



# FMSO Foreign Perspective Brief

Foreign Military Studies Office (FMSO)

## The People's Liberation Army's Evolving Close Air Support Capability

Kevin McCauley

### KEY TAKEAWAYS

- **The ability of China's People's Liberation Army (PLA) to carry out close air firepower support missions has improved over the past decades.** The PLA has considered aviation support to ground forces as another form of fire support. Command and coordination have changed over time although details of the process are not entirely clear. While the PLA defines close air support against ground and maritime targets, there is a notable focus on support to ground units.
- **PLA Air Force (PLAAF) fire support is likely meant to be employed against deeper tactical targets, although the proximity of strikes is dependent on the precision of the munition employed.** Army Aviation is likely intended to strike targets closer to friendly troops. Unmanned combat aerial vehicles (UCAV) will be used to a greater degree in the future, integrating intelligent technologies to coordinate swarm attacks against multiple targets or in sustained attacks against a single target.
- **The PLA's command and coordination structure for close air firepower support appears both more streamlined and simpler compared to U.S. close air support.** It also does not appear as integrated with ground maneuver. The PLA is capable of air-to-ground precision strikes directly supporting ground force's tactical combat but likely faces challenges in fully integrating these capabilities into a complex maneuver operation.
- **PLAAF modernization is fielding increasingly advanced reconnaissance and targeting systems.** The PLA's emphasis on precision munitions improves the capability to strike targets closer to friendly troops and closely integrate fires with maneuver. Improved close air firepower support would significantly enhance ground combat and maneuver warfare. Improvements to China's domestic chip-building capability and the development of a capable and redundant Beidou global navigation satellite system (GNSS) likely will support this effort.
- **Recent research sponsored by China increasingly is influenced by U.S. close air support (CAS) theory and practice.** PLA-affiliated scholars are closely studying the U. S. CAS process, communications, coordination, and weapons systems. While it is unlikely the PLA will copy U.S. procedures and organizations completely, it will likely adopt features it believes will improve its aerial fire support capabilities.

### Authors

**Kevin McCauley** served as senior intelligence officer for the Soviet Union, Russia, People's Republic of China (PRC), and Taiwan during 31 years in the federal government, and former Adjunct at the RAND Corporation. He served on numerous advisory boards and working groups supporting the Intelligence Community, National Intelligence Council, and U.S. Indo-Pacific Command. He currently writes on PRC and Taiwan military affairs for the US Government and various think tanks.

## INTRODUCTION

The People's Republic of China (PRC) has built an increasingly sophisticated precision strike complex as the People's Liberation Army (PLA) continues to develop the ability to carry out Multi-Domain Precision Operations. An important, but less studied element of this strike capability is close air support, or what the PLA calls close air firepower support. This capability, demonstrated as early as the 1950s, has direct implications for how possible military conflicts could play out from Taiwan to the Tibetan Plateau. This monograph examines PLA close air firepower support based on authoritative PLA sources including internal publications, as well as PRC aviation industry research. The PLA Air Force (PLAAF), Army Aviation, and unmanned aerial vehicle close air firepower support, command and control, and the firepower support process are examined. Each section provides a baseline of the PRC's progress against what authoritative PLA sources suggest is the end goal of its modernization for this mission set. Full assessment of certain topics, such as training on air-to-ground precision strikes by aviation and coordination with ground units are limited due to the sparse detail provided in media reporting regarding this type of training. The paper also explores PRC sources researching potential future operational and technological developments that could lead towards a capability more closely resembling U.S. CAS missions including increased integration of aerial firepower support with ground maneuver.

PLA research on historical and foreign close air support is extensive. Researchers have analyzed close air operations beginning in World War I through the U.S. involvement in both Iraq wars and Afghanistan. In addition, PLA and other PRC researchers have also analyzed Soviet and Russian air support operations and the Nagorno-Karabakh conflict. Their analysis concludes that the requirement for close air support has become more critical in recent conflicts and

the complexity of coordination between the Air Force and supported ground force units has increased according to target, location, time, task, and execution method. The increased lethality and precision of munitions and enhanced reconnaissance capabilities in the PLAAF have strengthened close air support capabilities.<sup>1</sup>

PRC analysts also studied the one joint operation the PLA has ever executed, the amphibious landing operation on the Nationalist-held Yijiangshan Islands in 1955. These islands, roughly 5.5 miles (8.8 km) off the coast of Zhejiang province, were part of an effort to limit Chinese Nationalist forces' footprint to Taiwan. The seizure of these islands involved rudimentary use of close air support against planned targets and in response to requests for strikes against newly discovered targets by the then-nascent PLA Air Force. While the PLA had gained significant experience during the Korean War as well as access to new capabilities in the form of Soviet-built weaponry, the campaign against the islands required previously unexercised structures.



Figure 1: Zhejiang Province and the Yijiangshan Islands.<sup>2</sup>

During the operation, the PLAAF established target guidance groups and organized coordination methods with the landing force, PLA Navy (PLAN) ships, artillery, and air defense forces. The PLAAF and Naval Aviation were combined under an Air Force Frontline Command Post. Target guidance groups were attached to ground units while Air Force liaisons were sent to support naval formations. The Air Force Frontline Command Post stationed an Air Force Operations Group in the Landing Command Post on a ship. An aviation liaison on the landing command ship instructed the aviation attack group to support the landing force experiencing counterattacks with the ground unit target guidance groups providing target locations and supporting damage assessments. PLA histories have described the aviation fire support as critical for the ground force consolidating the landing and eliminating

Nationalist resistance. Aviation initially targeted the Nationalist artillery presenting the greatest threat to the landing force. The landing force requested continued air strikes and strafing of enemy forces during combat as the attack on the island lost momentum. Subsequent air strikes, some conducted within 3-4 meters from ground units, supported the breakout from the beach into the depth of the enemy defenses targeting artillery, a command post, a radar station, fortified positions, and minefields as PLA ground forces seized the islands.<sup>3</sup> While short, this early experience of the close air fire support process continues to be referenced in the PLA literature and helped pave the way for the PLA's eventual development of close air firepower support capabilities.

## Terminology

It is important to note up front that the PLA uses different terms than the United States, substituting “close air firepower support” (hereafter, CAFS) to describe their version of CAS. While broadly similar, they also differ in crucial areas. Thus, it is necessary to differentiate between the U.S. definition and the group of relevant PLA concepts.

### **Close Air Support** (*U.S. Definition*)

CAS is air action by fixed-wing (FW) and rotary-wing (RW) aircraft against hostile targets that are in close proximity to friendly forces, and requires detailed integration of each air mission with the fire and movement of those forces.

