation Antisubmarine Equipment*, p. 188.

34 Ibid.

35 "Russia Starts Ka-28 ASW Deliveries to China," Shephard Media, 9 October 2009, https://www.shephardmedia.com/news/defence-helicopter/russia-starts-ka-28-asw-deliveries-to-ch/.

36 "NAVAL EQUIPMENT AND ARMAMENT CATALOGUE," The State Company Ukrspecexport, Not Dated, https://www.ukrspecexport.com/uploads/files/Categories/pdf_4/7250c8.pdf.

37 Xavier Vavasseur, "New Details On China's KQ-200 Maritime Patrol Aircraft", 29 April 2019, *Naval News*, https://www.navalnews.com/naval-news/2019/04/new-details-on-chinas-kq-200-maritime-patrol-aircraft/.

38 Jeffrey Lin and P.W. Singer, "China's Submarine Hunting Plane Has A Giant Stinger," *Popular Science*, 24 February 2015, https://www.popsci.com/y-8q-chinas-submarine-hunting-plane-has-giant-stinger/; and 公司深度报告●军工行业 [“Company Deep Report ● Military Industrial Industry”] China Galaxy Securities, 17 December 2020, https://pdf.dfcfw.com/pdf/H3_AP202012231442965695_1.pdf?1608715990000.pdf.

39 李姗 [Li Shan] and 王皓凡 [Wang Haofan], 声呐浮标 ["Sonobuoys"], 中国军网 [*China Military Online*], 29 October 2021, http://www.81.cn/jfjbmap/content/2021-10/29/content_301933.htm.

40 Sidharth Kaushal, "Chinese Anti-Submarine Warfare Capabilities: A Blunt but Evolving Tool," RUSI Defense Systems, 25 July 2022, https://www.rusi.org/explore-our-research/publications/rusi-defence-systems/chinese-anti-submarine-warfare-capabilities-blunt-evolving-tool.

41 卢万崎 [Lu Wanqi], 李小帅 [Li Xiaoshuai], 崔岩 [Cui Yan], 鲁宏捷 [Lu Hongjie], and 张贤春 [Zhang Xianchun], 声纳浮标 [Sonobuoy], PRC Patent CN114084285A, filed February 25, 2022, Status Pending; 刘金博 [Liu Jinbo], 崔岩 [Cui

Figure 5: SQ-4 and SQ-5 Sonobuoys[42]

Torpedoes

The Z-9C/DF and Z-18F are both able to accommodate lightweight torpedoes such as the Yu-7, although this may require tradeoffs in terms of other ASW equipment, especially on the smaller Z-9C/DF. The Z-18F can reportedly carry up to four lightweight torpedoes,[43] but it has only been observed with a maximum of two.[44] The Z-9C is limited to carrying one[45] or two.[46] Despite speculation that they could employ the newer pump jet-propelled Yu-11, no pump jet torpedoes have yet been observed on PLAN helicopters.[47] PLAN ASW Ka-28s can also accommodate weapons such as torpedoes and depth charges, possibly at the expense of some sensor capabilities. Like the Russian Ka-27PL on which they are based, PLAN Ka-28s may operate in pairs where one is focused on detecting and tracking enemy submarines while the other is equipped to engage it.[48]

Yan], 杨庆坤 [Yang Qingkun], 梅成 [Mei Cheng], and 李小帅 [Li Xiaoshuai], 管理声纳浮标的系统 [“Sonobuoy Management System”] PRC Patent CN114114281A, filed November 23, 2021, Status Pending; 赵新芳 [Zhao Xinfang], 曹文 [Cao Wen], 王永恒 [Wang Yongheng], 李欢利 [Li Huanli], and 梅成 [Meicheng.], 一种被动全向浮标 LOFIX 定位方法 [“Passive Omnidirectional Sonobuoy LOFIX Positioning Method”], PRC Patent CN114114278A, filed November 23, 2021, Status Pending; and 鲁宏捷 [Lu Hongjie], 一种航空声呐浮标多模式无线电调频技术 ["Multimode Radio Frequency Modulation Technology of Airborne Sonar Buoy"], 无线电工程 [*Radio Engineering*], vol. 52, no. 5 (2022), pp. 714-718.

[42] Lin and Singer, “China's Submarine Hunting Plane Has A Giant Stinger"; and “Company Deep Report ● Military Industrial Industry."

[43] Jane's International Defence, “Undersea dragon: Chinese ASW capabilities advance,” *Janes International Defence Review*, 3 August 2017.

[44] "Helicopters III,” Chinese Military Aviation, updated 17 March 2022, http://chinese-military-aviation.blogspot.com/p/helicopters-iii.html.

[45] 铸剑 | 揭秘中国鱼-7 系列反潜鱼雷 ["Casting a Sword | Demystifying the Chinese Yu-7 Series Anti-submarine Torpedoes"], 澎湃新闻 [*The Paper*], 15 August 2015, https://www.thepaper.cn/newsDetail_forward_1359942.

[46] "Helicopters I,” Chinese Military Aviation, updated 24 May 2021, http://chinese-military-aviation.blogspot.com/p/helicopters-i.html.

[47] “Undersea dragon: Chinese ASW capabilities advance.”

[48] "[Actu] Modernisation des Kamov Ka-27PL," Red Samovar, updated 3 March 2017, https://redsamovar.com/2017/03/03/dossier-modernisation-des-kamov-ka-27/.

Fixed-Wing Anti-Submarine Warfare Platforms

China's first fixed-wing maritime patrol aircraft was the domestically-designed SH-5 seaplane, which entered service in 1986 and could be equipped with ASW equipment such as a magnetic anomaly detector and sonobuoys.[49] One source even claimed that the PLAN used H/SKD-41 dipping sonar on them before appropriate rotary-wing platforms were available.[50] This seaplane no longer appears to be in service.

Currently, the PLAN's only fixed-wing ASW platform is the KQ-200, also known as Y-8Q or GX-6, which entered service in 2017.[51] As of early 2023, there appear to be over 20 KQ-200s fielded across all three theater command naval components (Northern, Eastern, and Southern).[52] The land-based KQ-200 provides the PLAN with higher speeds, longer ranges/endurance, and greater capacity for ASW equipment and crew compared to rotary-wing ASW platforms. The KQ-200 reportedly can reach speeds of up to 600 km/h, operate for 8+ hours, and has a range of about 5,000 km.[53] The KQ-200's key ASW components include a surface search radar, a large MAD in the tail, sonobuoy system, and an electro-optical turret.[54] Since 2020, rumors and images have circulated of a "next generation ASW aircraft," potentially known as the Y-9Q, being developed for the PLAN.[55] Major changes from the KQ-200 appear to be a shorter MAD stinger and larger nose cone instead of chin-mounted radar, but authoritative details have been sparse.[56]

The PLAN KQ-200's crew includes two pilots, a tactical commander, and a mix of four total radar technicians, sonar technicians, and electro-optical technicians. No mention was found of dedicated MAD technicians, but they are likely included in the crew.

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49 Peter Wood and Roger Cliff, *Chinese Airborne C4ISR*, (Montgomery, AL: China Aerospace Studies Institute, 2020), p. 9, https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Infrastructure/2020-12-17%20PRC%20Airborne%20C4ISR_eBook.pdf.

50 Ma, "Design and Testing of Aviation Dipping Sonar Receiving Array Retraction/Protraction System," p. 8.

51 Andreas Rupprecht, "Images confirm Y-8Q MPAs in service with China's Northern Theatre Command," *Janes*, 6 August 2019, https://www.janes.com/article/90310/images-confirm-y-8q-mpas-in-service-with-china-s-northerntheatre-command.

52 "Surveillance Aircraft I," Chinese Military Aviation, updated 8 February 2023, https://chinese-military-aviation.blogspot.com/p/surveillance-aircraft-i.html.

53 吴芳 [Wu Fang], 吴铭 [Wu Ming], 高青伟 [Gao Qingwei], and 刘首善 [Liu Shoushan], 反潜机磁探仪跟踪航路规划建模与仿真 ["Modeling and Simulating ASW Aircraft MAD Tracking Route Planning"], 火力与指挥控制 [*Fire Control and Command Control*], vol. 45, no. 11 (2020), p. 14; 潘磊 [Pan Lei] and 潘宣宏 [Pan Xuanhong], 反潜巡逻机与无人艇应召反潜中协同声纳搜潜研究 ["Research on Coordinating Sonar Search between ASW Aircraft and Unmanned Surface Vehicles in On-Call ASW"], 火力与指挥控制 [*Fire Control and Command Control*], vol. 46, no. 8 (2021), p. 84.; and J. Michael Dahm, "Special Mission Aircraft and Unmanned Systems," *Johns Hopkins University APL*, October 2020, accessed 16 March 2023, p. 29, https://apps.dtic.mil/sti/pdfs/AD1128646.pdf,

54 军迷天下 [Military Fan Realm], 直击演训场：超低空飞行 揭秘解放军"海天猎鲨人"的必杀技！反潜利器 中国首款固定翼反潜巡逻机大量细节披露！| 军迷天下 ["Live from Training Ground: Super Low Altitude Flight Reveals the Killing Blow of the PLA's "Naval Aviation Sub Hunters"! ASW Blade. Many details revealed about China's First Fixed-Wing ASW Patrol Aircraft | Military Fan Realm], YouTube video, 8:37, 25 April 2021, https://www.youtube.com/watch?v=cy6KTnQku_s.

