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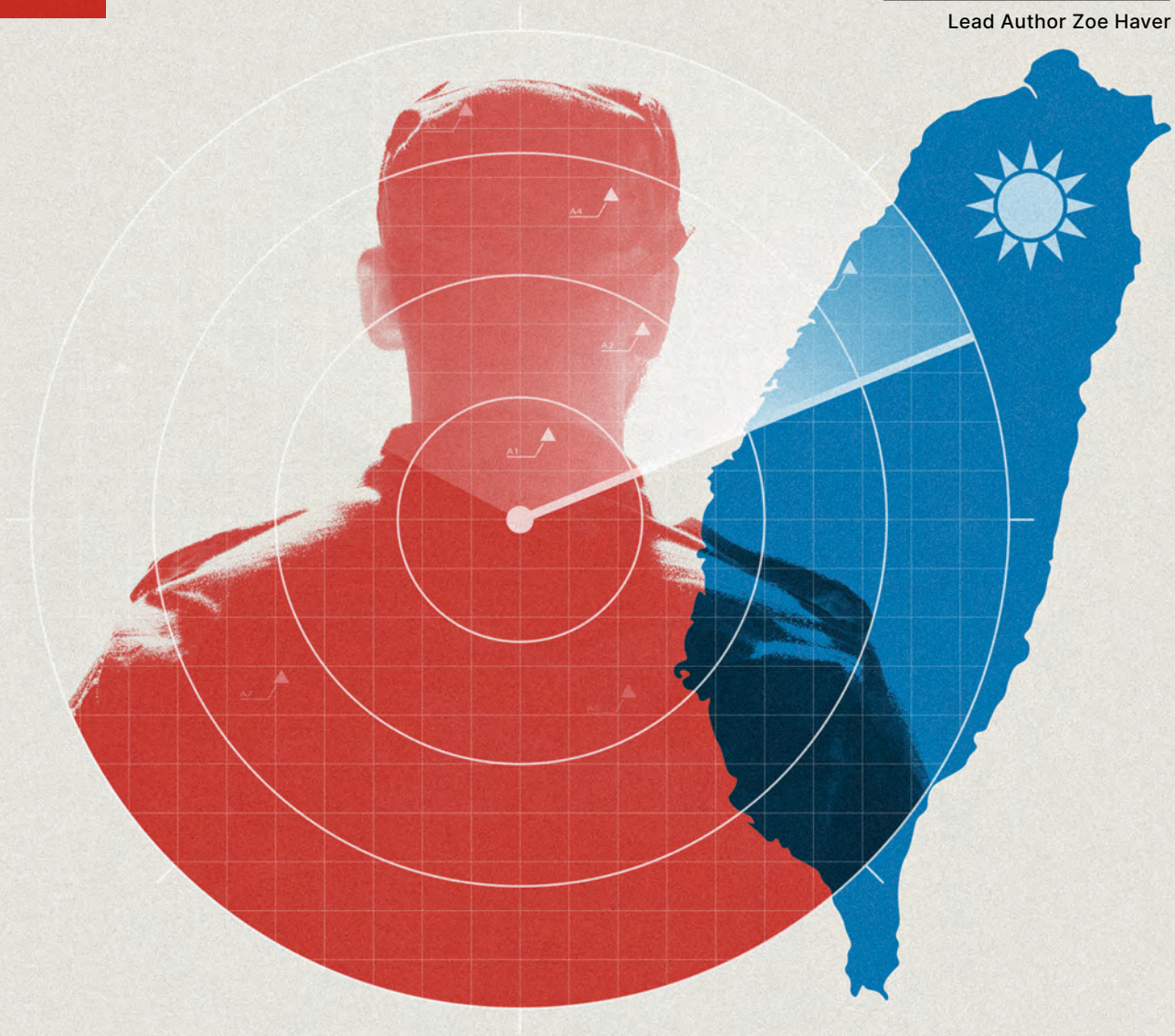

Speeding Toward Taiwan: China's Amphibious Armored Vehicles Development

China has consistently prioritized the development of amphibious armored vehicles with high water speed capabilities in preparation for potential Taiwan invasion scenarios.

China's Type-05 family of amphibious armored vehicles was designed for cross-sea landing operations, has high water speed capabilities, and has variants designed to fill various battlefield roles.

Since introducing the Type-05, China has continued to develop vehicles with new or improved capabilities, including prototypes reportedly capable of reaching 50 kilometers per hour on the water.

Note: The author, Zoe Haver, thanks Joshua Arostegui and Jake Vartanian of the US Army War College's China Landpower Studies Center for their generous support. More information about the author can be found at the end of this report.

Executive Summary

During an invasion of Taiwan, the People's Liberation Army (PLA) would almost certainly use amphibious armored vehicles in the initial landing force to help secure beachheads for the rest of the invasion force. To improve the chances of success for landing operations against Taiwan, the PLA and China's defense industry have consistently prioritized the development of amphibious armored vehicles with high water speed (HWS) capabilities. After years of research and development, China publicly unveiled the world's fastest amphibious armored vehicle, the Type-05, in late 2009, with reports of its water speed ranging between 27 and 45 kilometers per hour. This family of amphibious armored vehicles reportedly includes assault, infantry fighting, command, reconnaissance, medical, and obstacle-clearing variants, among others. Both the PLA Army (PLAA) and PLA Navy Marine Corps (PLANMC) use the Type-05, but the PLAA would very likely operate the majority of these amphibious armored vehicles during large-scale landing operations against Taiwan.

Since the introduction of the Type-05, the PLA and China's defense industry have continued to develop amphibious armored vehicles with new or improved capabilities. Open-source reporting reveals that China's defense industry has been developing new Type-05 variants and entirely new amphibious armored vehicles. Patent data likewise indicates that China's defense industry, PLA entities, and other Chinese organizations have continued to carry out research and development related to amphibious vehicles and amphibious armored vehicles. Based on an original dataset of over 100 patents filed between 2014 and 2023, we found that notable areas of interest include increasing water speed, streamlining transitions between water and land, optimizing maintenance, reducing corrosion, increasing land mobility, and improving operational safety. Open-source reporting, patent data, and PLA procurement records suggest that HWS has remained a priority for the PLA and China's defense industry, a reflection of the PLA's ongoing focus on preparing for potential Taiwan invasion scenarios, with prototypes and other experimental tests reportedly achieving water speeds of 50 kilometers per hour or faster. Defense planners in Taiwan, the United States (US), and elsewhere should continue to monitor the development of HWS amphibious armored vehicles in China to inform preparations for potential cross-strait invasion scenarios.

Key Findings

- The PLA very likely believes that joint island landing campaigns are contests of speed that require the landing force to execute rapid and continuous assaults onto land, which has led to the PLA prioritizing the development of HWS amphibious armored vehicles.
- The Type-05 family of amphibious armored vehicles serves as the PLA's main amphibious armored vehicle. It was specifically designed for cross-sea landing operations, has HWS capabilities, has variants designed to fill a variety of battlefield roles, and is the most advanced vehicle of its type currently in service; reports of its water speed range from 27 to 45 kilometers per hour.
- The development of the Type-05 took place between 2000 and 2004, involved multiple Chinese state-owned enterprises, took inspiration from the development of HWS amphibious armored vehicles in the US, and

required China's defense industry to develop novel solutions to various technical challenges, such as using dynamically adjustable bow and (possibly) stern flaps with an accompanying automatic control system to generate lift and reduce water resistance.

- Open-source reporting indicates that China's defense industry has continued to develop new Type-05 variants and entirely new amphibious vehicles, including a wheeled vehicle prototype with a reported maximum water speed of 50 kilometers per hour and an unmanned amphibious vehicle displayed at a defense industry exhibition.
- China's defense industry, PLA entities, and other Chinese organizations have filed numerous patent applications over the past decade related to amphibious vehicles and amphibious armored vehicles, including patents oriented toward increasing water speed, streamlining transitions between water and land, optimizing maintenance, reducing corrosion, increasing land mobility, and improving operational safety; other areas of likely interest include steering, training, manufacturing, heat dissipation and cooling, engine control and performance, controlling cavitation, and vehicle design.
- In September 2022, a Chinese state-owned defense industry research institute filed a patent application for an amphibious vehicle hull design that can purportedly facilitate water speeds between 50 and 55 kilometers per hour.
- Though China has developed world-class amphibious armored vehicles, the patents filed by China's defense industry, PLA entities, and other Chinese organizations reveal possible deficiencies in China's amphibious vehicles and amphibious armored vehicles; external factors such as the PLAN's sealift capacity, the weather conditions and sea state in the Taiwan Strait, and Taiwan's geography could also reduce the effectiveness of China's amphibious armored vehicles.