*Joint Publication  
3-09.3 Close Air Support (2009)*

While the U.S. CAS definition emphasizes integration of air strikes with ground maneuver, PLA writings on the subject differ somewhat. PLA CAFS is a form of fire support and is described as integrated into the tactical unit’s firepower plan to directly influence offensive and defensive combat. PLA CAFS strikes key enemy targets such as long-range artillery, surface-to-surface missiles, and command posts supporting tactical ground combat. The PLA appears to rely more on Army Aviation and ground fire support for close-in targets, with the Air Force striking targets deeper in the tactical depth.

The PLA has maintained a doctrine for ground-air coordination to initiate Air Force strikes on tactical ground targets for decades. While not meeting the U.S. definition of close air support, it does provide for aircraft attacking close-in ground targets in direct support of maneuver forces to affect combat.

The following terms associated with close air firepower support and derived from an

authoritative internal PRC military publication provide a guide for understanding PLA close air firepower support:

- **Air fire support** [航空火力支] is aviation air assaults carried out in support of ground or navy operations. It includes close air fire support [近距航空火力支援] and deep air assault [纵深空中突击].<sup>4</sup>
- **Close air fire support** [近距航空火力支援] is considered by the PLA as its equivalent of close air support although it does not meet the U.S. military’s definition. Close air fire support includes aviation support to ground forces or naval operations. Air strikes on surface targets are carried out in the enemy’s front, close-in-, shallow-, and in-depth tactical positions directly affecting the ongoing actions of friendly forces. It is divided into three phases: air fire preparation, air fire counter-preparation, and direct air fire support.<sup>5</sup>
  - » **Air fire preparation** [航空火力准备] is an air strike on the enemy prior to friendly ground forces initiating an attack or moving forward. It is divided into **preliminary air fire preparation** [预先航火力准备] and **direct air fire preparation** [直接航空火力准备]. It is usually carried out in conjunction with firepower preparations by artillery, Army Aviation, or missile strikes, but can also be conducted separately.<sup>6</sup> Preliminary fire preparation is strikes on important enemy targets such as in-depth targets and defense facilities to weaken the enemy and create conditions for friendly forces to attack. Direct fire preparation is intended to shock and annihilate the enemy forces in forward positions, damage and destroy its important defense facilities, suppress the enemy’s forward, near, and deep firepower, and create conditions for friendly attack forces.<sup>7</sup>
  - » **Air fire counter preparation** [航空火力反准备] is an attack to disrupt the enemy’s

ground forces. The objective is to destroy the enemy's offensive preparations, disrupt its offensive deployment and rhythm, and support the forward friendly ground forces. It is usually conducted in combination with artillery, Army Aviation, and missile fire counter preparations but can be conducted independently by the Air Force.<sup>8</sup>

- » **Direct air fire support** [直接航空火力支援] is initiated after the ground forces launch their attack, with the Air Force conducting air assaults on targets that directly threaten or hinder the actions of friendly forces. The PLA considers this the main form of close air fire support. It is usually combined with ground force operations or other fire assaults.<sup>9</sup>
- **Deep air assaults** [纵深空中突击] are conducted on targets within the enemy's tactical depth. It is usually unsupported but can also be conducted in cooperation with the long-range firepower of the Army, Navy, and Rocket Force.<sup>10</sup>
- **Target guidance group** [目标引导组] is a group dispatched by the Air Force to accompany the supported ground force unit or naval formation to provide target guidance for the aircraft. The main tasks of the group includes accurately guiding the attacking aircraft or helicopters to their targets; communicating the requirements for air support from the units they are supporting to the relevant echelon; and providing the supported forces with up-to-date status of the aerial situation and available aircraft, etc.<sup>11</sup>
- **Air corridor** [空中走廊] refers to the air passage designated for aircraft entering and leaving a specific area. Air corridors can be one-way (a racetrack-type circuit) or two-way air corridor. The width can be 8-10 kilometers but likely is situationally dependent.<sup>12</sup>

PLAAF modernization has affected the capability to provide close air firepower support. At the same time ground force modernization enhancing

maneuver capabilities has greatly increased the requirement for both planned and ad hoc CAFS.

---

## PLA AIR FORCE CLOSE AIR FIREPOWER SUPPORT

PLAAF inventory and capabilities impact the quantity and quality of close air firepower support. PLA CAFS has evolved over the past decades and continues to enhance capabilities. PLA theorists are analyzing the U.S. CAS process, planning, and operations to enhance capabilities.<sup>13</sup> PLAAF limitations in the numbers of ground attack aircraft, target guidance personnel, and a lack of proficiency in night operations limited CAFS capabilities and failed to meet ground force requirements. Prior to the force reductions in the late 1990's and subsequent modernization, the ground force lacked agility, affecting the pace of combat. Consequently, CAFS consisted mainly of planned strikes with inadequate flexibility to address mobile or newly discovered targets on the battlefield. As the ground forces became more motorized and mechanized, and PLAAF capabilities improved, the PLA was able to transition to a model of CAFS better able to respond to and strike newly identified targets.<sup>14</sup> PLAAF expansion and modernization including increased lethality and precision of munitions aided by advanced reconnaissance capabilities have enhanced capabilities significantly.<sup>15</sup>

The PLA considers air superiority or supremacy as a prerequisite for conducting CAFS. This requires suppression of primary air defenses, leaving out the more difficult-to-suppress threats from short-range, man-portable air defense missiles, anti-aircraft guns, and other short-range weapons. Air-to-surface weapons with a range of more than 10 km can carry out stand-off attacks on ground targets in support of ground units.<sup>16</sup> The PLA divides CAFS into planned and immediate CAFS. The communication and coordination process is considered significant for CAFS requests against newly identified targets.<sup>17</sup>



The PLAAF includes a number of multi-purpose aircraft, targeting systems, and munitions of varied capabilities into the CAFS mission.

## PLAAF AIRCRAFT CAPABLE OF GROUND ATTACK

CAFS missions are heavily dependent on command and control, the coordination and guidance process, as well as the available aircraft to carry out these missions. The rapid increase in the quality of aircraft and precision munitions available to the PLAAF likely will have a significant

impact on how CAFS-type missions proceed. An example of the generational improvements achieved in capabilities can be seen in the 2017 retirement of the Q-5 jet, in service since the 1960s, replacing it with the modernized JH-7A and newer platforms such as the J-10. These upgrades represent a significant shift in speed, lift capacity, and survivability of aircraft likely to be assigned for CAFS missions. These other airframes, including the indigenously designed J-10, Sukhoi-family derived J-16, and carrier-capable J-1518 are present in much larger numbers. **Table 1** shows PLA aircraft capable of surface attack.