55 "Surveillance Aircraft II," Chinese Military Aviation, updated 1 February 2023, http://chinese-military-aviation.blogspot.com/p/surveillance-aircraft-ii.html.

56 Ibid.

Pilots operate from the front cabin while tactical commanders lead other operators in the mission cabin and are responsible for command of ASW operations.[57] Tactical commanders coordinate between technicians and pilots, for example to adjust course for strikes on enemy targets or recommending the best altitude for sensor operation given weather or other operational factors.[58]

PLA sorties into Taiwan's air defense identification zone (ADIZ) have often included KQ-200s, which are likely used to monitor potential submarine "choke points."[59] Additionally, they have reportedly operated in the South China Sea. For example, in 2020, at least one KQ-200 was deployed to Fiery Cross Reef.[60] In March 2022, one KQ-200 probably crashed while operating in the Gulf of Tonkin.[61]

Magnetic Anomaly Detection

While information directly related to the MAD equipment used on the KQ-200 is tightly controlled, some PLA academic research and relevant patent filings may provide clues about capabilities or development trends of indigenously produced MAD systems. A 2020 study by authors affiliated with the Naval Aviation University (海军航空大学) and PLAN Unit 92697 assessed optimal flight routes for fixed-wing MAD search.[62] The authors fixed several parameters when running simulations, including a flight altitude target of 100 meters and an effective MAD probe range of 500 meters. This probe range may not indicate exact operational capabilities, but it would need to be close enough to make the simulations useful, and the involvement of an author from an operational unit may indicate the need to fly at low altitudes to detect submerged targets.

Patent filings from CETC 49th RI indicate it is involved in research to improve MAD capabilities. For example, in 2020, the Institute applied for a patent on components to enable an atomic magnetometer to sense the direction of a target rather than just its existence.[63] According to the filing, previous research on highly-sensitive atomic magnetometers had focused on scalar results (i.e. only the magnitude of a target's magnetic field), but could not provide vectors (i.e. magnitude and direction). MAD is already a shorter-range capability usually used for more precise positioning after other sensors have provided a rough search area, but any additional information could potentially give operators an edge during search operations.

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[57] P.R.C. Forces, 解放军海军航空兵战术指挥长考核 ["PLAN Aviation Tactical Commander Evaluations"], YouTube video, 1:43, September 26, 2022, https://www.youtube.com/watch?v=nKzB7-RH9zs.

[58] 陈晓杰 [Chen Xiaojie] and 高宏伟 [Gao Hongwei], 双鹰砺翅啸海空 ["The Sharp Wings of Two Eagles Whistle Over the Ocean Sky"], 中国军网 [*China Military Online*], 21 October 2022. http://www.81.cn/jfjbmap/content/2022-10/12/content_325582.htm.

[59] Olli Pekka Suorsa, "The Anti-Submarine Warfare Component of China's Sorties in Taiwan's ADIZ," *The Diplomat*, 4 November 2021, https://thediplomat. com/2021/11/the-anti-submarine-warfare-component-of-chinas-sorties-intaiwans-adiz/.

[60] Dahm, "Special Mission Aircraft and Unmanned Systems," p. 12.

[61] Olli Pekka Suorsa and Adrian Ang U-jin, "The Changing Pattern of China's Aircraft Incursions Into Taiwan's ADIZ, *The Diplomat*, 13 May 2022", https://thediplomat.com/2022/05/the-changing-pattern-of-chinas-aircraft-incursions-into-taiwans-adiz/.

[62] Wu, et al., "Modeling and Simulating ASW Aircraft MAD Tracking Route Planning, p. 11-15.

[63] 孙立凯 [Sun Likai], 宋尔冬 [Song Erdong], 王辉 [Wang Hui], 毕佳宇 [Bi Jiayu], 王亚彬 [Wang Yabin], 徐兴晔 [Xu Xingye], and 邵志强 [Shao Zhiqiang], 可用于矢量探测的原子磁力仪探头 ["Atomic MAD Probe that Can be Used for Vector Measurement"], PRC Patent CN111398873A, filed 20 March 2020, Status Pending.

Another 2020 filing from the CETC 49th RI focuses on improving the signal-to-noise ratio when using atomic magnetometers to enable more sensitive measurements.[64]

Sonobuoys

The only sonobuoys publicly reported to be used on KQ-200s are the AVIC SQ-4 and SQ-5 sonobuoys, which are briefly introduced in the rotary-wing sonobuoy section above.[65] The KQ-200 however, is widely reported to hold 100 of these sonobuoys, which it deploys from four rotary cabinets through corresponding openings in its fuselage. While direct references to SQ-4 and SQ-5 performance are likely unavailable, some capabilities are loosely implied in research published by PLAN-affiliated authors. A study by PLAN Command College researchers describing a model for coordinating ASW between surface vessel and fixed-wing aircraft presumed their sonobuoys had a 2 km sonar range, 2 hour operating limit, and 60 km range for communications with the aircraft.[66] A similar article written by individuals affiliated with the same institution on coordinating ASW between unmanned surface vehicles (USV) and fixed-wing aircraft reported that an unspecified model of sonobuoy could work for 6-8 hours in passive mode or 2-3 hours in active mode, and that it could detect targets as far as 10 km in passive mode. Another study by analysts from the PLAN Naval Aviation University and PLA Unit 91388 (a Testing Area in Zhanjiang[67]) on the optimal working depth of passive sonobuoys in shallow seas (where sonar detection is more challenging) indicated optimal ranges of about 1 to 1.7 km depending on conditions.[68]

[64] 孙立凯 [Sun Likai], 宋尔冬 [Song Erdong], 王辉 [Wang Hui], 徐兴烨 [Xu Xingye], 毕佳宇 [Bi Jiayu], 邵志强 [Shao Zhiqiang], and 陈亚洲 [Chen Yazhou], 一种基于光虚拟磁场技术的原子磁力仪探 [“Atomic Magnetometer Probe Based on Optical Virtual Magnetic Field Technology”], PRC Patent CN112180302A, filed 28 September 2020, Status Pending.

[65] Xavier Vavasseur, “New Details On China’s KQ-200 Maritime Patrol Aircraft”, 29 April 2019, *Naval News*, https://www.navalnews.com/naval-news/2019/04/new-details-on-chinas-kq-200-maritime-patrol-aircraft/.

[66] 唐晨 [Tang Chen]，孙秀文 [Sun Xiuwen]，and 吴刚 [Wu Gang], 水面舰艇与反潜巡逻机协同检查搜潜队形配置研究 ["Research on Formation Configurations for Cooperative Submarine Search between Surface Vessels and ASW Aircraft"], 指挥控制与仿真 [*Command Control & Simulation*], vol. 44, no 2 (2022), p 36.

[67] *2021 Directory of Military Personalities,* (Washington, D.C.: Defense Intelligence Agency, March 2021), p.103.

[68] 郁红波 [Yu Hongbo], 鞠建波 [Ju Jianbo], and 杨少伟 [Yang Shaowei], “浅海”条件下声纳浮标最佳入水深度 ["Optimal Sonobuoy Depth under ‘Shallow Seas’ Conditions"], 探测与控制学报 [*Journal of Detection & Control*], vol. 42, no. 5 (2020), pp. 100-101.

Figure 6: Sonobuoy Cabinet on KQ-200[69]

A 2022 AVIC patent application for an improved sonobuoy management system includes a discussion of current systems, probably on both PLAN fixed- and rotary-wing ASW assets.[70] For example, the current system(s) requires a complicated and labor-intensive series of manual button presses to configure sonobuoy parameters such as radio working frequency, working depth, working time, and pulse form to fit maritime conditions before deployment. Data is shared between the sonobuoy rack or tube (likely on fixed or rotary-wing aircraft, respectively) and launch system, but not to the display and control system. This means the display and control system is unaware of whether a sonobuoy is on the rack or has been launched, what type of sonobuoys have been launched, or the parameters of any launched sonobuoys. Instead, operators must manually input this data into the display and control system. The application describes a new management system to better share and synchronize data across these system components.

Weapons

The KQ-200 features a more robust weapons loadout than PLAN ASW helicopters. It can reportedly be equipped with as many as ten lightweight torpedoes such as the Yu-7 in its weapons bays.[71] KQ-200s are likely better equipped than helicopters to accommodate the larger pump jet-propelled Yu-11 torpedo, although its use has not been officially confirmed. In June 2023, PLA media highlighted a PLAN Southern Theater Command KQ-200 dropping an unspecified model of torpedo that may have featured a pump jet rather than propeller.

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[69] "Surveillance Aircraft I," Chinese Military Aviation, updated 28 February 2023, https://chinese-military-aviation.blogspot.com/p/surveillance-aircraft-i.html.

[70] Liu Jinbo et al, Sonobuoy Management System, PRC Patent CN114114281A.