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Sources

This report assesses the role of amphibious armored vehicles in PLA joint island landing campaigns, China's current amphibious armored vehicles, and ongoing amphibious armored vehicle research and development efforts in China. Sources we used to support our assessments include Chinese state media reporting, particularly a CCTV documentary that details the development of the Type-05 based on interviews with engineers who participated in the project and a defense industry magazine interview of the Type-05's lead designer;[1] authoritative PLA texts concerning operational art like *Science of Campaigns*, *Informatized Army Operations*, and *Research on Port Landing Operations*;[2] research by foreign experts on the PLA, especially the writings of Joshua Arostegui and Dennis Blasko;[3] foreign reporting on and analysis of China's amphibious armored vehicles, such as articles from *Janes*; an original Insikt Group dataset of over 100 patent applications from China's defense industry, PLA entities, and other Chinese organizations; and PLA procurement records collected in the Recorded Future Intelligence Cloud.

Amphibious Armored Vehicles in a Joint Island Landing Campaign

A full-scale invasion of Taiwan would require the PLA to carry out a joint island landing campaign, which would almost certainly involve the use of amphibious armored vehicles.[4] *Science of Campaigns* claims that a joint island landing campaign would involve three basic phases: advance operations, embarkation and sea crossing, and assault onto land and establishment of landing sites.[5] After consolidating its landing sites, the PLA would then push inland, which some experts have described as the fourth phase of the joint island landing campaign.[6]

- **Advance operations**. The first phase would include the seizure of information, air, and sea dominance, as well as missile and air strikes against critical targets and coastal defenses in Taiwan, among other elements.[7]
- **Embarkation and sea crossing**. The second phase would include loading forces and equipment onto ships, navigating from staging areas to waters near Taiwan's western coast, and preparing for the forthcoming assault on Taiwan.[8]
- **Assault onto land and establishment of landing sites**. The third phase would include a three-dimensional assault onto land by amphibious, airborne, and airmobile forces; securing landing sites; and expanding these landing sites to facilitate the arrival of follow-on forces.[9] PLA texts such as *Science of Campaigns*, *Informatized Army Operations*, and *Research on Port Landing Operations* have consistently emphasized the importance of rapid and continuous assaults onto land for overwhelming the enemy and establishing defensible beachheads,[10] a principle that has directly informed the development of HWS amphibious armored vehicles in China.[11]

Because Taiwan's challenging geography would complicate initial landing efforts and subsequent mechanized pushes deeper into the island, the PLA has reportedly been shifting to prioritize initial airborne and airmobile assaults to help pave the way for follow-on forces.[12] This being said, experts still assess that any joint island landing campaign would still require large-scale amphibious assaults, and so China's amphibious armored vehicles would almost certainly still feature prominently in an invasion of Taiwan.[13] Likewise, *Research on Port Landing Operations* highlights the continued usefulness of China's newest amphibious vehicles in modern joint landing operations, noting that new technologies have increased the performance of these vehicles on the water and enhanced their command and control capabilities.[14] It praises the "rapid firepower and strong amphibious assault power" of amphibious armored mechanized units and their

ability to directly assault the shore, establish beachheads, and guide follow-on forces to land.[15] Similarly, though *Informatized Army Operations* discusses the benefits of helicopters and other new platforms for landing operations, it contends that these new platforms cannot perform every role in large-scale landing operations and recommends actively developing and fully using amphibious assault vehicles.[16] The text suggests that amphibious armored vehicles provide a helpful combination of mobility, protection, and firepower.[17]

During a joint island landing campaign against Taiwan, China's amphibious armored vehicles would almost certainly perform a number of battlefield roles. For example, China has reportedly developed amphibious vehicles capable of clearing mines and other obstacles from the shore to allow the landing force to proceed onto the beach; carrying infantry from the sea to shore; providing fire and artillery support for the landing force; performing command, communications, and reconnaissance functions; and providing medical aid to wounded personnel and recovery for damaged vehicles.[18]

In the main landing force of a joint island landing campaign, PLAA amphibious combined arms brigades would very likely operate the majority of China's amphibious armored vehicles, as the PLANMC possesses amphibious armored vehicles but is not optimized for large-scale operations.[19] The PLAA has six amphibious combined arms brigades under the 72nd, 73rd, and 74th group armies stationed on China's eastern coast (and are therefore prepared for Taiwan contingencies), each of which reportedly includes four combined arms battalions, among other elements (see **Table 1** below).[20] Each combined arms battalion contains two amphibious assault gun companies, two amphibious mechanized infantry companies, a firepower company, and a service support company.[21] These combined arms battalions operate equipment like amphibious assault vehicles, amphibious infantry fighting vehicles, amphibious engineering vehicles, and amphibious howitzers.[22] Experts have estimated that each amphibious assault gun company and amphibious mechanized infantry company is equipped with fourteen vehicles, each combined arms battalion has around 80 vehicles, and an entire amphibious combined arms brigade possesses over 400 vehicles (see **Table 2** below).[23] As such, the PLAA's six amphibious combined arms brigades likely command over 2,400 vehicles at full strength.[24] Of these, roughly 1,900 vehicles are likely operated by the combined arms battalions, including approximately 670 amphibious assault vehicles and 670 amphibious infantry fighting vehicles, among other amphibious armored vehicles.[25]

Group Army	Brigade	Combined Arms Battalions	Location
72nd Group Army	5th Amphibious Combined Arms Brigade	4	Zhejiang
	124th Amphibious Combined Arms Brigade	4	Zhejiang
73rd Group Army	14th Amphibious Combined Arms Brigade	4	Fujian
	91st Amphibious Combined Arms Brigade	4	Fujian

74th Group Army	1st Amphibious Combined Arms Brigade	4	Guangdong
	125th Amphibious Combined Arms Brigade	4	Guangdong

***Table 1**: PLAA amphibious combined arms brigade structure on China's east coast (Source: The PLA Army Amphibious Force; PLA Army and Marine Corps Amphibious Brigades; Insikt Group[26])*

PLAA Entity	Total Number of Entities	Vehicles Per Entity	Total Combined Vehicles
Amphibious Combined Arms Brigade	6	400	2400
Combined Arms Battalion	24	80	1900
Amphibious Assault Gun Company	48	14	670
Amphibious Mechanized Infantry Company	48	14	670

***Table 2**: Rough estimate of the number of vehicles in the six amphibious combined arms brigades of the 72nd, 73rd, and 74th group armies (Source: The PLA Army Amphibious Force; PLA Army and Marine Corps Amphibious Brigades; Insikt Group[27])*

China's Current Amphibious Armored Vehicles

Type-05

China's Type-05 family of amphibious armored vehicles serves as the PLA's main amphibious armored vehicle. It was specifically designed for cross-sea landing operations and is the most advanced vehicle of its type in the world.[28] The Type-05 family of amphibious armored vehicles reportedly includes assault, infantry fighting, command, medical, communications, armored recovery, obstacle clearing, and reconnaissance vehicles, among others.[29] China's defense industry reportedly began developing the Type-05 in 2000 and finished in 2004, a remarkably quick development timeline.[30] Production of the first Type-05 vehicles reportedly finished in January 2005, and China officially unveiled the Type-05 at the National Day parade in October 2009.[31] Both the PLAA and PLANMC use the Type-05 family of vehicles.[32]

During amphibious operations, amphibious armored vehicles like the Type-05 would likely disembark from transport vessels between four and eight kilometers from the shore.[33] Under good conditions, these vehicles can also reportedly swim across bodies of water without transport vessels, such as from the Chinese mainland to Taiwan's outlying islands.[34] The ZBD-05, the amphibious infantry fighting vehicle variant of the Type-05, is equipped with a 30mm gun with a four-kilometer max range, HJ-73 anti-tank guided missiles (ATGM), and a 7.62mm machine gun; weighs 26.5 tons; and can carry three crew and eight infantry (see **Figure 1** below).[35] The amphibious assault variants of the Type-05, known as the ZTD-05 or ZLT-05, are armed with a rifled 105mm gun capable of being fired during water navigation, a 12.7mm machine

gun, and the HJ-73 ATGM; weigh 28 tons; and have a crew of four (see **Figure 2** below).[36] The Type-05 family of amphibious armored vehicles uses tracks rather than wheels and can reach speeds of around 65 kilometers per hour on land.[37]