Aircraft	Armament	Sensor Systems	Range (miles)	Approx. Numbers
J-10/ J-10A	Cannon, Air-to-Surface Missiles, Laser Guided Bombs	The J-10 is equipped with a pulse-Doppler radar system, typically the Type 1475 or the improved Type 1475A. These radar systems provide air-to-air and air-to-ground targeting capabilities, track targets at long ranges, and support the integration of various radar-guided missiles. The aircraft can be fitted with a K/JDC01A forward-looking infrared and laser target designator pod, which supports the deployment of laser and satellite navigation-guided weapons.	1240	565
J-10B	Air-to-Surface Missiles, Laser Guided Bombs	Longer nose radome possibly housing an active electronically scanned array radar (AESA), an electro-optic targeting sensor.	1240	
J-10C	Air-to-Surface Missiles, Laser Guided Bombs	Equipped with an indigenous AESA fire-control radar.	1240	
JH-7A	Air-to-Surface Missiles, Laser Guided Bombs	Aircraft is compatible with airborne sensors such as radars and electro-optics so that the sensors are slaved to helmet-mounted systems, enabling fast-tracking, and aiming of the weaponry; The modernized JL-10A Shan Ying pulse-Doppler radar enables the JH-7A to launch laser-guided bombs and Kh-31P anti-radiation missiles.	1095	120
J-16	Air-to-Surface Missiles, including a stand-off submunitions dispenser similar to U.S. AGM-154 Joint Stand-Off Weapon (JSOW)	Features a new AESA radar and an improved electro-optical targeting system, featuring longer target acquisition distances and multiple target tracking capability. Includes Beidou satellite-guided and laser-guided bombs.	2420	250
Su-30MKK	Air-to-Surface Missiles	Upgraded avionics and maritime strike capabilities. SUV-P air-to-ground subsystem utilizes identical hardware of SUV-VEP air-to-air subsystem but with a different processing requirement.	1864	73
J-15 Carrier-based	Air-to-surface missiles, and various types of bombs including a 500-kilogram (kg) bomb. The J-15's maximum take-off weight from ski-jump carrier decks is reportedly 12 tons. <sup>20</sup>	Possibly equipped with an AESA radar system.	2175	60

It is worth noting that the PLAAF and PLA Naval Aviation aircraft have other aircraft types (some in large numbers) with some level of air-to-ground attack capability, but which are likely primarily tasked with air-to-air missions. The PRC has developed a J-20 stealth fighter, believed to be intended for a long-range air-to-air role. The aircraft does have a secondary strike capability and can be equipped with rocket pods and the LS-6 precision-guided glide bomb developed for stand-off attacks on fixed ground targets.<sup>21</sup> The J-11 fighter is based on the Su-27. While primarily designed for an air-to-air role, the J-11B can carry unguided 90mm rockets or 250kg general-purpose bombs for ground attack. It does not have a confirmed precision strike capability.<sup>22</sup>

The PLAAF can deliver a variety of precision air-to-surface munitions using laser and satellite aided inertial guidance. These include the LT-2/LS-500J laser-guided bombs and the FT and LS series of satellite-aided inertially guided bombs which are analogues to the U.S. Joint Direct Attack Munition (JDAM). For example, the FT-9 precision-guided bomb uses internal navigation system (INS)/satellite navigation with a circular error probability (CEP) equal to or less than 15 meters, while the LS-6 precision-guided bomb uses combined INS/GPS guidance with a CEP of 3 meters for fixed targets and ten meters for moving targets. The PLA inventory includes land attack and anti-ship air-to-surface missiles. Examples include the KD-88 standoff land attack missile and the Yj-91A anti-ship missile. Air-to-ground missiles include the TL-1 with a CEP of equal to or less than one meter and the TL-17 with a CEP of equal to or less than three meters. Available munitions also include a 250 kg fuel-air explosive bomb.<sup>23</sup>

The PRC's Beidou Navigation Satellite System provides accurate positioning data for precision strikes as well as communications between widely dispersed forces and platforms. The PRC established its satellite navigation system in competition with the U.S. Global Positioning

System (GPS). In addition to providing positioning data, the Beidou system (BDS) has a text messaging capability which represents a significant enhancement over GPS. The Beidou system used by the PLA since 2003 and People's Armed Police as well as for civilian use. The system has provided important support to disaster relief missions. BDS terminals are now used throughout the force for both positioning and communications. Specialized units such as special operations forces (SOF) and reconnaissance units have BDS terminals down to squad level used for targeting. BDS is integrated into the command information system to provide a digital battlefield situation map in command posts and vehicles with friendly unit locations. The PRC has continually expanded the BDS constellation coverage and capabilities. An integrated, intelligent comprehensive system is reportedly planned by 2035.<sup>24</sup>

There is limited reporting in PRC media about CAFS training. A survey of the available reporting in the PLA press on aircraft ground attack training since 2017 shows slightly more involvement of J-10s (13 instances) than J-16s (9 instances) and only one instance of JH-7A. Air-to-ground attack training appears to be against chalk-drawn targets with one training exercise targeted derelict vehicles.<sup>25</sup> The development of aircraft, munitions, and targeting systems for this role and their employment by the PLA indicates this capability exists, although it is difficult to assess the quality and readiness.

---

## COMMAND AND COORDINATION

PLA ground-air requirements and coordination procedures are established for an operation by the joint command. The joint command would normally be the theater joint command's Joint Operations Command Center (JOCC), but in certain circumstances could be the Central Military Commission's (CMC) JOCC. The theater command would provide the concept of operations, and general guidance, set the procedures for the

exchange of information between services, and assign forces to an operation. The theater command and subordinate command posts' intelligence centers provide information on the operational environment including enemy situation and force deployment. This information can be provided through the command information system's digital battlefield situation map available throughout the force or through a database that units can query.<sup>26</sup>

The command and coordination for close air firepower support are not clearly described in a single source. Based on several sources, and supported by additional references, the PLA structure for CAFS appears to be the following:<sup>27</sup>

- **Theater JOCC develops the operations plan, provides general guidance and coordination measures, and allocates forces.**
  - » **Air Force Support Coordination Group** – assists the Army in the employment, coordination, and distribution of tactical air support.
- **Group Army Command Post**
  - » **Tactical Air Force Control Center** – provides air operations coordination with the Army
  - » **Air Force Support Operations Center** – Organizes ground-air coordination; provides planning, intelligence, and operational support; includes attached Army fire support liaison for coordination.
- **Division, Brigade/Regiment, and possibly Battalion Command Posts**
  - » **Tactical Air Force Control Group** – Assists with tactical planning and coordination; briefs ground units on Air Force capabilities; coordinates with ground fire support; passes on CAFS requests to strike newly discovered targets; and assists in controlling movement of aircraft to the target area.
- **Battalion**
  - » **Firepower Team in command post** – Composed of a firepower team leader, firepower coordination staff officer, and

artillery liaison officer to support operations. An Army Aviation ground guidance officer is attached to support helicopter strikes. The team plans and coordinates fire support for the battalion, requests support from higher headquarters, and evaluates the strike effects.