[71] "Casting a Sword | Demystifying the Chinese Yu-7 Series Anti-submarine Torpedoes."

The tactical commander, a PLAN Lieutenant who appeared to release the torpedo, indicated that this was his first time participating in the live drop of a torpedo.[72]

While KQ-200 torpedo training appears to be somewhat rare, the PLAN trains often on using depth charges.[73] These aircraft are reportedly equipped with depth charges with a guidance system in the front section and a rudder to acoustically seek targets rather than detonating at a set depth.[74] This type of depth charge could be used more sparingly with a higher hit rate rather than dropping traditional depth charges in mass in hopes of contacting a target.

Employment

The PLA regards aerial ASW assets as components of a larger ASW system that combines underwater, seabed, and surface platforms into a system-of-systems intended to defeat its enemy's system-of-systems. This system-of-systems is intended to coordinate multiple platforms using complementary sensors, conduct coordinated handoffs, supply an on-demand ASW aviation capability to surface formations, protect high-value surface assets or formations, block or monitor access in key maritime areas, protect ports, assist in mine clearance operations, and be capable of forcing submarine contacts out of an area.

PLA academic discussions do not necessarily demonstrate commonly held assumptions or agreed upon analysis within the military about how these platforms will be used. But they do offer insights into the types of discussions and issues prioritized by the PLA and, potentially, operational concepts at a very basic level. Indeed, some studies from PLA academic institutions include authors from operational units, making them more operationally relevant. These sources are highlighted where appropriate. Some articles written by PLA affiliated individuals employ dated or basic employment concepts in their simulations. This should be interpreted as a baseline of capabilities or understanding of modern ASW aviation TTPs and not the current development or understanding of PLA airborne ASW employment concepts.

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[72] 新闻直播间 [Live News], 海军航空兵展开反潜巡逻机实投鱼雷训练 ["Naval Aviation Launches Anti-submarine Patrol Aircraft Torpedo Drop Training"], CCTV, 27 June 2023, https://tv.cctv.com/2023/06/27/VIDEmT4oudP8Fg5NBbOuyiSi230627.shtml.

[73] 秦钱江 [Qin Qianjiang] and 高宏伟 [Gao Hongwei], 南部战区海军航空兵某团实投深弹训练：海空"猎鲨"响惊雷 ["A Naval Aviation Regiment in the Southern Theater Command Practices Depth Charge Training: 'Shark Hunting' Thunders the Sea Air"], 中国军网 [China Military Online], 30 September 2021, http://www.81.cn/zq/2021-09/30/content_10094936.htm.; and Chen and Gao, "The Sharp Wings of Two Eagles Whistle Over the Ocean Sky."

[74] 张良 [Zhang Liang], 航空反潜守海固疆 ["Airborne ASW Guarding the Sea and Borders"], 生命与灾害 [*Life and Disaster*], June 2020, p. 21.

Anti-Submarine Warfare Operations

When discussing multiple aircraft engaging in coordinated ASW operations, authors affiliated with the Naval Submarine Academy and the then Naval Aeronautical and Astronautical College[75] outline the overall mission of ASW as destroying enemy submarines or preventing them from carrying out combat operations.[76] According to the authors, the main tasks conducted by the airborne component include: (1) escorting large fleet formations to ensure their safety, and conducting ASW sweeps to sanitize an area prior to surface groups entering the area; (2) conducting ASW patrols to protect surface forces in port, at naval bases, or at standby points; and (3) driving away or attacking discovered enemy submarine targets and providing support and coverage for strategic nuclear submarines to "transit straits" (出海峡).[77] According to a separate analysis, other missions for airborne ASW forces include "closing entry points" (封闭入口)—possibly a reference to monitoring or preventing enemy access to key straits—and comprehensive ASW alerts.[78] The authors of this study place emphasis on the vulnerability of surface vessels when transiting combat areas and assembling formations, indicating a need for ASW support at these times.[79]

Operational preparation and operational implementation are identified as two key phases for ASW aviation operations. The operational preparation phase involves clarifying the responsibilities of each aerial grouping, outlining and likely coordinating which aircraft is responsible for which section of the operational area, identifying takeoff and assembly areas, and coordinating shift change plans for aircraft and plans to conduct handoffs between aircraft during shift changes.[80] Other components of the preparation phase include reviewing the enemy's assessed disposition, required total time on station and number of aircraft, sea state and weather conditions, and search methods.[81]

The operational phase is composed of searching for or tracking submarines to drive them out of an area or engage them with weapons. Academic discussions of this phase focus on a combination of aircraft with a preference for using at least a pair of aircraft with complimentary sensors to enable one of them to engage targets, or pairing a guiding aircraft (引导机) transmitting detailed target information with an attack aircraft (攻击机) to conduct an attack on the target.[82]

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[75] Also known as the Navy Aviation Engineering Academy, in 2017 this school was merged with the Naval Flight Academy to become the Naval Aviation University. For more information, see Kenneth Allen and Mingzhi Chen, *The People's Liberation Army's Academic Institutions*, (Montgomery, AL: China Aerospace Studies Institute, 2020), p. 130, https://www.airuniversity.af.edu/CASI/Display/Article/2216778/the-peoples-liberation-armys-academic-institutions/.

[76] 吴杰 [Wu jie], 孙明太 [Sun Mingtai], and 刘海光 [Liu Haiguang], 反潜机协同作战样式及关键问题研究 ["Modes and Critical Issues in Cooperative Operation for Anti-Submarine Aircraft"], 国防科技 [*National Defense Science and Technology*], vol. 37, no. 2 (April 2016), p. 101.

[77] Ibid., p. 101.

[78] 吴芳 [Wu Fang], 吴铭 [Wu Ming], and 高青伟 [Gao Qingwei] 基于综合作战区域的舰机协同反潜模型及仿真 ["Models and Simulations for the Ship-Heli Cooperating Anti-submarine Based on Integrated Combat Zone"], 舰船电子工程 [*Ship Electronic Engineering*], vol. 39, no. 7 (2019), p. 82.

[79] Ibid., p. 83.

[80] Wu, Sun, and Liu, "Modes and Critical Issues in Cooperative Operation for Anti-Submarine Aircraft," p. 101.

[81] Ibid.

[82] Ibid., p. 102.

In addition to pairing aircraft of the same type, pairing aircraft of different types is described by PLAN-affiliated authors as allowing for a certain level of flexibility. Pairing patrol aircraft and helicopters together is described by PLAN-affiliated authors as enabling the fixed-wing platform to conduct broader area searches and the helicopters to fix targets and attack them.[83] Fixed-wing aircraft and helicopters can be layered to play to the strength of each platforms operational range, sensor range, and optimal altitude for operations to allow for a more effective combination of these systems.

When engaging targets with depth charges, PLAN-affiliated authors argue that aircraft should be grouped in pairs to conduct a parallel bombardment while flying over the target.[84] When engaging a target with torpedoes, they propose that aircraft engage a target from the front along its assessed course, allowing for the torpedo to be within maximum effective range and outside of the minimum distance needed to arm.[85]

Training Trends and Observations

Descriptions of training exercises in PLA media have become less and less forthcoming with actual tangible discussion of tactical improvements or discussions of advancements in TTPs developed, but the available sources do suggest general improvements in TTPs, organization, and training realism. The concept of combining different types of PLAN assets to conduct ASW began appearing around the 2015/2016 PLA reorganization, with references in *People's Navy* (人民海军) from 2015 emphasizing the importance of coordinating ASW operations between airborne assets and surface vessels to effectively conduct ASW operations.[86] During this time period, PLAN ASW aviation was publicizing training to track submarines using acoustic and electromagnetic decoys.[87] More recently, *People's Navy* articles indicate that the PLAN has begun training for operations in contested airspace,[88] which is possibly combined with other contested conditions to make a more complicated training environment.

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[83] Ibid.

[84] Ibid.

[85] Ibid.

[86] 丁会柱 [Ding Huizhu], 孙井位 [Sun Jingwei], and 王晶[Wang Jing] "准星"瞄向海战-北航部队开展实战化训练闻思录["'Crosshairs' Aiming at Naval Warfare- Northern Naval Aviation Troops Carry Out Practical Training"], 人民海军 [*People's Navy*], 7 July 2015, p. 2; 李胜之 [Li Shengzhi], 王庆厚 [Wang Qinghou], 李丁 [Li Ding], and 张剑 [Zhang Jian], 联训,实战化的"砺兵台" 北海舰队某基地组织辖区联合防卫作战演练纪实, ["Joint Training, Warlike Conditions 'Sharpening the Soldiers'——Documentary Of the Joint Defense Combat Exercise in The Area Under the Jurisdiction of a Base in the North Sea Fleet"], 人民海军 [*People's Navy*], 30 September 2015, p. 3.

[87] 伍尚锐 [Wu Shangrui] and 任伟 [Ren Wei], 海天猎鲨——目击某舰艇编队与反潜机开展海空立体联合反潜训练 ["Sea And Sky Shark Hunting——Witnessing a Ship Formation and Anti-Submarine Aircraft Carry Out Joint Sea-Air Three-Dimensional Anti-Submarine Training"], 人民海军 [*People's Navy*], 9 March 2015, p. 2.