***Figure 1**: ZBD-05 vehicles operated by the PLAA (Source: China Military Online[38])*

***Figure 2**: Type-05 amphibious assault vehicles operated by the PLANMC (Source: China Military Online[39])*

The most notable aspect of the Type-05 is its HWS. The Type-05 can reportedly travel at speeds of at least 27 or 28 kilometers per hour on the water,[40] with some sources suggesting that it can reach up to 45 kilometers per hour, though

the veracity of these claims is unclear.[41] The US Defense Intelligence Agency suggests that the water speed of the Type-05 is less than 37 kilometers per hour.[42] The Type-05's predecessor, the Type-63A, could reach speeds of around fifteen kilometers per hour.[43] For comparison, the US does not currently have an HWS amphibious armored vehicle; its Amphibious Assault Vehicle (AAV) can only reach speeds of around thirteen kilometers per hour on the water, and the AAV's replacement, the Amphibious Combat Vehicle (ACV), also currently appears to lack HWS capabilities (see **Figure 3** below).[44]

***Figure 3**: The ACV (Source: BAE Systems[45])*

Project 212

The PLA articulated HWS as a core requirement for the development of the Type-05, which was known as "Project 212" (212工程) and involved participants from state-owned enterprises like China Ordnance Industry Group Corporation Limited (NORINCO Group; 中国兵器工业集团有限公司) and China State Shipbuilding Corporation (CSSC; 中国船舶集团有限公司).[46] According to Chinese state media interviews of Project 212 engineers, China's military studied amphibious landings during the Second World War, including the Normandy landings and US landing operations in the Pacific, concluding that such operations require armored vehicles to transport troops directly to the beach with accompanying firepower and that HWS is essential for improving battlefield survival rates.[47] As such, the PLA asked China's defense industry to produce an HWS amphibious armored vehicle capable of executing cross-sea landing operations and providing the basis for an entire family of amphibious vehicles, including assault, infantry fighting, command, and medical vehicles.[48]

Project 212 engineers were unable to simply increase engine power to achieve HWS.[49] Increasing engine power generally requires the use of a heavier engine, which makes the vehicle heavier.[50] In turn, this requires more engine power and, therefore, an even heavier engine, and so on, a well-known vicious cycle in amphibious vehicle design that China's defense industry had already encountered when trying to improve the Type-63's water speed.[51]

China's defense industry reportedly designed folding, dynamically adjustable bow and (possibly) stern flaps to help realize the Type-05's HWS capabilities (see **Figure 4** below).[52] In developing these flaps, they reportedly took inspiration from the US's now-canceled efforts to develop the Expeditionary Fighting Vehicle (EFV), previously known as the Advanced Amphibious Assault Vehicle (AAAV), which used a folding bow flap and had HWS capabilities.[53] However, China was reportedly unable to replicate the powerful engine that the EFV used to surpass a speed "hump" and enter a semi-planing state in which hydrodynamic lift facilitates HWS (see **Figure 5** below).[54] To make up for reduced engine power, the Project 212 team developed flaps that can be dynamically adjusted to optimal angles while the Type-05 is navigating on water, a novel invention that allows the Type-05 to generate lift and reduce water resistance.[55] Some sources suggest that both the bow and stern flaps of the Type-05 are adjustable,[56] while others indicate that the former is adjustable but the latter has a fixed angle while in the water.[57] Based on video footage of gauges in the Type-05's cockpit as well as video footage of gauges used during the development of the Type-05's flap control system, it is plausible that both flaps are adjustable (see **Figure 6** below).[58]

***Figure 4**: The Type-05 with its bow and stern flaps unfolded (Source: CCTV[59])*

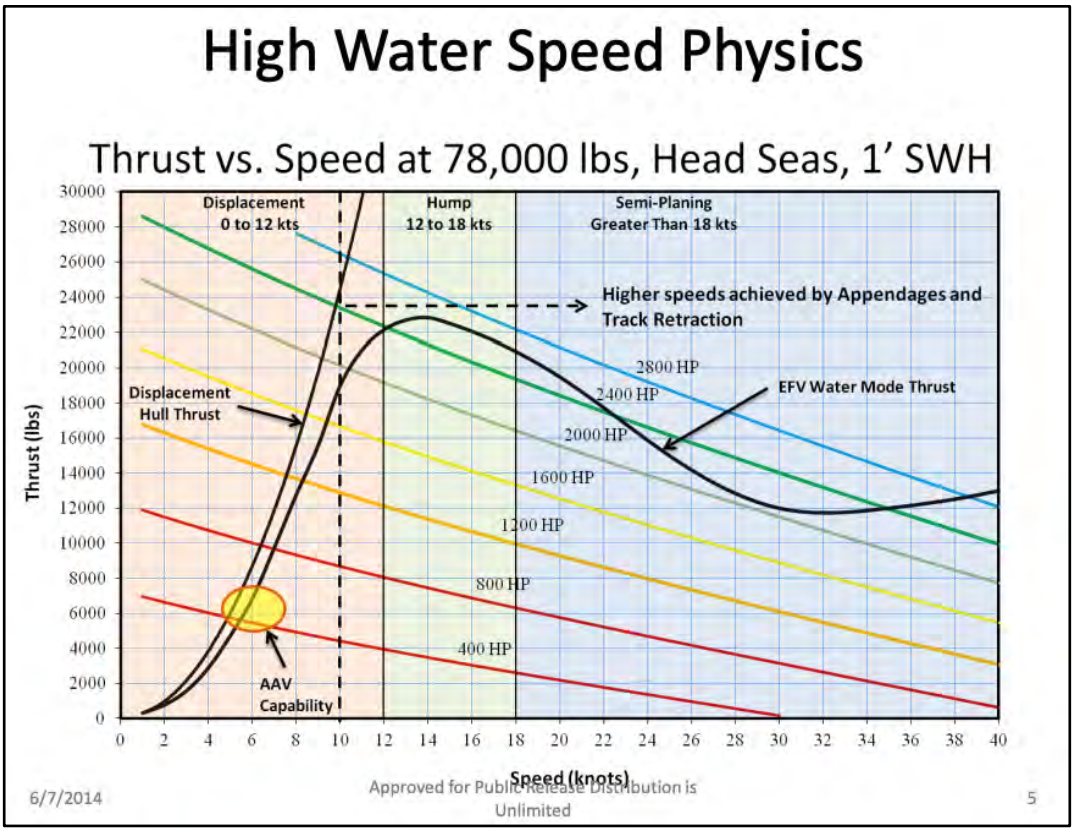

***Figure 5**: Graph of HWS physics that depicts the engine horsepower requirements to move from the speed hump to the semi-planing state (Source: Concept Exploration of the Amphibious Combat Vehicle[60])*

***Figure 6**: Experimental Type-05 gauge showing upper and lower bow flap angles (left); experimental Type-05 gauge showing stern flap angle (center); Type-05 gauge likely showing upper and lower front bow angles and stern flap angle (right) (Source: CCTV[61])*

In addition to the Type-05's dynamically adjustable flaps, Project 212 engineers adopted numerous other measures to improve the vehicle's water speed. For example, they reportedly employed water jet propulsion, designed retractable tracks to reduce drag, used aluminum alloy for the vehicle's body to reduce weight and developed specialized welding

techniques for this aluminum alloy, designed a unique wing shape for the Type-05's stern flap to improve lift (see **Figure 7** below), reduced the number of support structures for the wing-shaped flap, improved the strength and reduced the weight of the front flap, added foamed plastics to elements of the vehicle to improve buoyancy, and created an automatic control system to optimize and simplify flap adjustment.[62]