- » **Air Force Target Guidance Group** – Provides target information and location; guides aircraft to the target; and designates the target. Assists, in combination with ground reconnaissance units, in battle damage assessment of strike on target to support a decision on re-striking the target, if needed.

The CAFS process begins at the strategic level with the theater joint command developing the concept of operations and allocating forces to support the main operational and supporting directions. The PLA has preferred centralized command with superior headquarters providing detailed planning for subordinate headquarters operations and deployments. While highlighting the need for more decentralization to promote initiative by subordinate commands, the PLA has preferred centralized command in main directions, with decentralized command in secondary directions. The PLA appears to be moving towards higher echelons providing general guidance and assignment of objectives allowing subordinate commands to conduct the detailed planning to achieve the assigned objectives. At the operational level, the group army with the attached Air Force element provides operational planning based on the theater commander's intent, coordination measures, and allocation of assigned forces for subordinates. The Air Force element at the brigade level supports tactical level planning and coordination and transmits requests for unplanned close air firepower support against newly discovered targets. The Air Force element at this level also guides aircraft movement to the target area.<sup>28</sup> A *PLA Daily* article from 2017 confirms an Air Force element, an Air Force Liaison Group, deployed to a combined brigade.<sup>29</sup> The firepower team in the battalion



command post is responsible for planning and coordinating firepower supporting the unit's combat. The firepower team can request support from higher headquarters and assess firepower strike effects. The target guidance group assigned to maneuver battalions assists in guiding the aircraft to the target and designates the target for the strike. The target guidance group with intelligence from reconnaissance patrols supports decision-making at the battalion command post for requesting additional air strikes on the target based on the battlefield damage assessment.<sup>30</sup> The same *PLA Daily* article from 2017 reported an Air Firepower Guidance Officer trained by the Air Force being deployed to special forces, armor, and other units. The article indicated improvements in the communication system to aid ground-air coordination.<sup>31</sup>

A *PLA Daily* article from September 2023 reported that a battalion from the 72nd Group Army, Eastern Theater Command, had established a joint firepower coordination position in the battalion command post. The joint firepower coordinator assesses the intended target, develops a firepower plan, and requests support. While the article only discusses coordination with an Army Aviation brigade for firepower support to a ground offensive operation, apparently coordination with other services can occur. The article states that in the past requests for joint firepower strikes required passing up echelons with multiple planning stages and a lengthy coordination time to receive support. This could be local experimentation by this unit or could indicate an evolution to streamline the joint firepower process. This development also supports earlier reporting on the establishment of a firepower team within the battalion command post.<sup>32</sup>

The modernization of the command information system enhances integration and provides communications between the services. A *PLA Daily* article from 2009 indicates the transition from coordinated to integrated joint operations. The article discusses the improved sharing of

information between the Army and Air Force, as well as closer training between the services.<sup>33</sup>

The U.S. component command and control agencies for close air support are depicted in **Figure 2** for comparison to the PLA structure.

Component Agency	United States Air Force	United States Army	United States Navy	United States Marine Corps	Special Operations Forces
TAGS Element	Theater air control system	Army air-ground system	Navy tactical air control system	Marine air command and control system	Special operations air-ground system
Air Control Center	Air Force air operations center	Airspace element	Tactical air control center/ tactical air direction center	Tactical air command center/tactical air direction center	Joint special operations air component
	Airborne warning and control system				
	Joint surveillance and target attack radar system			Tactical air coordinator (airborne)	
	Control and reporting center		Fleet air warfare coordinator	Tactical air operations center	Special operations command and control element
Liaisons to the JFACC	Air Force liaison element	Battlefield coordination detachment	Naval and amphibious liaison element	Marine liaison element	Special operations liaison element
Air Support Control Agency	Air support operations center		Air support coordination section	Force fires coordination center/ fire support coordination center	Joint special operations air component
	Tactical air coordinator (airborne)		Tactical air coordinator (airborne)	Tactical air coordinator (airborne) Tactical air control party	
Fire Support Coordinating Element		Fires cell	Supporting arms coordination center	Direct air support center	Joint fires element
Tactical Air Support Control Agency	Tactical air control party				
Terminal Attack Element	Forward air controller (airborne)		Forward air controller (airborne)	Forward air controller (airborne)	
	Joint terminal attack controller		Joint terminal attack controller	Forward air controller/ joint terminal attack controller	Joint terminal attack controller

Legend

JFACC joint force air component commander TAGS theater air-ground system

Figure 2: Component Air Command and Control Agencies for Close Air Support.<sup>34</sup>

### Ground-Air Coordination Planning

General planning designating campaign objectives and coordination methods between the services begins at the joint command level. Planning and

coordination methods are detailed in greater detail at lower echelons – Group Army and brigade. PLA publications describe the Army and Air Force jointly developing the ground-air coordination

plan. The coordination plan specifies the overall mission; the number of sorties per operational phase; specific assault targets; dispatch of sorties during each stage of the operation; timing of the strikes; deployment method and air routes; attack methods; distinguishing targets from those for artillery, Army Aviation or operational-tactical missiles; communication method and liaison organization for coordination between the various units; mutual identification methods (identification friend or foe); directions and signals to indicate targets; and friendly and enemy unit locations.<sup>35</sup>

---

## TARGET GUIDANCE PERSONNEL

### Air Force Target Guidance Groups

An Air Force target guidance group is assigned to assist aviation strikes supporting ground force brigade/battalion or PLA Navy ships. One PLA source compares the target guidance group to the U. S. Tactical Air Control Party (TACP) and the Joint Terminal Attack Controller (JTAC). The Air Force apparently had increased the numbers of target guidance groups to shift their deployment from division-level, down to brigade and regiment, and finally to battalions. However, it is likely that target guidance groups were only provided to units conducting important operations, such as main attacks or defending against enemy main attacks. The target guidance group provides updates to the Air Force command on the supported unit's requirements for CAFS, accurately guides air strikes against the planned targets, informs supported units of the situation of the aircraft or helicopters, and other pertinent information.<sup>36</sup>