[88] 卜令彬 [Bu Lingbin], 吴雄兵 [Wu Xiongbing], and 段宴兵 [Duan Yanbing], 战鹰掠猎海[黑鲨]——北航某飞行团组织潜机对抗训练见闻 ["War Eagle Plunders the Sea [Black Shark]——A Flying Group of the Northern Theater Navy Organizes Submersible Aircraft Confrontation Training Experience"], 人民海军 [*People's Navy*], 16 August 2022, p. 2.

The PLAN as a service has been a first mover in adapting task-based organization, and ASW is a prime example of this. In training exercises, on-call MPRA ASW operations appear to be coordinated by a land-based command post. A surface formation can request MPRA support and dictate an "on-call point" (应召点) or search area to the aircraft if they have already made contact with a submarine.[89] However, the tactical commander within a KQ-200 can request that the surface formation change course and dictate ideal course altitudes and flight paths to their pilot to better prosecute or detect submarine contacts.[90] PLA media has highlighted handoffs between ASW aircraft in training exercises, along with back-to-back sorties to improve coverage time of on-call aircraft.[91] More recently, PLA media has highlighted MPRA aircraft training to regain contact with enemy submarines after they dived to avoid detection, possibly trying to take advantage of the thermal layer.[92]

Implementation of the aviation component of a multi-platform ASW system in training exercises involves multiple tasks, with KQ-200s conducting wide area searches, helicopters conducting searches in more precise locations, probably with dipping sonar (given the lack of MAD and sonobuoys on many PLAN ASW helicopters), while surface vessels conduct "blanket searches" (毯式搜索).[93] A 2022 report describes a "ship-aircraft coordinated ASW training" (舰机协同反潜训练) event where an unidentified MPRA unit's aircraft transmitted target signal information to a command ship (指挥舰), which then integrated it with information from other sources and checked the information against a target information database to confirm whether or not the target was an enemy submarine.[94] This indicated both a potential command relationship from command vessels to ASW aircraft and confirmed that the PLAN trains to compare potential targets to a database, despite its small (but expanding) ocean surveillance and intelligence collection fleet and a nascent underwater surveillance capability.

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[89] 陈晓杰 [Chen Xiaojie] and 秦钱江 [Qin Qianjiang], 立体组网 "狩猎"海天——海军航空兵某团组织舰机协同反潜训练 ["Three-Dimensional Networking 'Hunting' the Sea and the Sky——A Regiment of the Naval Aviation Corps Organized Ship-Aircraft Cooperative Anti-Submarine Training"], 解放军报 [*PLA Daily*], 23 November 2022, p. 4.

[90] 秦钱江 [Qin Qianjiang], 南部战区海军航空兵某团协同水面舰艇部队开展反潜训练——深悔猎鲨, 紧盯每一片风浪 ["A Regiment of the Naval Air Corps of the Southern Theater Command Cooperates With Surface Ships to Carry Out Anti-Submarine Training—Deeply Regrets Hunting Sharks, Keeping An Eye On Every Wind And Wave"], 人民海军 [*People's Navy*], 13 July 2022, p. 1.

[91] Bu, Wu, and Duan, "War Eagle Plunders the Sea [Black Shark]," p. 2.

[92] 正午国防军事 [National Defense and Military Noon update], [正午国防军事]长航时 不间断搜攻潜训练 海军航空兵某部：锤炼飞行员长航时飞行本领 ["[Noon National Defense Military] Long-Endurance, Uninterrupted Submarine Search And Attack Training, A Certain Department of the Naval Air Force: Temper The Pilot's Long-Endurance Flight Skills"], CCTV, 27 November 2022, https://tv.cctv.com/2022/11/27/VIDE1zC48yFKeDy4WHHWMnbI221127.shtml.

[93] 樊斌 [Fan Bin], 张磊 [Zhang Lei], 董满 [Dong Man], and 张硕 [Zhang Shuo], 深海猎鲨，东部战区全面提升联合反潜作战能力 ["Shark Hunting in the Deep Sea, The Eastern Theater Has Comprehensively Improved Its Joint Anti-Submarine Warfare Capabilities"], 中国军网 [*China Military Online*], 9 August 2022, http://www.81.cn/zq/2022-08/09/content_10177020.htm, 09 08 2022.

[94] Chen and Qin, "Three-Dimensional Networking 'Hunting' the Sea and the Sky," p. 4.

In terms of training limitations, *People's Navy* articles prior to 2016 described the PLAN's limited hydrographic information as an obstacle to both training and exercises.[95] However, more recent PLAN media accounts do not suggest such information gaps continue to exist. *People's Navy* has begun to include more references to recording data and other electronic records relating to ASW training, as well as further analysis of this data.[96] In 2015, *People's Navy* published an article publicizing the benefits of training centers to increase joint training opportunities for surface warfare and aviation personnel.[97] More recently, it published an article that mentioned the importance of breaking down administrative barriers and rotating forces to conduct training outside of simulators.[98]

The PLAN has begun using a training simulator system for ASW aircraft that provides better, more realistic training. ASW missions have been a component of PLAN training simulations since the early 2000s.[99] PLAN has made it a priority to develop improved systems that allow for more realistic ASW training and better feedback. In 2016, authors affiliated with the Naval Aeronautical and Astronautical College published an article describing a simulator system that the PLAN had adopted for ASW helicopter training. According to the authors, this system was better able to model helicopters, surface vessels, and submarines in a more realistic acoustic environment. The system had advanced interfaces that enabled better recording and playback functionalities, which facilitated more prompt evaluations of training intervals.[100]

The article stated that the simulator system contained stations for tactical commanders and equipment operators. Tactical commander stations allowed trainees to organize and coordinate sensor operations, adjust planning as the situation developed, and plan for weapons engagement.[101] The sensor operator stations allowed trainees to search and track submarines using MAD, dipping sonar, and sonobuoys, while providing information to the tactical command station.[102] Live control over submarine target behavior allowed for dynamic changes during a training interval, reportedly creating a more challenging simulation.[103] All of these operations were done simultaneously and run on the same simulation timer.

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[95] 丁玉宝 [Ding Yubao], 孙国强 [Sun Guoqiang], and 于航 [Yu Hang], 曾经沧海难为水——再访"核潜艇精神"发源地北海舰队某潜艇基地 ["Difficult Seas Were Once Difficult——Revisiting a Submarine Base of the North Sea Fleet, The Birthplace of the 'Nuclear Submarine Spirit'"], 人民海军 [*People's Navy*], 15 May 2015, p. 1.

[96] 翟国栋 [Zhai Guodong] and 张振 [Zhang Zhen], 某飞行团自主开发飞行训练辅助软件 ["A Flight Regiment Independently Develops Auxiliary Software For Flight Training"], 人民海军 [*People's Navy*], 1 April 2016, p. 2.

[97] 李建红 [Li Jianhong], 邵龙飞 [Shao Longfei], and 徐广 [Xu Guang], 斗室之间, 跨越联训门槛 ["Between Small Rooms, Crossing the Threshold of Joint Training"], 人民海军 [*People's Navy*], 25 March 2015, p. 2.

[98] 钱晓虎 [Qian Xiaohu], 孟印祺 [Meng Yinqi], and 徐巍 [Xu Wei], 基于任务编组 依托体系强能 东部战区海军部队强化战训耦合推行反潜轮值组训 ["Based on Task Organization and Relying On Strong Systems, The Naval Forces in the Eastern Theater Strengthen Combat Training Coupling And Implement Anti-Submarine Rotation Training"], 人民海军 [*People's Navy*], 5 July 2022, p. 1.

[99] Ryan D. Martinson, "China Maritime Report No. 24: Incubators of Sea Power: Vessel Training Centers and the Modernization of the PLAN Surface Fleet," China Maritime Studies Institute, November 2022, p. 8, https://digital-commons.usnwc.edu/cmsi-maritime-reports/24/.

[100] 陈遵银 [Chen Zunyin] and 杨明绪 [Yang Mingxu], 直升机反潜作战训练仿真系统设计与实现 ["Design and Implementation of Helicopter Anti-submarine Combat Training Simulation System Equipment Management and Maintenance"], 设备管理与维修 [*Equipment Management and Maintenance*], no. 11 (2016), p. 105.

[101] Ibid.

[102] Ibid.

[103] Ibid., p. 104.