***Figure 7**: Demonstration of the Type-05's wing-shaped stern flap (Source: CCTV[63])*

Other Vehicles

In addition to the Type-05, the PLA also operates various other amphibious armored vehicles. For example, it uses the PLZ-07B amphibious self-propelled howitzer, which is armed with a 122mm gun with an 18-kilometer max range and a 12.7mm machine gun, weighs 24.5 tons, and has a crew of five (see **Figure 8** below).[64] The PLA also has a family of 8x8 wheeled amphibious armored vehicles, which includes the ZBL-09[65] infantry fighting vehicle and ZTL-11 assault vehicle (see **Figure 9** below).[66] The ZBL-09 reportedly has a maximum speed of 100 kilometers per hour on land, faster than the Type-05's reported maximum speed of around 65 kilometers per hour on land, but this family of 8x8 vehicles lacks the Type-05's HWS and is very likely not optimized for cross-sea landing operations.[67] The PLA also reportedly still operated the Type-63A, an upgraded version of China's Type-63 first-generation amphibious assault vehicle, as of the early 2020s (see **Figure 10** below).[68] The original Type-63 designed in the 1960s had a water speed of around twelve kilometers per hour, and the upgrade in the 1990s has reportedly allowed the Type-63A to reach fifteen kilometers per hour on the water.[69]However, in recent years, experts have predicted that the Type-63A will be retired soon, and by mid-2024, the PLA may have already retired the vehicle.[70]

Figure 8: *PLZ-07B amphibious self-propelled howitzer operated by the PLAA (Source China Military Online[71])*

Figure 9*: The ZTL-11 amphibious assault vehicle (People's Republic of China [PRC] Ministry of National Defense[72])*

***Figure 10**: The Type-63A amphibious assault vehicle (Source: Hunan Today[73])*

Ongoing Amphibious Armored Vehicle Development in China

Open-Source Reporting

New Type-05 Variants

Since the Type-05 made its public debut in 2009, China has reportedly introduced multiple new variants in the vehicle family. For example, in September 2020, *Janes* reported that Chinese state media had revealed a new amphibious armored reconnaissance vehicle that seems to be based on the Type-05 (see **Figure 11** below).[74] According to *Janes*, the vehicle is equipped with an electro-optical and infrared system, laser range finder, and X-band radar mounted on a telescopic mast; a 12.7mm machine gun; and a retractable catapult system for launching a small unmanned aerial vehicle.[75] The vehicle is reportedly intended to perform intelligence, surveillance, target acquisition, and reconnaissance functions to help other PLA units engage targets during landing operations.[76] In November 2019, *Janes* also reported that Chinese state media had unveiled a new amphibious armored breaching vehicle that appears to be based on the Type-05 family (see **Figure 12** below) and is equipped to quickly move through obstacles.[77] The new vehicle appears to lack the front and rear flaps typical of most Type-05 vehicles, meaning that it very likely has a lower water speed.[78]

***Figure 11**: Chinese state media broadcast that reportedly depicted the PLA's new amphibious armored reconnaissance vehicle based on the Type-05 (Source: Janes[79])*

***Figure 12**: Chinese state media broadcast that reportedly depicted China's new amphibious armored breaching vehicle based on the Type-05 (Source: Janes[80])*

New Wheeled 8x8 Vehicle

In addition to designing new variants of the Type-05 family, China has continued to develop its 8x8 wheeled amphibious armored vehicles as well. In November 2023, *Janes* reported that Chinese state media had covered the introduction of a new 8x8 amphibious infantry fighting vehicle, possibly known as the Type-19.[81] *Janes* suggests that the vehicle uses a new turret and new hull features such as redesigned suspension and automotive components.[82] This new vehicle is reportedly designed to support a higher gross vehicle weight, which *Janes* assesses would allow it to have better armor and heavier mission systems.[83] Various low-confidence sources have also discussed the introduction of this vehicle, identified it as the Type-19, and claimed that the vehicle uses an unmanned turret; some sources describe it as a third-generation, domestically produced infantry fighting vehicle and suggest it will replace the ZBL-09.[84] There is currently a dearth of authoritative open-source information about the Type-19. Like its predecessors, the Type-19 is very likely not optimized for cross-sea landing operations.

Wheeled HWS Vehicle Prototype

In October 2017, multiple Chinese state media outlets, including the official newspaper of China's Ministry of Science and Technology, reported that China was developing a new wheeled amphibious vehicle with HWS capabilities.[85] The reports claimed that the prototype 5.5-ton vehicle could reach speeds of up to 50 kilometers per hour on the water, used a V-shaped hull and retractable wheels to reduce drag, and was intended for both military and civilian use, with applications including maritime personnel and material transport and special operations.[86] According to Chinese state media, China North Vehicle Research Institute (CNVRI; 中国北方车辆研究所) was the main designer for the new vehicle.[87] CNVRI is a subsidiary of China NORINCO Group.[88] The report suggests that CNVRI began raising funds for the project around 2012, that the project was technically challenging and required significant time and resources, and that the project involved main components independently developed in China.[89] Images published earlier in June 2017 that purportedly depict the prototype show that it is a 4x4 wheeled vehicle but blur lower areas of the hull (see **Figure 13** below).[90] Various low-confidence sources have speculated that, if finalized, the vehicle would likely be outfitted with heavier armor, which would likely reduce its water speed.[91]

***Figure 13**: Purported photograph of CNVRI's new HWS amphibious vehicle prototype (Source: Sina Military[92])*

Unmanned Systems

In November 2022, China's defense industry displayed a new "amphibious unmanned combat vehicle" (两栖无人战车) at the 14th Airshow China in Zhuhai, Guangdong (see **Figure 14** below).[93] According to Chinese state media, the amphibious unmanned combat vehicle is a light, mobile platform developed for future diversified missions and can meet the requirements of PLAA amphibious combined arms brigades, special operations forces, coastal defense forces, and the PLANMC.[94] Video footage from the exhibition indicates that the vehicle traverses land using four retractable triangular tracks.[95] Though Chinese state media reporting described the amphibious unmanned combat vehicle as a China Ordnance Equipment Group Corporation (China South Industries Group Corporation; CSGC; 中国兵器装备集团) product, the exhibition video footage shows NORINCO Group's name and logo on the vehicle's plaque as well, which suggests that the development of the vehicle was likely a joint effort between CSGC and NORINCO Group.[96] Due to differences between the vehicle displayed at the 14th Airshow China and the likely prototype shown in CSGC promotional materials, observers have speculated that the version displayed at the exhibition may have been a "mockup meant to reflect a more production-representative version".[97] It is unclear how thickly this vehicle is armored.

***Figure 14**: The "amphibious unmanned combat vehicle" displayed at the 14th Airshow China in 2022 (Sources: China News Online[98])*

In April 2019, China's defense industry reportedly delivered a military and civilian dual-use "amphibious unmanned boat" (陆两栖无人艇) known as the "Marine Lizard" (海蜥蜴).[99] According to Chinese state media, its possible missions include delivering special forces over the water, beach landings, border defense patrols, near-shore early warning, and island-reef airfield defense.[100] These reports claim that the boat is equipped with missiles and machine guns and can engage armored, air, and sea targets.[101] The boat can reportedly operate autonomously or through remote control, and it can supposedly reach speeds of around 93 kilometers per hour on water and at least 20 kilometers per hour on land.[102] Given its low speed on land, very high speed on water, and the presence of "boat" in its name, the amphibious unmanned boat is likely more of a boat with limited land mobility rather than a true amphibious vehicle akin to others detailed in this report.

Patent Data

Over the past decade, entities belonging to China's defense industry and military have filed a large number of patent applications related to amphibious vehicles that likely provide insight into the ongoing development of amphibious armored vehicles in China. These documents reveal ongoing efforts to increase water speed, streamline transitions between water and land, optimize maintenance, reduce corrosion, increase land mobility, and improve operational safety. Other areas of likely interest include steering, training, manufacturing, heat dissipation and cooling, engine control and performance, controlling cavitation, and vehicle design. In justifying their innovations, these documents frequently discuss purported deficiencies in China's amphibious vehicles and related technologies; China's amphibious armored vehicles are world-class, but they are not perfect.