The target guidance group employs several methods to identify targets in the forward area of friendly ground troops. The first method is providing target or target area coordinates on a map or imagery. The second method is providing azimuth and distance using a known piece of terrain as a base point to guide the aircraft toward the target. The third method is to provide the target's relative position to a geographic location. The fourth method is to deploy signals near or directly

FMSO.TRADOC.ARMY.MIL

on the target. Laser designation is employed for laser-guided munitions.<sup>37</sup>

Personnel, training, and inter-service coordination issues appear to be a stumbling block for PRC efforts to build effective air firepower support capabilities. The Air Force has complained that it did not have enough personnel to provide the required numbers of target guidance groups to ground units. A *PLA Daily* article from 2022 described an Air Force base in the Western Theater Command training Army officers from reconnaissance units to provide guidance for air-to-ground strikes. According to the report, hundreds of personnel have received training to provide CAFS guidance. The article noted that problems remain between the services including the use of different data standards, terminology, and understanding of other service's tactics. However, this is an important development in providing sufficient target guidance capabilities for CAFS to Army units.<sup>38</sup>

An article from 2019 reported 14 Air Force pilots sent to an infantry battalion subordinate to the 83rd Group Army to serve as platoon leaders to gain familiarity with ground tactics so they could provide better strike support in the future.<sup>39</sup> Another article from 2019 also reports pilots being attached to ground units in the 75th Group Army for familiarization.<sup>40</sup> These developments appear to improve ground-air coordination by improving pilot familiarity with ground operations, also indicating continuing issues in inter-service knowledge and understanding that can hinder the PLA's joint operations capability.

There is also a possible change in terminology. An article from 2023 described joint tactical guidance personnel guiding aircraft in strikes on ground targets, with joint tactical guidance taught at a special operations brigade in the Eastern Theater Command. Issues were reported during training including inaccurate guidance and insufficient tactical connection, possibly referring to conflicts in establishing or maintaining communications between services.<sup>41</sup>

## Ground Force Reconnaissance Support

Reconnaissance resources will identify potential targets. Ground forces use various reconnaissance methods to monitor the battlefield, including reconnaissance patrols, unmanned aerial vehicles (UAVs), optical, acoustic, and other means. Increasingly, tactical units rely on UAVs to provide intelligence. The PLA has discussed the U.S. use of forward air controller (airborne) (FAC (A)) and reconnaissance UAVs to support CAS missions, assessing it as an important element of future CAS operations. The FAC (A) provides mobility and flexibility, especially in complex terrain such as jungles or mountains. There appears to be some effort to develop similar capabilities. An article from 2019 describes a combined arms battalion employing UAVs to identify targets. The battalion called for close air firepower support, although the exact means of requesting support was not provided. Reportedly, within ten minutes two Air Force aircraft conducted a precision strike on the target.<sup>42</sup>

## Special Operations Forces

The PLA's special operations forces have expanded in size over the past several decades. Each Group Army has a special operations brigade tailored for its likely wartime missions which include reconnaissance as well as direct-action. The other services also include similar units. In addition, these units' equipment and capabilities have likely improved. In addition to Air Force target guidance groups supporting ground units, special forces personnel are trained to provide target guidance for aircraft and ground fire support against targets they identify in the enemy rear area. PLA special operations force reconnaissance or direct-action groups can request aviation strikes on newly discovered targets or support direct-action missions in the enemy's rear area. An authoritative publication from the PLA's Academy of Military Sciences on special forces operations describes guiding strikes on key enemy targets as a SOF mission. SOF reconnaissance teams also provide targeting data for Army Aviation

strikes. SOF personnel are equipped with advance reconnaissance, positioning, and communications equipment to provide accurate information, status updates, and locations of targets for air, missile, or artillery strikes. SOF can use laser designation or signals such as markers, lights, or smoke to guide aircraft to the targets. SOF will also support battle damage assessments to support decision-making to conduct further strikes on the target. It is not clear the process for SOF requests for air strikes but requests likely are coordinated through the SOF brigade's command post.<sup>43</sup>

## Coordination between Aviation and Ground Fire Support

Coordination between aviation and ground fire support is also required. This coordination includes timing, targets, altitudes, airspace and air routes, and coordination with the target guidance group. Normally aviation only attacks targets that cannot easily be fired on by artillery or rockets. Coordination is accomplished by the following methods:<sup>44</sup>

- **Timing:** When aviation and artillery are attacking the same target, the timing of the strikes is differentiated and coordinated. When aircraft and artillery attack different targets, the PLA prefers sequential attacks although air and ground attacks can occur simultaneously. The rationale is to ensure that the artillery fire does not affect the air corridor used by the attack aircraft.<sup>45</sup>
- **Targets:** Differentiation of targets in principle dictates that aviation strikes targets that artillery cannot easily attack or are beyond their range. Usually, artillery will strike targets relying on guidance from artillery observation assets. The Group Army command in coordination with the Air Force liaison makes target assignments for objectives that could be struck by either air or artillery assets or designate joint strikes.<sup>46</sup>
- **Altitude:** Each strike mission requires coordination between ground fire support,



surface-to-surface missiles, and air units on altitude levels. An air corridor is designated, and artillery and missile ranges and firing areas are determined. Aviation is prohibited from areas designated for artillery or missile fire. If aircraft need to pass through a designated firing area, they will be required to pass through at a higher or lower altitude than the trajectory of ground fire. Artillery and missiles are prohibited from firing through air corridors.<sup>47</sup>

- **Airspace/area:** Targets can be differentiated by assigning areas of operation. This coordinates aircraft and ground fire support by space prohibiting aircraft and ground fire support from striking targets in the other's assigned space without the approval of the Group Army command post. The command post can temporarily prescribe conditions to intrude on space assigned to the other fire support asset by designating the altitude and location of strikes.<sup>48</sup>