The system described in the article maintained the ability to dynamically plot movements of aircraft, sonobuoys, submarines, and likely surface vessels, as well as to record simulated weather conditions, save files, and generate files based on captured recordings to assist in analyzing training intervals.[104]

Fundamental Operational Concepts

Sonobuoy Array Shapes

Authors affiliated with the Naval Aeronautical and Astronautical College outline four basic sonobuoy array shapes that can be deployed by fixed-wing maritime patrol aircraft as well as ASW helicopters. These array shapes include "linear arrays" (线形阵), "square arrays" (方形阵), "fan arrays" (扇形阵), and "circular arrays" (圆形阵).[105] The authors describe linear arrays as the most flexible, being easy to modify to fit mission requirements and easily layered. The authors state that linear arrays are the most commonly employed as they have a high probability of detecting submarines.[106]

The authors describe square arrays as being more "convenient" (方便) to deploy, but not necessarily the most efficient in terms of area coverage.[107] Fan arrays are described as the most flexible arrays but are more difficult to deploy and maintain.[108]

Systems engineers affiliated with the National University of Defense Technology (国防科技大学/NUDT) outline the basic sonobuoy array shapes deployed by helicopters as square, circle, and triangular arrays, which are centered around on-call points.[109] These authors indicate that square arrays are required to be composed of deployed buoys in multiples of four in order to close arrays with enough overlap in coverage to detect submarines. [110] These authors describe circular arrays as having greater coverage area than square arrays, but likely taking longer to deploy.[111] Triangular arrays are required to be deployed in multiples of three to maintain a closed loop.[112]

Several PLAN-affiliated authors have discussed how the initial information given to on-call MPRAs should drive the choice of sonobuoy arrays. The consensus seems to be that if an on-call MPRA platform initially receives only target coordinates, it should first deploy a round, square, or triangular array to "surround" (包围) the target.

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104 Ibid.

105 李心舒 [Li Xinshu], 李伟波 [Li Weibo], and 罗木生 [Luo Musheng], 声呐浮标阵有效搜索面积建模 ["Effective Search Area Modeling of Sonar Buoy Array"], 指挥控制与仿真第 [*Command Control & Simulation*], no. 4 (August 2017), p. 26.

106 Ibid.

107 Ibid., p. 27.

108 Ibid.

109 朱智 [Zhu Zhi], 雷永林 [Lei Yonglin], and 朱一凡 [Zhu Yifan], 直升机反潜航路规划仿 ["Simulation of Helicopter Anti-Submarine Route Planning"], 系统仿真学报 [*Journal of System Simulation*], vol. 31, no. 7 (July 2019), p. 1283.

110 Ibid.

111 Ibid.

112 Ibid.

If the initial information includes both coordinates and heading, it should first deploy an arc-shaped, line, or broken line array ahead of the target's known path to "intercept" (拦截) it.[113] A 2020 study that includes an author from PLA Unit 91388 (a Testing Area in Zhanjiang) indicates that "surround" and "intercept" are common objectives driving MPRA sonobuoy placement.[114]

MAD Employment

PLAN academic literature is more focused on MAD employment as a method to find and fix targets that have been identified by other sensors or platforms. Discussions of MAD employment by PLA academics from the Naval Aviation University and from members of the operational community center around an implied on-call ASW scenario, where a surface combatant or other platform has already detected an enemy submarine contact operating in the area.[115] Authors indicate that aircraft may fly in "figure eight" (八字形), "clover leaf" (苜蓿叶形), and "figure eight clover leaf" (八苜形) search patterns, as depicted below, as possible methods of tracking an enemy submarine contact.[116] Authors indicate that in their simulations under the same sea state conditions and target behavior, the figure eight clover leaf search pattern was the most effective at regaining contact with the submarine for which the aircraft had been called in to search.[117]

The simulated speed and altitude of the aircraft while it conducts MAD sweeps was 300 km/h and 100 meters, and the effective range of its MAD probe was assumed to be 500 meters.[118] Other articles that mention this information list a speed of 360 km/h and altitude of 100 meters.[119]

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[113] 樊振凯 [Fan Zhenkai], 固定翼飞机声呐浮标布阵优化研究 ["Research on Sonobuoy Array Optimization for Fixed-Wing Aircraft"], 西北工业大学学报 [*Journal of Northwestern Polytechnical University*], no. S1 (2017), p. 83.

[114] Yu, Ju, and Yang, "Optimal Sonobuoy Depth under 'Shallow Seas' Conditions," p. 97.

[115] Wu, et al., "Modeling and Simulating ASW Aircraft MAD Tracking Route Planning, p. 12.

[116] Ibid., p. 14.

[117] Ibid., p. 15.

[118] Ibid., p. 14.

[119] 李启飞 [Li Qifei], 温玮 [Wen Wei], 韩蕾蕾 [Han Leilei], 周烨 [Zhou Ye], and 李沛宗 [Li Peizong], 基于短时互相关算法对航空磁异常信号的检测 ["Detection of Magnetic Abnormal Signal Based on Short Time Correlation Algorithm"], 兵器装备工程学报 [*Weapons and Equipment Engineering Journal*], vol. 41, no. 6 (June 2020), p. 181.

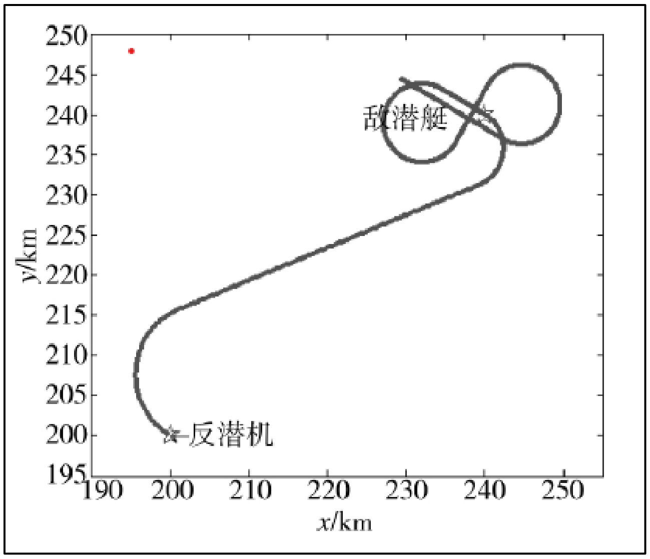

Figure 7: Figure Eight Search[120]

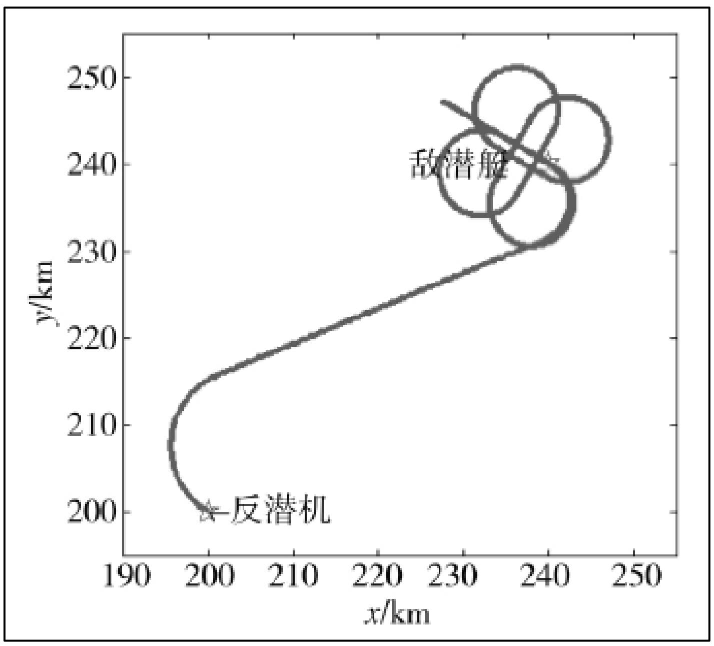

Figure 8: Clover Search[121]

[120]Wu, et al., "Modeling and Simulating ASW Aircraft MAD Tracking Route Planning," p. 14.
[121] Ibid.

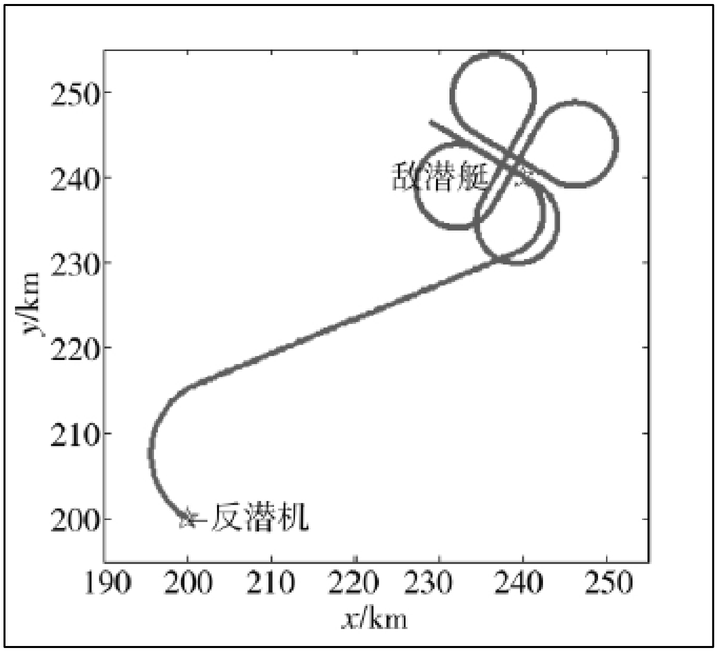

Figure 9: Figure Eight Clover Search[122]

Anti-Submarine Warfare Helicopter Employment Concepts

PLA-affiliated systems engineers from NUDT outline hypothetical search grids for ASW helicopters conducting search tasks with dipping sonar and sonobuoys using different search patterns. Given the employment differences between dipping sonar and sonobuoys, authors outline six different search patterns, three for dipping sonar and three for sonobuoys.