Using data from Google Patents, Insikt Group collected and reviewed over 300 Chinese amphibious vehicle-related patent applications, hereafter referred to as "patents", that were filed between 2014 and 2023. Our dataset comprises patents from three categories: patents assigned to CNVRI that include the word "amphibious" (两栖); patents assigned to PLA entities that include the word "amphibious"; and patents assigned to other Chinese organizations like subsidiaries of state-owned defense companies, universities, and private companies that include the phrase "amphibious armored" (两栖装甲). While many of the CNVRI and PLA patents broadly refer to amphibious vehicles rather than focus specifically on amphibious armored vehicles, the innovations detailed in these documents could still be applicable to amphibious armored vehicles or otherwise inform the development of amphibious armored vehicles. We selected CNVRI as one of our primary research targets because of the organization's known involvement in amphibious armored vehicle development, its status as a state-owned defense industry research institute, and the large number of relevant patents that the organization has produced in recent years.[103]

From our preliminary dataset of over 300 patents, Insikt Group created a final dataset of 107 documents we assessed to be relevant to this investigation. Some of these patents specifically focus on amphibious (armored) vehicles, while others present inventions that are more broadly applicable but are described as being relevant to amphibious (armored) vehicles. Our final dataset includes several patents that appear to be duplicates or near duplicates of other documents. Our dataset provides qualitative examples of likely research and development activity related to amphibious (armored) vehicles in China, but it should not be interpreted as an exhaustive, quantitative study of all Chinese research and development activity related to amphibious (armored) vehicles between 2014 and 2023. There is no guarantee that China's defense industry or the PLA has adopted or will adopt the inventions detailed in these patents or that the technical claims detailed in these patents are accurate.

Water Speed

CNVRI, PLA entities, and other Chinese organizations filed numerous patents related to increasing the water speed of amphibious vehicles between 2014 and 2023, one of which specifically focuses on amphibious armored vehicles.[104] Many of these patents prioritize reducing various forms of water resistance, including by employing retractable hydrofoils to improve lift,[105] using high-pressure fans to add airflow to the water surface,[106] streamlining and sealing the vehicle hull,[107] adopting novel vehicle hull designs,[108] using retractable suspension,[109] and using wing-like structures.[110] Other water speed-related patents address elements like propulsion,[111] transmission,[112] and guidance plates.[113]

For example, in September 2022, CNVRI filed a patent application for an amphibious vehicle hull design that, based on experimental testing, can purportedly help amphibious vehicles reach water speeds of 50 to 55 kilometers per hour, which is significantly faster than the reported water speeds of the Type-05 and comparable to the wheeled vehicle prototype that CNVRI revealed in 2017 (see **Figure 15** below).[114] According to the document, water resistance has a significant effect on the water speed of an amphibious vehicle, and the design of a vehicle's hull significantly influences its water resistance.[115] The document further claims that standard amphibious vehicle hull designs, including the kind of hull the Type-05 uses, do not have any special water resistance reduction structures, leading to lower water speeds.[116] As such, the patent proposes a hull design that uses left and right vehicle bodies with a connecting central body to form an air passage capable of generating upward lift.[117] The lift this air passage generates can reportedly reduce the vehicle's immersion depth and water resistance, allowing it to achieve faster water speeds.[118] The design also features a stern flap and retractable tracks and plates that can seal the retracted tracks to further reduce resistance (see **Figure 16** below).

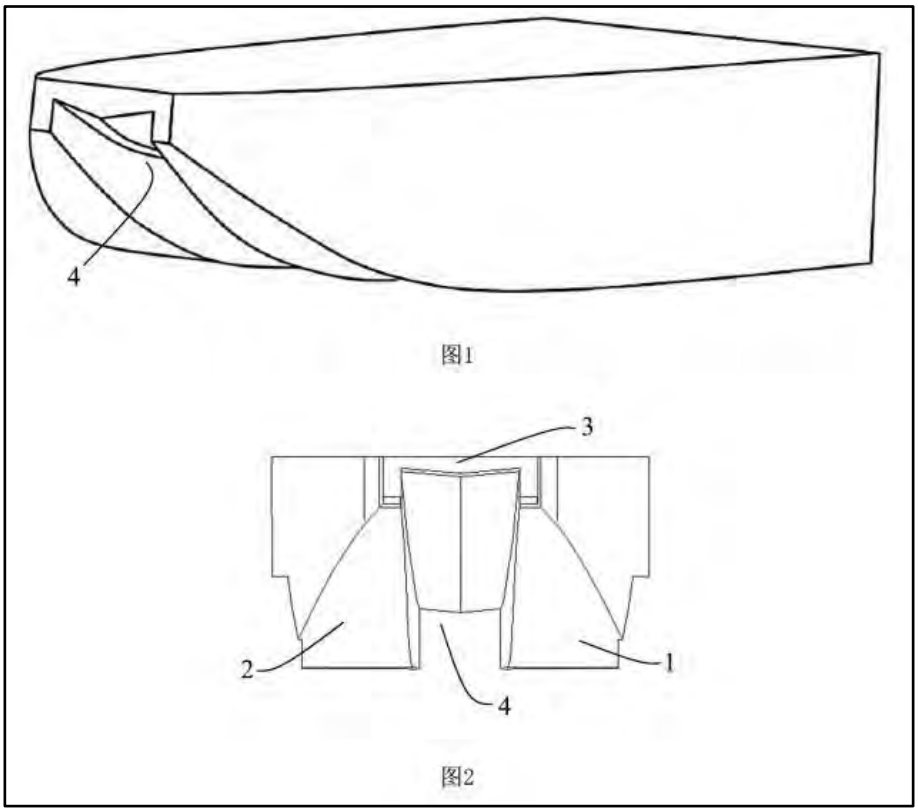

***Figure 15**: Diagrams of the proposed amphibious vehicle hull design depicting the left, right, and central vehicle bodies (Source: Google Patents)*[119]

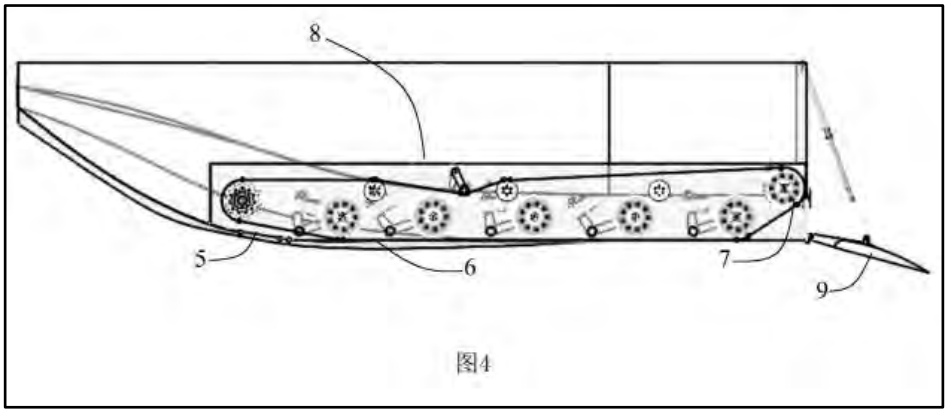

***Figure 16**: Diagram of the proposed amphibious vehicle hull design depicting the retractable tracks, sealing plates, and stern flap (Source: Google Patents)*[120]

Transitioning Between Water and Land

CNVRI, PLA entities, and other Chinese organizations filed patent applications related to rapidly transitioning between water and land in amphibious vehicles, two of which specifically focus on amphibious armored vehicles.[121] The inventions detailed in these documents aim to increase the speed of unfolding and retracting bow flaps,[122] automatically convert bogie limiters in tracks between water and land states,[123] automatically switch between the water and land

states of an automatic transmission,[124] facilitate single-button control for switching between water and land states,[125] and switch air intake between water and land states.[126]

For example, PLA Unit 92228 (92228部队), which is very likely the Specialized Services Institute of the Naval Research Academy (海军研究院特种勤务研究所),[127] filed a patent application in November 2021 intended to reduce the time it takes for an amphibious vehicle to unfold or retract its bow flap from around two minutes to roughly 30 seconds (see **Figure 17** below).[128] The document also suggests that traditional bow flap designs, which fold up over the front of vehicles, can impede vehicle maintenance and require manual operation by vehicle drivers.[129] Unit 92228 claims to have developed a new bow flap design that folds down, making daily maintenance of the vehicle easier; is operated through a single button, reducing the driver's workload; and unfolds and retracts through electrical controls, significantly increasing the speed of the retracting and unfolding process.[130]