Coordination of fire support between the Army and Air Force is conducted primarily at the firepower coordination center at the Group Army command post and likely the Air Force Base providing the air firepower support. A PLA publication from 2014 Army Combined Arms Battalion Tactics confirms that 'tactical aviation control groups' (a slight change in terminology) can be deployed to battalion command posts to provide coordination. Maneuver battalion command posts reportedly use the tactical internet and field area communication network providing a communication backbone equipped with integrated standard communications to directly contact the Air Force, Army Aviation, campaign and tactical missile forces, special operations forces, artillery, and so on. The firepower strike guidance data link is used to command and precisely guide strikes by the Air Force, Army Aviation, Rocket Force, and artillery. The combined arms battalion can receive planned or ad hoc fire support from fixed or rotary-wing aircraft. The combined arms battalion's intelligence reconnaissance network

is integrated with the other services and supports attached Air Force personnel and the target guidance group in guiding strikes. The two services exchange liaison personnel to support coordination providing information on service capabilities and requirements. Coordination includes formulating firepower coordination lines and firepower demarcation lines for offensive and defensive operations of troops; specifying targets and areas of operations of various services; formulating strict procedures, technical specifications, and operational rules for organizing and implementing air strikes including identification of friend or foe, as well as coordinating the actions of air defense and other fire support units.<sup>49</sup>

---

## IDENTIFICATION, FRIEND OR FOE (IFF)

The ability to identify friendly and enemy units on the dynamic battlefield is critical to avoid fratricide. The tactical Air Force control group and target guidance group provide timely reports to the ground forces on the number and types of aircraft, altitude, route, airfield, and take-off time. The target guidance group provides instructions to aircraft after taking off and entering the designated air corridor and area of operation guiding the sortie to the target. The coordination of the ground attack remains flexible with timely updates on the target and friendly forces. Radar units or airborne early warning aircraft also provide guidance for aircraft toward the target and update possible air threats.<sup>50</sup>

The PLA has been improving measures and equipment to reduce fratricide. Identification of friend or foe is accomplished through a combination of wired and wireless communications between the tactical Air Force control group, target guidance group, supported ground forces, and attack aircraft. Ground force communication and coordination are conducted through the tactical Air Force control group using ultrashort-wave radios to communicate with the aircraft. The identification



between ground forces and aircraft uses radio identification. The aircraft uses an identification code issued each day. As the aircraft flies over supported units or other friendly units a ground interrogator will start to request identification and the aircraft responds automatically with the identification code. Ground units can employ visual signals such as flares, smoke, pyrotechnics, or visual panels for identification. Updating identification measures as combat phases transition and units move on the battlefield requires constant discipline and updating of identification methods.<sup>51</sup>

Additional measures to reduce the probability of fratricide include establishing a unified radar reporting system to update air defense units on friendly and enemy air situations. Aircraft are required to remain in designated air corridors and areas. Air defense and ground fire cannot pass through an air corridor or area. Aircraft are not allowed to pass through designated fire control zones. If an aircraft does need to pass through a fire control zone the plane must request approval from the relevant command post and then pass through the zone at the assigned altitude.<sup>52</sup>

### **Ground Force Offensive Operations**

A PLA publication from 2001 states that the safe distance for close air firepower support to ground troops was 1-2 km, whereas the safe distance for artillery was 200 m. A publication on combined battalion tactics from 2014 provides more detailed information on safety margins between a ground unit and the firepower strike area for various types of ground fire as follows: 200-400 meters for rifled guns; 800-1000 meters for rocket launchers; and 200-300 meters for mortars. A journal article from 2021 states that strikes can be between hundreds of meters to several kilometers from the forward position of friendly troops. This could represent closer integration of CAFS with maneuver forces but is likely contingent on availability of precision munitions and their assessed accuracy. During the firepower preparation stage before the ground unit launches an attack, the close air firepower preparation strikes occur before artillery fire.

According to the PLA, this sequencing is to allow the ground forces to launch their assault to take full advantage of the effects of the artillery fire preparation.<sup>53</sup> Although not the focus of this monograph, the Air Force will also conduct deep air assaults on key enemy targets and infrastructure that can affect ground operations.

When an advancing unit encounters enemy forces, the unit can submit an air support request for strikes against newly discovered targets. The Air Force maintains contact with ground forces and can maintain attack aircraft on standby in nearby air space or airfields to respond rapidly. Aviation is also employed to strike obstacles and choke points that could impede the advancing unit's movement.<sup>54</sup>

A combined arms brigade or regiment conducting a main attack receives additional support or reinforcement. Firepower support can include additional ground artillery units, attack aircraft, and attack helicopters. The publication from 2001 gives the example of assigned air support consisting of approximately 12 sorties. The actual number of sorties would depend on the situation, importance of the assault, aircraft availability, number of targets that would ideally be attacked by aircraft rather than other fire support systems, and similar considerations.<sup>55</sup>

The attacking maneuver brigade's firepower is concentrated in the main attack direction against important targets. Firepower is planned in several phases with requirements and targets adjusting to each new battlefield situation. Firepower assets receive specific targets based on the advantages of employing each specific fire support system against the target.<sup>56</sup>

Firepower preparation prior to the ground assault includes artillery and close air firepower preparation. The firepower coordination center at the brigade level or firepower team in battalion command posts monitors, adjusts, and coordinates the fires. These organizations supplement and adjust fires on targets that did not sustain the

requisite damage or newly identified targets. Two types of fires are employed, assault and destruction. Assault fires [急袭射击] are sudden, heavy strikes with a planned expenditure of ammunition in a short time. The PLA considers this as a method for suppression and annihilation of the target. Destruction fires [破坏射击] usually attack fixed targets such as enemy fortifications or buildings and typically lasts 40 to 60 minutes. Enemy armor, fire support, command posts, reconnaissance units, electronic warfare equipment, and if necessary, obstacles are targeted during the firepower preparation. Close air firepower preparation is launched before or simultaneous with the artillery fire preparation. Air strikes against targets in the tactical depth include enemy fire support units, air defenses, reserve forces, and targets not easily destroyed by artillery. CAFS during this phase is usually conducted against planned targets. Attack helicopters target armor and artillery in the forward area of the main attack. Aircraft and attack helicopters also strike targets in the enemy's tactical depth in support of friendly units that have penetrated the enemy rear area.<sup>57</sup> Requests for support can be submitted for newly discovered targets.