These authors outline the following dipping sonar search patterns: "spiral search pattern" (螺旋式方形搜索), "parallel search pattern" (平行来回式搜索), and a "line search pattern" (直线拦截搜索).[123] The spiral search pattern is centered around the on-call point, the point at which helicopters are directed by surface ships. The on-call point appears to be a point along the last assessed course of a submarine contact and potentially ahead of the submarine given last known heading and speed.[124] The distance between segments of the spiral is determined by the maximum detection range of the dipping sonar, ensuring enough overlap to maintain high detection probability while maximizing coverage.[125] The parallel search pattern is described as being used when a submarine is known to be active, but its location is unknown.[126] The line search method involves a single pass perpendicular to the assessed course of a submarine target, with an equal number of dips along either side.[127]

[122] Ibid.

[123] Zhu, Lei, and Zhu, "Simulation of Helicopter Anti-Submarine Route Planning," p. 1281.

[124] Ibid., p. 1287.

[125] Ibid., p. 1281.

[126] Ibid.

[127] Ibid.

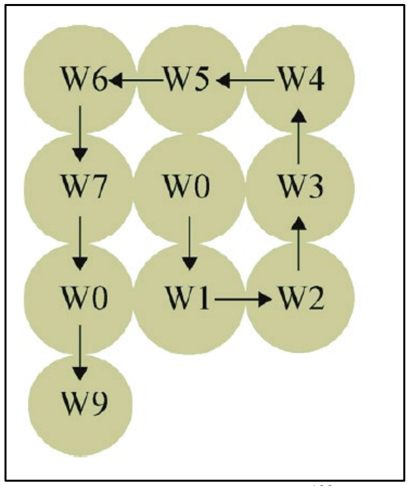

Figure 10: Spiral Search[128]

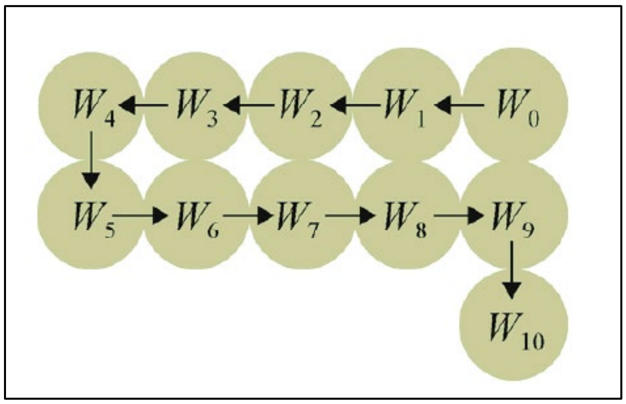

Figure 11: Parallel Search[129]

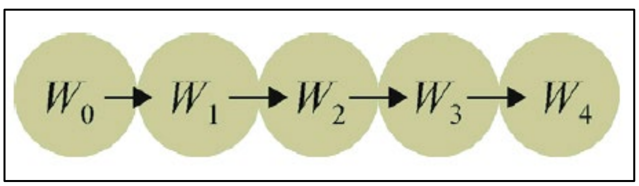

Figure 12: Line Search[130]

Anti-Submarine Warfare Helicopter Operational Concepts

Naval Aviation University-affiliated authors write on the benefits of pairing helicopters with surface combatants to coordinate sonobuoys, dipping sonar, and towed sonar arrays to search for enemy submarines. These authors write that by combining active and passive sonar systems the total area covered by the combined team can be increased.[131]

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[128] Ibid.

[129] Ibid.

[130] Ibid.

[131] 鞠建波 [Ju Jianbo], 张雨杭 [Zhang Yuhang], and 李沛宗 [Li Peizong], 舰机协同下多基地声纳阵应召搜潜效能研究 ["Research on the Performance of Multi-Base Sonar Arrays Under the Condition of On-Call Anti-Submarine and Warship-Helicopter Cooperation"], 计算机仿真 [*Computer Simulation*], vol. 37, no. 2 (February 2020), p. 10.

The shapes of the sonobuoy fields employed in this context are triangles, circles, and squares, and they are deployed in advance of an underway surface platform and around the assessed probable location of a submarine contact.[132] Authors indicate that the first buoy deployed in any array should be deployed along the most direct route between the helicopter's direct flight path to the last known position of the submarine, with subsequent buoys deployed to encircle the submarine contact (12 buoys for each array).[133] Figure 13 (below) depicts the employment of a circular array from this scenario.

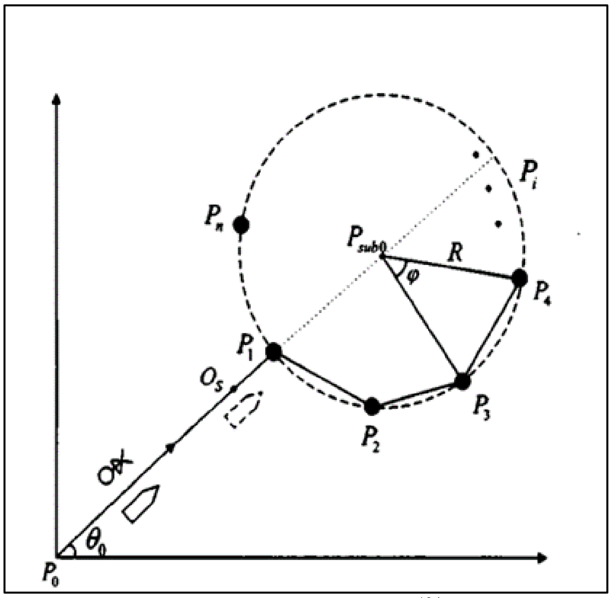

Figure 13: Circular Array[134]

In addition to on-call search, multiple individuals affiliated with the Naval Aeronautical and Astronautical College recommend that helicopters perform escort missions to protect high value surface combatants and escort task groups. When discussing escort missions, these authors tend to focus on helicopters employing dipping sonar to conduct a series of searches behind and in front of underway surface vessels.[135] These authors indicate preference for dipping sonar due to buoy stores limitations on the small number of PLAN helicopters equipped with sonobuoys.[136]

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[132] Ibid.

[133] The authors describe circular arrays as the most efficient use of sonobuoys. Ibid., p. 12.

[134] Ibid., p. 11.

[135] 丛红日 [Cong Hongri], 周海亮 [Zhou Hailiang], and 沙德鹏 [Sha Depeng], 反潜直升机"弓"字形前方护航搜索方法及其仿真 ["A 'Bow' Shape Search Method When Antisubmarine Helicopter Ahead Escort and Its Simulation"], 舰船电子工程 [*Ship Electronic Engineering*], vol. 36, no. 6 (June 2016), p. 25; 罗木生 [Luo Musheng], 曾家有 [Zeng Jiaoyou], and 侯学隆 [Hou Xuelong], 反潜直升机吊放声纳水面舰艇编队尾后锯齿形法搜潜 ["Antisubmarine Helicopter Searching Stern of Ship Formation Adopting Saw-Tooth Method with Dipping Sonar"], 航空学报 [*Acta Aeronautica et Astronautica Sinica*], vol. 38, No. 1 (January 2017), p. 1.

[136] Luo, Zeng, and Hou, "Antisubmarine Helicopter Searching Stern of Ship Formation Adopting Saw-Tooth Method with Dipping Sonar," p. 1.

Models for conducting an ASW escort with dipping sonar-equipped helicopters involve search patterns implemented by a single or group of aircraft, involving periodic dips and turns so as to provide comprehensive underway coverage while maintaining "anti-submarine patrol lines" (反潜巡逻线) that are synchronized with surface group movements.[137] Dipping sonar search patterns referred to by PLAN-affiliated authors resemble the Chinese character for "bow" (弓)[138] or "saw-tooth shapes" (锯齿形)[139] in this escort context.