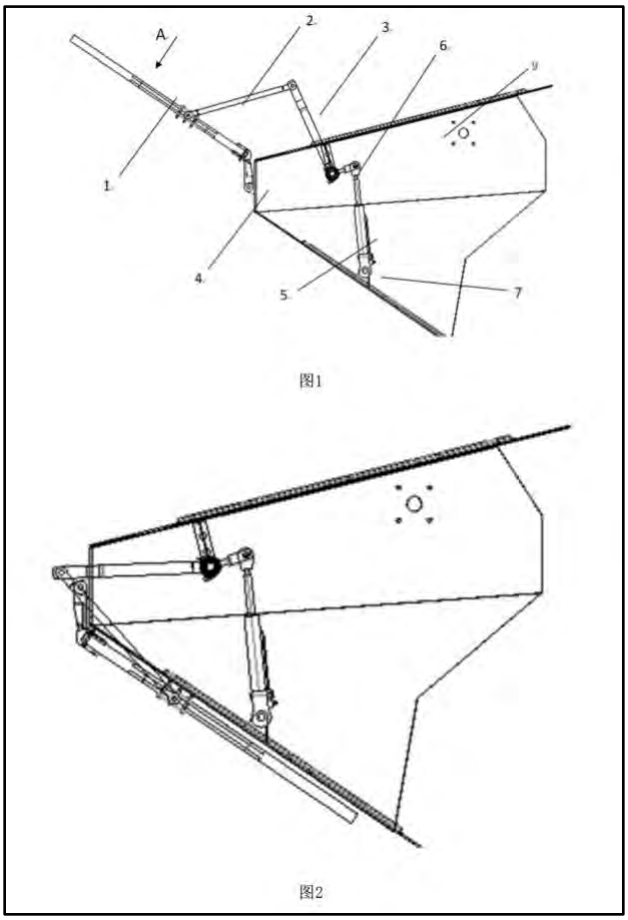

Figure 17: *Diagrams of the proposed bow flap design (Source: Google Patents)*[131]

Maintenance and Corrosion

PLA entities and other Chinese organizations filed various patents related to optimizing maintenance, reducing corrosion for amphibious vehicles, or both, the majority of which are specifically oriented toward amphibious armored vehicles. These documents address the detection of defects in ceramic composite armor,[132] corrosion of track pins,[133] detection of

electrical system issues,[134] corrosion-resistant materials,[135] sealing elements of the transmission against corrosion,[136] and fenders getting in the way of maintenance on tracked armored vehicles.[137]

For example, PLA Unit 73156 (73156部队), which is likely the 14th Amphibious Combined Arms Brigade under the PLAA's 73rd Group Army,[138] filed a patent application in February 2023 that details a plug for amphibious vehicle track pins intended to prevent corrosion of a vehicle's track pins and reduce its daily maintenance workload (see **Figure 18** below).[139] According to the document, China's tracked amphibious armored vehicles frequently experience track pin breakage during day-to-day use.[140] The patent claims that, during daily maintenance, the track pin bodies cannot be visually inspected if the tracks are not disassembled, and so only the ends of the track pins are immediately visible.[141] This reportedly leads to track pin damage and corrosion going unnoticed, which, over time, can lead to track breakage and thrown tracks.[142] The document notes that a major source of track pin corrosion is seawater and silt residue left in the pins, which are hollow.[143] This seawater and silt residue can build up quite quickly, reportedly causing issues after around two months, and the labor required to restore these pins significantly increases the vehicle's maintenance workload, as a single vehicle can have over 400 pins.[144] As such, Unit 73156 proposes using plugs in both ends of a track pin to prevent seawater and silt from entering the pins, prolonging the service life of the track pins, increasing the vehicle's buoyancy, and reducing daily maintenance requirements.[145]

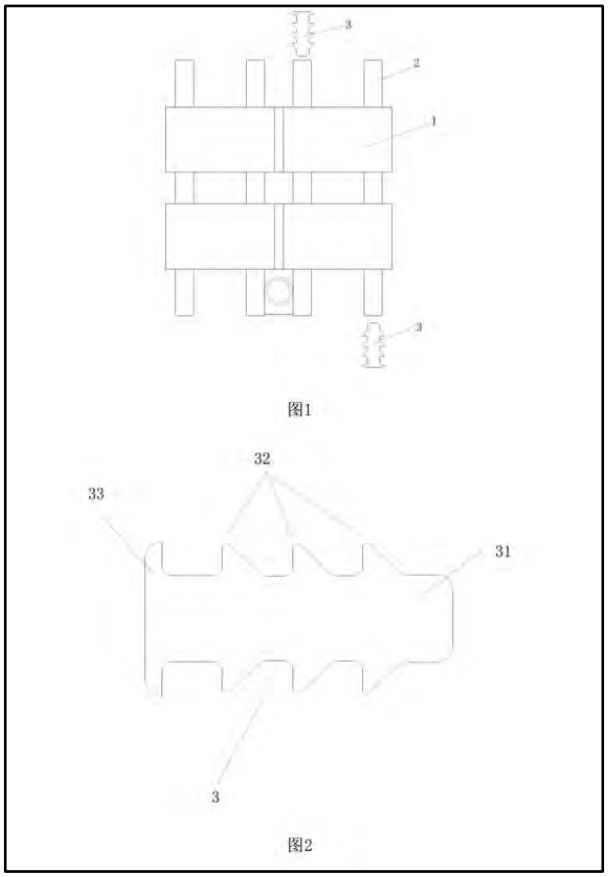

***Figure 18**: Diagram of the proposed track pin plug design (Source: Google Patents)*[146]

Land Mobility

CNVRI, PLA entities, and other Chinese organizations filed several patents related to improving the land mobility of amphibious armored vehicles, none of which specifically focus on amphibious armored vehicles. Multiple patents involve the use of auxiliary retractable tracks on wheeled amphibious vehicles to improve performance on difficult terrain.[147] Others address suspension, transmission, and wheels.[148] A number of these inventions were very likely intended for use in an amphibious logistics vehicle project that involved both PLA National University of Defense Technology (NUDT; 国防科技大学) and Wuhu Shipyard Co., Ltd. (芜湖造船厂有限公司),[149] a major state-owned naval shipbuilder.[150]

For example, in September 2020, NUDT filed a patent application for an auxiliary track system for a wheeled amphibious vehicle, which would allow the vehicle to take advantage of the benefits of both wheels and tracks while traveling on land (see **Figure 19** below).[151] According to the document, wheeled amphibious vehicles can achieve high speeds on paved surfaces but can struggle on difficult terrain, including beaches and other areas where land and water meet, and tracked amphibious vehicles perform better on difficult terrain but are slower overall.[152] This patent and other related patents from NUDT and Wuhu Shipyard suggest that retractable auxiliary tracks can improve the performance of a wheeled amphibious vehicle on difficult terrain without impeding its performance on paved surfaces.[153]

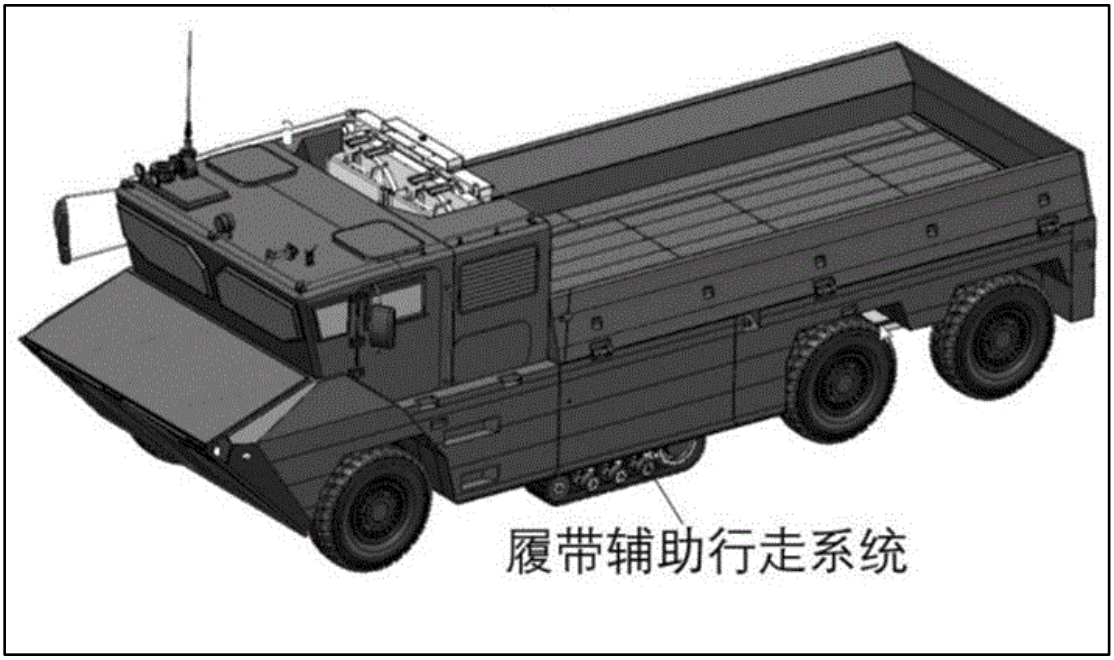

Figure 19: *Diagram depicting the proposed auxiliary crawler system on a very likely amphibious logistics vehicle (Source: Google Patents)*[154]