Fire support assists in repulsing enemy counterattacks, destroying encircled enemy forces, and during pursuits. Artillery, attack aircraft, and helicopter fire support are conducted to prevent or resist an enemy counterattack. The main objective is to suppress and block the enemy counterattack and directly support friendly units. Targets include enemy maneuver forces, reserves, artillery, and air landing forces. Artillery, attack aircraft, and helicopters support the annihilation of encircled enemy forces. The main tasks are to support friendly forces, and interdict lines of communication such as passes, bridges, and other choke points to delay reinforcing enemy forces or a breakout by encircled forces. During pursuit attack aircraft strike enemy forces and choke points to disrupt, isolate, and impede their movement.<sup>58</sup>

## GROUND FORCE DEFENSIVE OPERATIONS

In the past, close air firepower support appeared to focus on supporting offensive combat, specifically main attacks, but air strikes also support ground defensive operations. CAFS during defensive operations would likely be concentrated against the enemy's main attack. The Air Force supports ground forces by disrupting enemy attack preparations, preventing enemy breakthroughs, and supporting friendly force's counterattacks. When ground forces are withdrawing, artillery strikes close-in targets while aircraft attack targets of opportunity in the enemy's depth to cover the withdrawing unit.<sup>59</sup>

The Air Force air fire counter preparation supports friendly forces on the defense to seize battlefield opportunities and undermine the enemy's offensive preparations. This air support is usually combined with ground fire support and possibly Rocket Force strikes. Air strikes are concentrated against enemy fire support that is not easily targeted by or out of range of friendly artillery. Additional targets can include command posts, choke points, and key weapons and equipment. The optimal time for air firepower counter preparation is when enemy units are advancing, deploying, or occupying assembly or standby areas or attack departure positions for the attack but not in direct contact with friendly forces.<sup>60</sup>

Attack aviation prioritizes strikes on enemy artillery and tactical missiles during an enemy breakthrough attempt to support friendly ground forces holding their forward positions. Aviation also concentrates attacks on the enemy's forward forces and attempts to block their advance. Additional air strikes target enemy follow-on echelons, long-range artillery, and lines of communication to isolate the attacking force.<sup>61</sup>

During urban defensive operations, air strikes are concentrated against enemy forces on the periphery. The objective is to prevent the enemy

from entering the city. Attack aircraft also target enemy follow-on echelons moving toward the city to impede their movement by attacking choke points.<sup>62</sup>

The Air Force supports ground forces during transitions to counterattacks against the enemy. Attack aircraft can be designated to stand by at airfields to respond to sudden situations. Air firepower counter-preparation initiates sudden and heavy assaults on targets in the main counterattack direction to destroy or suppress key enemy forces as well as disrupt other forces that could intervene. The sudden attack is intended to disintegrate enemy morale and create conditions for a successful counterattack. Once the counterattack is launched direct air firepower support closely coordinates with other fire support assets to assist ground forces in encircling and annihilating the enemy. Attack aircraft will also attempt to interdict enemy forces and attack reinforcements to delay their advance. When an encircled enemy attempts to break out the Air Force will strike key choke points to block the retreat.<sup>63</sup>

The Air Force also strikes enemy airborne landings. Attack aircraft can rapidly respond to a landing to eliminate the enemy airborne force. Ideally, the enemy airborne operation is disrupted at the airborne departure airfields or en route.<sup>64</sup>

ARMY AVIATION FIREPOWER  
SUPPORT

Like the PLAAF, the PLA Army’s (PLAA) aviation branch has seen both expansion in size and improvements in quality. Eleven group armies have a dedicated aviation brigade while the remaining two have an air assault brigade instead. There are also two independent Army Aviation Brigades in the Western Theater Command. The aviation units are equipped with transport, reconnaissance, and attack helicopters and their inventory reportedly ranges from 36 to 96 aircraft. **See Table 2** for primary attack and reconnaissance helicopters in the brigades.<sup>65</sup>

Table 2: PLA Attack and Reconnaissance Helicopters <sup>66</sup>				
Helicopter	Type	Armament	Range (kilometers)	Approximate Inventory
Z-9	Attack and Reconnaissance	HJ-8 wire-guided Antitank Guided Missiles (ATGM) or two 57mm or 90mm rocket pods; Alternatively, the aircraft can carry two 12.7mm machine gun pods or two 23mm cannon	1000 with an internal auxiliary tank	200+
Z-10	Attack	KD-9 or KD-10 ATGMs; 23mm PX-10A Chain Gun; rocket pods of various calibers	800	208
Z-19	Attack and Reconnaissance	KD-9 ATGM; 12.7 or 23mm gun pods; and rocket launchers	700	186+

The PLA has studied U.S. Army and Marine rotary-wing close air support for lessons learned including operations in Vietnam, Iraq, and Afghanistan. PLA studies are familiar with relevant U.S. military manuals describing the planning, preparation, and execution of Army Aviation support to ground forces.<sup>67</sup>

PLA theorists note the increased impact of Army Aviation as the force has grown and

tactics refined. Air firepower assault groups play an important role as a component in tactical formations (a modular task force capable of relatively independent combat) as helicopters have high speed, high maneuverability, and the ability to conceal themselves and make sudden attacks. However, Army Aviation is at risk from almost all enemy weapons systems, which requires accurate intelligence on enemy locations and capabilities to protect the asset. Army Aviation

primarily concentrates strikes on enemy armor but also attacks other important targets. The combined battalion firepower team will evaluate the degree of damage resulting from a strike. When the desired effects are not achieved, the battalion can transmit a request to the brigade firepower coordination center and aviation unit to organize additional strikes.<sup>68</sup>

An Army Aviation liaison can be attached to the supported combined battalion command's firepower team to support planning, coordination, and guidance for supporting helicopters. An Army Aviation target guidance group with its communication equipment can deploy to support the maneuver unit command post to assist with coordination and control of helicopter support. Combined arms battalion reconnaissance troops will directly guide attack helicopters that are held on standby to strike targets. The combined arms battalion's intelligence reconnaissance network is integrated with those of other services and supports attached air liaison officers to assist in guiding strikes on ground targets.<sup>69</sup> Special operations reconnaissance teams can also provide target locations to attack helicopter pilots.<sup>70</sup> Recent PLA articles show Army Aviation receiving UAV reconnaissance to support ground attacks. This UAV support can come from the combined arms battalion's UAVs or the Army Aviation Brigade's organic UAV reconnaissance battalion. A *PLA Daily* article from August 2019 reported an Army Aviation flight staff officer assigned to a combined arms battalion requesting a strike on an artillery position of the Blue (enemy) force in a confrontation exercise that opened a gap in the opposing force's defensive position. Highlighting a communication system issue, the same article reported a reconnaissance squad calling for a strike on an important blue target, but the Army Aviation support never arrived, and the squad was destroyed by the blue force.<sup>71</sup>