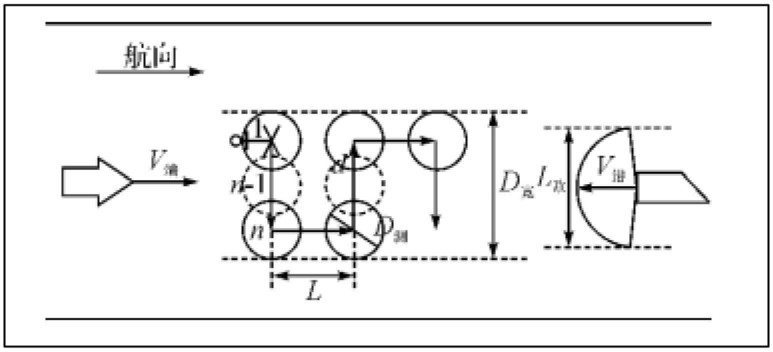

Figure 14: Bow Shaped Search[140]

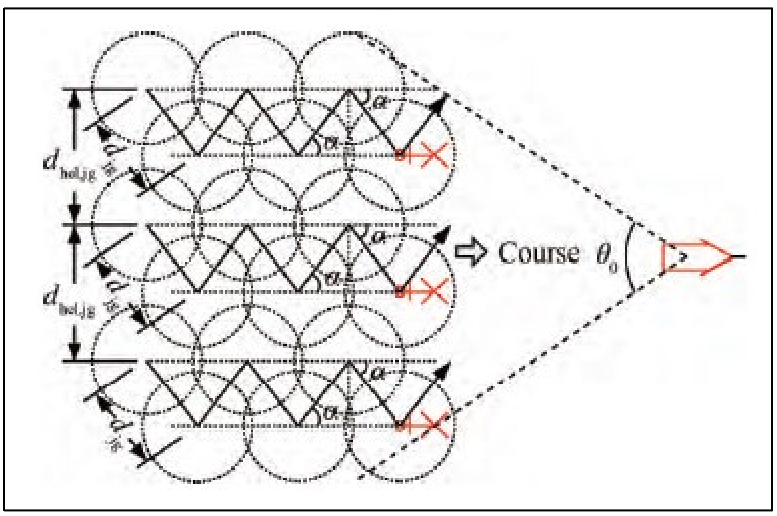

Figure 15: Saw-Tooth Search[141]

The benefits of the saw-tooth search method are described by PLAN-affiliated authors as allowing for the employment of more helicopters to enable comprehensive coverage of the area transited by the vessel being covered, typically identified as a high value asset such as an aircraft carrier.

[137] Cong, Zhou, and Sha, "A 'Bow' Shape Search method When Antisubmarine Helicopter Ahead Escort and Its Simulation," p. 24.

[138] Ibid.

[139] Luo, Zeng, and Hou, "Antisubmarine Helicopter Searching Stern of Ship Formation Adopting Saw-Tooth Method with Dipping Sonar," p. 1.

[140] Cong, Zhou, and Sha, "A 'Bow' Shape Search method When Antisubmarine Helicopter Ahead Escort and Its Simulation," p. 25.

[141] Luo, Zeng, and Hou, "Antisubmarine Helicopter Searching Stern of Ship Formation Adopting Saw-Tooth Method with Dipping Sonar," p. 2.

Authors note, however, that adding more aircraft eventually leads to a diminishing area of coverage.[142] The angle of the area behind the surface vessel, represented by Θ_0 in Figure 15, is identified as another factor which influences the total area helicopters are able to cover. The larger the angle, the closer to the surface vessel helicopters are forced to search with an ultimately smaller total search area. Given the technical specifications laid out in an article which discusses this search pattern, the authors claim that two or more helicopters are necessary to cover a sufficient area behind a surface formation. The authors indicate at a minimum, two helicopters within a 80.9 degree angle can conduct minimal dipping sonar searches 15 nautical miles behind a surface combatant, and three helicopters within 51 degree fan behind a surface vessel can cover an area of 60km behind a surface vessel, with at least nine dipping points for each helicopter.[143]

PLAN scholarship on dipping sonar sweeps conducted in advance of underway surface vessels is slightly less forthcoming on operational concepts. One study does not appear to allow for overlap in dipping detection ranges and stipulates that dipping points be at least one to two times the detection distance range away from each other.[144] The authors do comment that the smaller the distance between dipping points, the higher the probability of detection of an enemy submarine.[145] If the newer approach of intentionally creating overlapping dipping sonar coverage is followed, it would lead to a potentially tighter search pattern.

PLAN authors also write about helicopters escorting ASW capable surface vessels on both the port and starboard sides, referred to as "two-wing forward coordinated vessel-aircraft cooperative search" (两翼前出型舰机协同搜索).[146] Intended to provide an ASW escort to a larger surface formation, (i.e., a carrier strike group),[147] this search grouping is composed of at least one surface vessel and two helicopters, with the possibility of adding a second surface vessel to the formation. The formation would proceed in front of the surface group it is escorting, to place the friendly formation outside of the range of enemy submarine-launched torpedoes. See Figure 16 below.[148]

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[142] Ibid., p. 4.

[143] Ibid., pp. 5-6.

[144] 丛红日 [Cong Hongri], 周海亮 [Zhou hailiang], 陈邓安 [Chen Dengan], 舰载反潜直升机蛇形机动前方护航搜索方法及其仿真 ["Carrier Antisubmarine Helicopter Snakelike Move Search Method When Anterior Convoy Antisubmarine Defending and Its Simulation Study"], 兵器装备工程学报 [*Weapons and Equipment Engineering Journal*], vol. 37, no. 6 (June 2016), p. 161.

[145] Ibid.

[146] 吴芳 [Wu Fang], 高青伟 [Gao Qingwei], 吴铭 [Wu Ming], 舰机两翼侧出前向协同巡逻护航反潜模型及仿真 ["Models and Simulations for the Ship-Heli Cooperating of Forward Patrol and Anti-submarine of the Two-Wing Warships"], 指挥控制与仿真 [*Command and Control Simulation*], vol. 39, no. 6 (December 2017), p. 35.

[147] Ibid., p. 37.

[148] Ibid., p. 36.

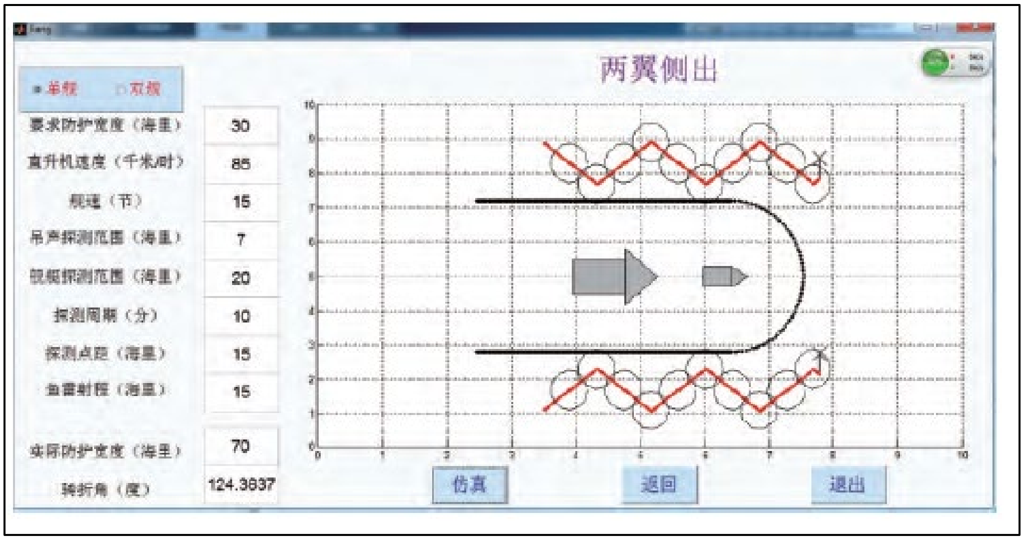

Figure 16: Vessel-aircraft cooperative search (两翼前出型舰机协同搜索)[149]

Maritime Patrol and Reconnaissance Aircraft Operational Concepts

Authors affiliated with the PLAN Naval Command College (海军指挥学院) outline a coordinated search for submarines by MPRA and surface vessels. This model is based on a formation of three to four surface vessels conducting a sweep between two linear sonobuoy arrays, advancing in the direction of the submarine contact.[150] The authors outline a search corridor that has the minimum necessary overlap between the sensors of the surface vessels and the sonobuoys to maximize detection area while maintaining a tight cordon. The authors describe spacing the first sonobuoys in the fields within the minimum distance needed for submarine contacts to evade detection by the surface vessels, without being close enough to the surface ships to receive interference from their wake after they pass, and spacing subsequent buoys with minimum overlap.[151] For the purposes of the paper, the authors outline two different schemes for placing sonobuoys, the first is used twice, and the last is used once. See Figures 17 and 18 below.

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[149] Ibid., p. 37.

[150] Tang, Sun, and Wu, "Research on Formation Configurations for Cooperative Submarine Search between Surface Vessels and ASW Aircraft," p. 33.

[151] Ibid., p. 34.