Safety

Various Chinese organizations, including subsidiaries of both NORINCO Group and CSGC, as well as a PLA factory, filed patents related to improving the operational safety of amphibious armored vehicles.[155] The majority of these patents aim to increase buoyancy or improve watertight sealing to prevent amphibious armored vehicles from sinking because of misoperation, poor weather conditions, and other factors.[156] One patent proposed a safety hatch for amphibious

armored vehicles that can reportedly open both inward and outward, intending to improve the safety of these vehicles in emergency situations without compromising convenience or taking up unneeded space.[157]

For example, in December 2022, Jianglu Machinery Group Co., Ltd. (江麓机电集团有限公司), a subsidiary of NORINCO Group, filed a patent application for a device intended to lock and seal the rear gate of an amphibious armored vehicle to prevent the vehicle from sinking (see **Figure 20** below).[158] The document argues that door locks designed for land-based armored vehicles are not secure enough for use by amphibious armored vehicles, noting that passenger misoperation and external forces can rotate a vehicle's internal and external handles, which can result in the vehicle sinking and lead to casualties.[159] It also notes that wear and tear on sealing elements of vehicle doors can also lead to the vehicle sinking and casualties.[160] According to the document, attempts to remedy these issues with auxiliary locking mechanisms have been complicated and expensive.[161] To address these issues, Jianglu Machinery Group Co., Ltd., designed a rear gate lock mechanism that uses a key to prevent misoperation and improved sealing elements.[162]

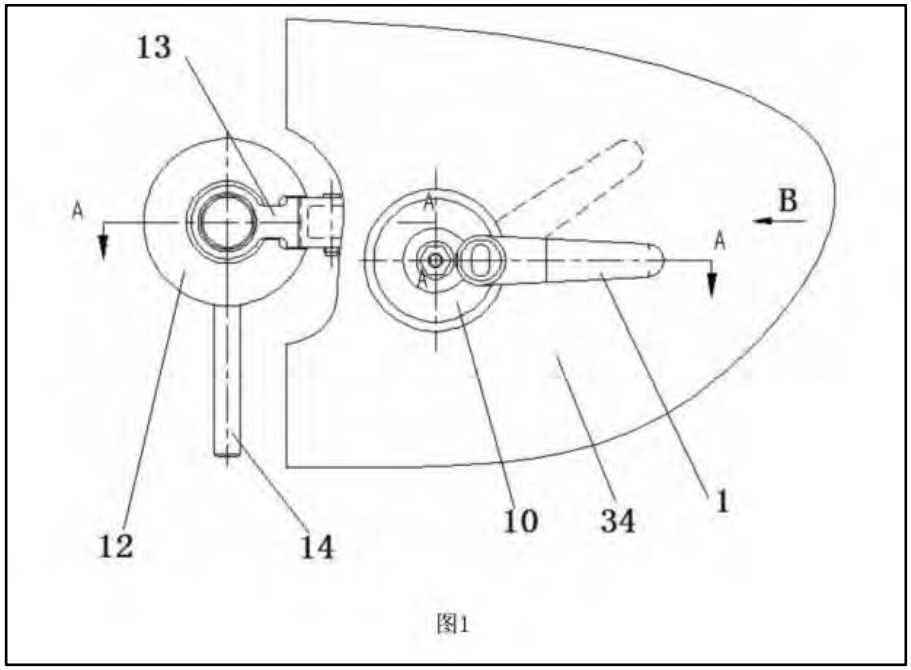

***Figure 20**: Diagram of the proposed rear gate locking and sealing mechanism (Source: Google Patents)[163]*

Other

CNVRI, PLA entities, and other Chinese organizations have also filed patents related to other elements of amphibious vehicles, including steering,[164] training,[165] manufacturing,[166] heat dissipation and cooling,[167] engine control and performance,[168] controlling cavitation,[169] and vehicle design,[170] among others.

For example, in September 2017, CNVRI filed a series of connected patents pertaining to an integrated water-land steering system for wheeled HWS amphibious vehicles (see **Figure 21** below).[171] According to one of the patents, most amphibious wheeled vehicles in China use two completely separate steering systems for navigating on water and land, which has several downsides.[172] It suggests that the use of two steering systems takes up precious space in the already cramped driver cabins of wheeled amphibious vehicles; requires drivers to be trained in both systems, which is

impractical; and requires drivers to subjectively evaluate two different sets of steering characteristics, such as steering sensitivity, creating serious safety risks.[173] Accordingly, CNVRI claims to have developed an integrated water-land steering system that uses a single steering wheel, can quickly switch between water and land states, has a simple structure, takes up a small amount of space, and is low-cost, stable, convenient to maintain, and lightweight, among other benefits.[174]

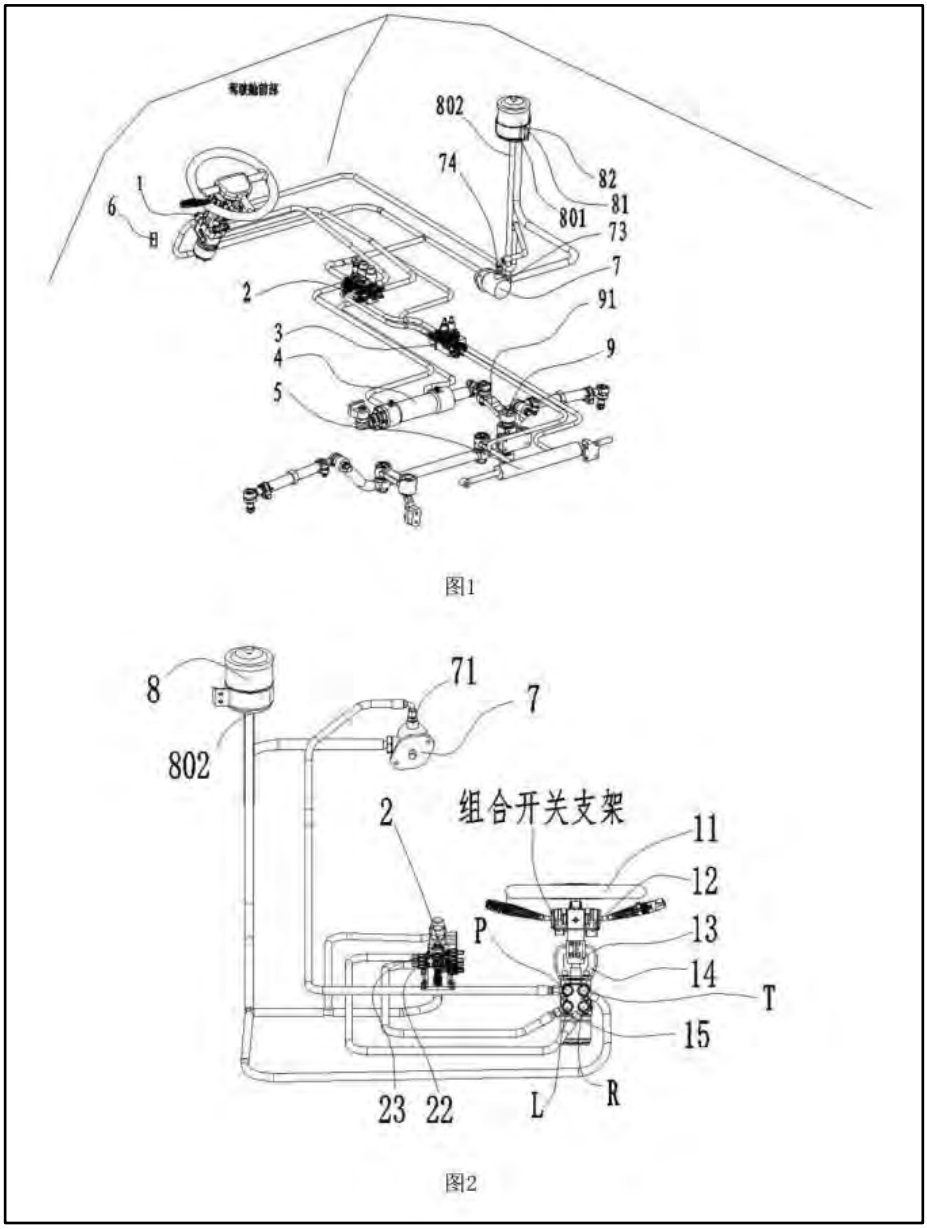

***Figure 21**: Diagrams of the proposed integrated steering system (Source: Google Patents)*[175]

In late 2021, the Specialized Services Institute of the Naval Research Academy filed a series of patents related to improving simulation training for amphibious vehicles.[176] One of the patents focuses on simulating the operation of an amphibious armored vehicle while injured due to battle damage (see **Figure 22** below).[177] It suggests that whether the injured operator can use their uninjured limbs to prevent the vehicle from sinking or force the vehicle onto the beach is

an important factor for the fighting strength of the first wave of landing forces.[178] However, China reportedly does not have any simulators or simulation methods suitable for this scenario.[179] Therefore, the Specialized Services Institute proposed a simulation method that limits the training subject's limbs, requiring the training subjects to operate an amphibious vehicle using only a single hand and a single foot.[180]

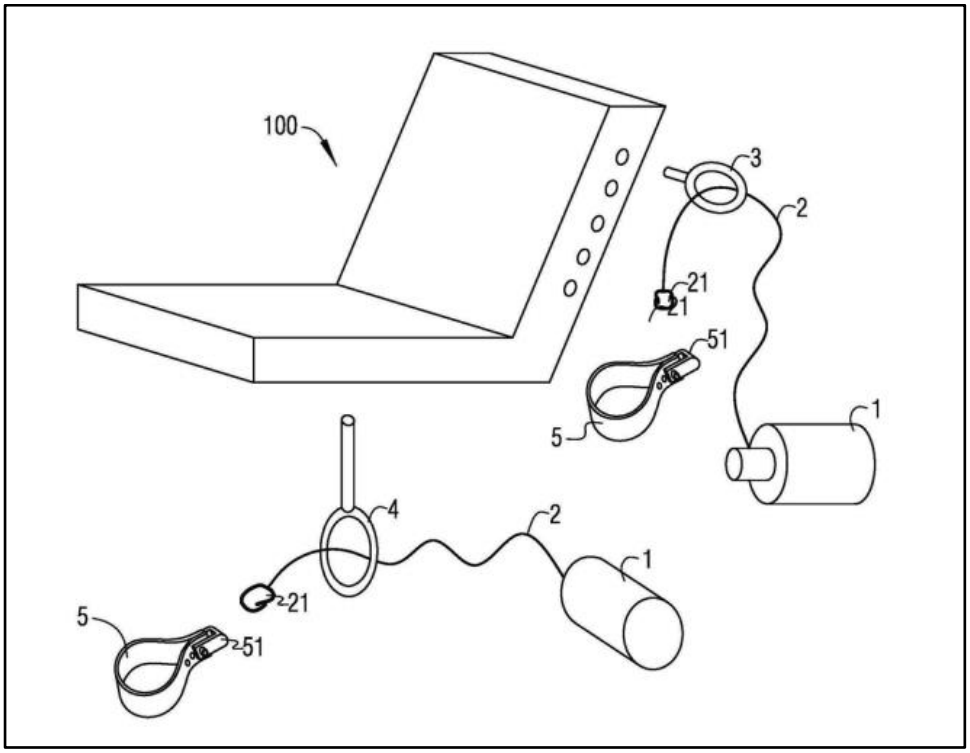

***Figure 22**: Diagram depicting elements of the proposed simulation method (Source: Google Patents)*[181]

Procurement Records

PLA procurement records also offer some insight into amphibious armored vehicle research and development activity in China. Notably, in May 2020, Unit 63966 (63966部队) of the PLAA published a tender for the development of a hydrological observation system that provides further evidence of the PLA carrying out ongoing research and development activity focused on HWS amphibious armored vehicles.[182] According to the document, Unit 63966 was seeking a hydrological observation system that would be "mainly used to complete high navigation speed new-type amphibious armored vehicle experimental evaluation research; develop hydrological testing systems; complete near seas experimental sea state parameter testing, data collection, storage, and transmission; and provide sea state testing methods and data support for high navigation speed new-type amphibious armored vehicle experimental evaluation research and maritime experiments".[183]

In October 2020, the Army Academy of Armored Forces (军陆军装甲兵学院) published a tender for research on maritime safety guarantees and development of rush repair equipment oriented toward use in actual combat for "new-type amphibious armored equipment".[184] In December 2023, the academy published a tender related to the creation of unit-level "repair technical regulations" and "repair processes" for an unspecified amphibious armored rush repair vehicle.[185]

Outlook

Given the PLA's focus on preparing for Taiwan invasion scenarios, China's defense industry will almost certainly continue carrying out research and development related to amphibious armored vehicles for the foreseeable future, and HWS will very likely remain a priority. This research and development will very likely include incremental improvements to amphibious armored vehicles that are currently in service as well as the introduction of new variants to existing vehicle families. Though China's defense industry has demonstrated interest in developing novel amphibious armored vehicles, it is unclear whether the PLA currently has any plans to replace the Type-05 family of amphibious armored vehicles. The development of a new family of amphibious armored vehicles would almost certainly require a major defense industry initiative comparable to Project 212 and would almost certainly be kept a secret, so credible open-source information about such a project would be limited or non-existent.

Despite the Chinese defense industry's efforts to develop world-class amphibious armored vehicles, external factors may diminish the PLA's ability to effectively use these vehicles in an invasion of Taiwan, including the PLAN's sealift capacity, the weather conditions and sea state in the Taiwan Strait, and Taiwan's geography, among others.[186] For example, experts have assessed that the PLAN does not have enough landing ships to sufficiently support a cross-strait invasion.[187] Estimates of the PLAN's current fleet suggest that it is capable of generating enough sealife for around 670 ZTD-05 amphibious assault vehicles, which is nowhere near enough sealift for the number of amphibious armored vehicles operated by the PLAA's six amphibious combined arms brigades under the 72nd, 73rd, and 74th group armies.[188] As noted earlier in this report, the 48 amphibious assault gun companies and 48 amphibious mechanized infantry companies under these brigades are estimated to operate roughly 1,340 vehicles at full strength, not to mention the other amphibious armored vehicles present in these brigades and the PLANMC's amphibious armored vehicles.[189] PLAA coastal defense forces are expected to supplement the PLAN's sealift with their landing craft, but these craft are reportedly "older, smaller, and slower" than PLAN vessels, and so experts have suggested that "watercraft units must modernize to provide more reliable cross-strait lift options to the PLA".[190] Moreover, PLAA coastal defense landing craft are likely optimized for delivering forces to the shore rather than deploying amphibious armored vehicles on the sea.[191] China has also been experimenting with using its civilian merchant fleet to provide further sealift PLA forces, including Type-05 amphibious armored vehicles, but the use of civilian vessels would very likely create additional challenges for the PLA.[192]

Recorded Future reporting contains expressions of likelihood or probability consistent with US Intelligence Community Directive (ICD) 203: Analytic Standards (published January 2, 2015). Recorded Future reporting also uses confidence level standards employed by the US Intelligence Community to assess the quality and quantity of the source information supporting our analytic judgments.

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