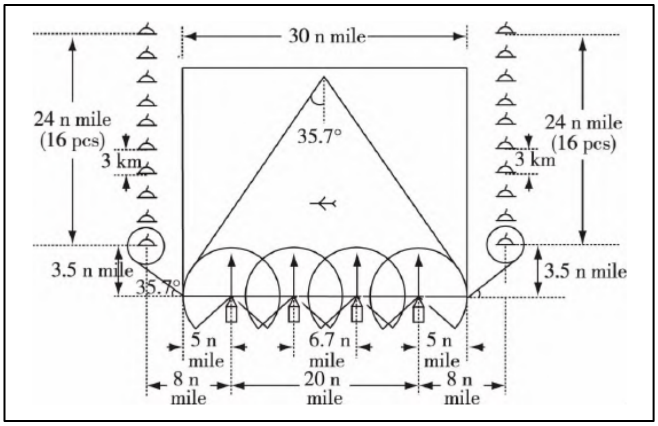

Figure 17: First and Second laying of sonobuoys[152]

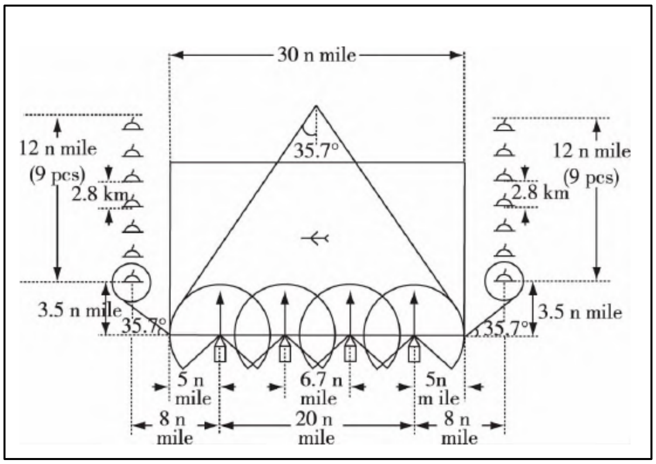

Figure 18: Third laying of sonobuoys[153]

After the MPRA aircraft deploy the sonobuoys, the authors indicate that the aircraft should fly over the center area in a figure eight pattern to maintain contact with the sonobuoys, which is also a MAD search pattern discussed by PLA authors.[154] This would allow for better fixing of submarine targets to subsequently engage with weapons if necessary. This scheme involves a total of 86 sonobuoys, the majority of the sonobuoy stores on a KQ-200, and covers a total of 2,318 nm^2 with a total search time of five hours. While operating from the mainland, this sort of mission requirement is well within KQ-200 payload capacity and loiter times for key straits north and south of Taiwan.[155]

However, when operating from outposts in the South China Sea, assessments of Y-9 operational ranges allot 3-5 hours of loiter time in the southern approach to the strait of Malacca, the Celebes Sea, the eastern portions of the Sulu Sea, and the northern reaches of the Java Sea.[156]

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[152] Ibid., p. 37.

[153] Ibid.

[154] Ibid.; and Wu, et al., "Modeling and Simulating ASW Aircraft MAD Tracking Route Planning," p. 14.

[155] Dahm, "Special Mission Aircraft and Unmanned Systems," p. 29.

[156] Ibid., p. 30.

Operating from these outposts enables KQ-200s to have significantly longer loiter times over the South China Sea and the western portion of the Sulu Sea.[157]

If the initial three deployments under this hypothetical operation were unable to successfully drive out a submarine contact or provide a suitable enough firing solution for a weapons engagement, a relief aircraft would be required to ensure a submarine contact was successfully driven out of the operational area.

PLAN authors affiliated with the Dalian Naval Academy (海军大连舰艇学院) emphasize the importance of maximizing the effectiveness of limited resources in the employment of multi-layer bounding arrays during on-call searches. Their analysis indicates that while possible locations of a submarine contact could be calculated given last known location, course, and speed, submarines are capable of maneuvering to avoid detection or escape an array. As such, deploying a layered buoy array at a distance from the point of last contact based on maximum assessed speed unnecessarily consumes material and will require aircraft to conduct a handoff.[158]

The authors recommend a more active approach that is less likely to allow the enemy submarine time and room to maneuver and escape detection.[159] As in all on-call search methods, the two key factors determining array placement are the time it takes for the on-call aircraft to reach the area of the last detection of the submarine contact and the distance the submarine could travel in that time. The formulas and simulation results provided in the discussion of bounding arrays indicate that with more sonobuoys, tighter arrays can be created. But arrays with more buoys may take longer to deploy, giving the target submarine more time to maneuver, depending on its speed and the time it took the search aircraft to reach the target area.[160] Accordingly, the initial search area can be reduced by taking measures to reduce the time it takes to generate a sortie. A depiction of a multilayer bounding array is provided below.

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[157] Ibid., p. 29.

[158] 谭安胜 [Tan Ansheng], 反潜巡逻机声呐浮标应召搜索研究———态势分析与包围阵参数确定 ["On-Call Search of Anti-submarine Patrol Aircraft Using Sonobuoys—Situation Analysis and Determination of Bounding Array Parameters"],电光与控制 [*Electronics Optics & Control*], vol. 26, no. 12 (December 2019), p. 2.

[159] Ibid.

[160] Ibid., p. 3.

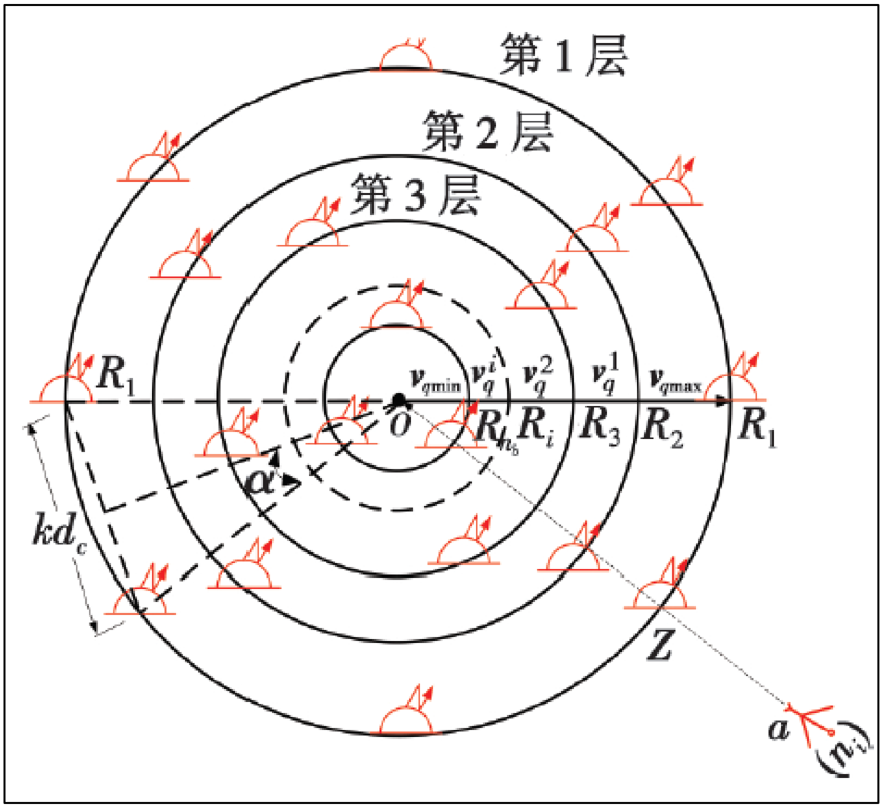

Figure 19: Multi-Layer Bounding Array[161]

The simulations run in the article show the different arrays required given different assessed submarine target speeds, different numbers of segments required by the first layer of the array, and the time it takes aircraft to reach the on-call point. The authors assume the distance from the airfield to the on-call point ranges from 100 to 700 kilometers, and the time it takes to reach the operational area and drop the first sonobuoy ranges from approximately 42 minutes to 106 minutes.[162] Another study by PLA-affiliated researchers described methods to optimize on-call search efficiency by eliminating areas the target is very unlikely to be when the search began and creating a search area that can be updated as conditions change rather than set at initial discovery and rigidly followed.[163]

[161] Ibid., p. 3.

[162] Ibid.

[163] 郑润高 [Zheng Rungao] and 张成栋 [Zhang Chengdong] 基于航空反潜战术搜索确定区域的优化方法 ["An Optimal Method for Determining Areas Based on Aviation Anti-submarine Tactical Search"], 舰船电子工程 [*Ship Electronic Engineering*], no. 1 (2018), p. 22.

Conclusion

The PLAN recognizes the importance of a capable and credible ASW system composed of modern systems across all domains, among which the aviation component plays a key role. The PLAN clearly views fixed-wing and vertical lift ASW capabilities as a crucial component necessary for any of its amphibious based contingencies, be that a seizure of an island or reef, or the successful implementation of a Joint Island Landing Campaign against Taiwan. ASW capabilities would be crucial for safeguarding high value surface assets such as carriers or an amphibious landing group, protecting them as they are in port embarking forces, sanitizing the operational area of enemy submarines, and escorting these assets on their way to staging areas and operational areas.
In addition to these wartime responsibilities, the PLAN clearly views fixed-wing ASW as an important enabler of its at-sea nuclear deterrent, a critical maritime domain awareness asset, and a deterrent to use against enemy submarine operations in peacetime or as part of a demonstration of growing capability in a Taiwan context.

The PLAN has acknowledged its limitations and has begun taking steps to improve the quality of its ASW training, both in simulators and in physical training environments. PLAN ASW units are training under more realistic conditions, and breaking down administrative barriers which prevented them from generating more training opportunities in different operational environments. While the PLAN has developed basic operational concepts and is undergoing efforts to develop, test, and adopt more modern technologies and platforms to improve its ASW capabilities, the training of the operators of these systems will play a crucial role in determining the success of their employment. Judging both the actual capabilities of these operators and how the PLAN perceives the capabilities of these operators is a difficult but important task, which is worthy of future study using all available means.

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