The combined arms battalion command post includes a firepower team responsible for coordinating firepower support according to

a 2014 publication by the Academy of Military Science. The team is composed of a firepower team leader, a firepower coordination staff officer, an artillery liaison officer, and an Army Aviation ground guidance officer. The team coordinates firepower support, requests support from higher headquarters, and evaluates the effects of strikes.<sup>72</sup> A *PLA Daily* article from September 2023 indicated a change in ground-air coordination. The article details the establishment of a joint firepower coordinator position in a maneuver battalion's command post. The coordinator planned and requested close air firepower support from an Army Aviation Brigade to strike targets affecting the unit's attack.<sup>73</sup> Coordination between attack helicopters and artillery occurs when the aviation strikes are within the artillery mission area or the artillery unit indicates targets for the aviation unit. During joint artillery and Army Aviation strikes the combined arms battalion commander clearly identifies the aircraft types, sorties within the artillery mission area, target, time of attack, entry and exit routes, and flight altitude. The aviation unit is notified of the artillery unit's location, target, firing time, direction of fire, and maximum ballistic altitude. Before the aviation strike, the artillery unit will focus on suppressing enemy air defenses, providing cover for the aviation attack, and achieving a minimal time interval between artillery and aviation strikes. After the aviation strike, the helicopter unit immediately notifies the artillery unit of the completion of the mission and withdrawal status. When artillery indicates targets for the Army Aviation unit, the combined arms battalion commander provides information on aircraft type and numbers, number of sorties, entry and exit routes, flight altitude, time to reach and attack the target, start and end time, and ammunition used. Red smoke markers are usually employed to indicate the target for the helicopters. When the artillery unit is responsible for terminal guidance of the air-launched missiles, the combined arms battalion commander needs to be aware of the attack direction, altitude, and timing of the aviation, and the location and timing



of the artillery laser designation group. After the aviation strike, the artillery unit immediately reports the completion of the mission and the withdrawal status of the aviation unit.<sup>74</sup>

## AIR FIRE ASSAULT GROUPS

A 2014 book from the PLA's National Defense University provides some insight into Army Aviation operations. According to the authors, Army Aviation units form air fire assault groups to support the tactical formation according to the mission. The group is either organized as a single formation with one type of helicopter or as a mixed formation with reconnaissance and electronic warfare helicopters supporting the attack helicopters. A single formation (see Table 3 for formation types and composition) of attack helicopters is used when intelligence is clear about the enemy situation and other electronic warfare assets can provide support.<sup>75</sup>

A single formation is used against a specific type of target such as armor, fortified positions, buildings, infantry positions, logistics, artillery positions, or suppress areas depending on the weapons carried. A mixed formation is modular with multiple types of helicopters to enable multiple missions against varied targets, as well as conducting reconnaissance and electronic warfare missions. The PLA also categorizes formations as small, medium, or large. Medium and large formations can also form single-mixed or double-mixed formations. Medium double-mixed formations are composed of several small formations, and large double-mixed formations are composed of several small or medium-sized formations to conduct multiple missions. **Table 3** provides examples of helicopter formations, composition, and missions.<sup>76</sup>

Scale	Formation Type	Composition	Capability
<b>Small Formation</b>	Grouping Method for Maritime Attack	2 or 4 attack helicopters	Strong firepower, quick response, and quick response to unexpected situations
		1 reconnaissance helicopter, 3 attack helicopters	Strong firepower and reconnaissance capability
	Grouping Method for Ground Attack	1 reconnaissance helicopter, 3 attack helicopters	Strong firepower, able to complete specific tasks, such as anti-armor, ground attack, etc.
<b>Medium Size Formation</b>	Grouping Method for Maritime Attack	2 - 3 small formations	Capability to simultaneously attack multiple targets
	Grouping Method for Ground Attack	2 reconnaissance helicopters, 1 electronic warfare helicopter, and 5 attack helicopters or 3 reconnaissance helicopters, 1 electronic warfare helicopter, and 8 attack helicopters	Has a certain electronic interference capability, able to cope with various emergencies
<b>Large Formation</b>	Grouping Method for Maritime Attack	4-6 small formations or 2 medium formations	Can cope with various emergencies, with a multiple points continuous attack capability
	Grouping Method for Ground Attack	4 reconnaissance helicopters, 2 electronic warfare helicopters, and 10 attack helicopters or 6 reconnaissance helicopters, 3 electronic warfare helicopters, and 15 attack helicopters	Able to cope with a variety of emergencies, such as air cover, reinforcements near the island defense, etc.



Electronic warfare missions are conducted by specialized helicopters or transport helicopters temporarily equipped with specialized personnel and equipment. Additional electronic warfare helicopters are deployed when large formations are attacking multiple targets in different directions. In medium and large size formations, the reconnaissance helicopter can provide command. Transport helicopters can also be equipped to operate as command posts. Large formations can carry out continuous attacks on the same target, alternate attacks on different targets, or conduct multiple missions such as ground attacks and air combat.<sup>78</sup>

---

## DEPLOYMENT

According to PLA writings, the Army Aviation Brigade will establish a temporary forward base that provides concealment for combat preparation of the air group.<sup>79</sup> The aviation group prepares and awaits orders at that location. The forward base appears similar to a U.S./NATO forward area arming and refueling point (FARP). The air group conducts maintenance and support, refuels, and rearms upon completion of a combat mission. The forward base is situated in an area with concealment, meets airspace management requirements, is on hard soil in flat terrain, and is near a friendly air defense firepower group for protection. It should be out of range of much of the enemy's artillery and air defense systems in the tactical area. The prepared area usually covers half a square kilometer, allowing sufficient space to accommodate small, medium, and large formations or roughly 34 helicopters. The base is located to allow aviation units to reach the forward area in about ten minutes.<sup>80</sup>

The air fire assault group moves forward to a standby area located near the attack direction to temporarily hide before launching an attack. The group makes last-minute adjustments and preparations to the attack formation, checks, and calibrates weapons, etc. The site selection is

similar to that for the forward base. Usually, 1 to 2 or more standby areas are selected to provide flexibility for carrying out attacks. The standby areas are situated approximately 15-20 km from the front to enable the air group to reach the front within minutes. Since the group in the standby area is within range of enemy fire support, the group must be able to disperse for survivability.<sup>81</sup>

The attack routes are chosen to make advantageous use of terrain and weak areas of the enemy's defenses. The route will typically follow the enemy's flank, joints, blind spots for radar, valleys with complex terrain, forest edges, and tree-lined roads. Routes should have obvious ground features for orientation and navigation, and short flight time but avoid straight lines to limit exposure to enemy air defenses. When coordinating maneuver with ground forces, the ground unit can deploy part of its air defenses in the direction of the air fire assault group for support.<sup>82</sup>

The position for carrying out the attack on a target is selected on the flank or rear of the target. The distance is usually based on two-thirds of the maximum range of the weapon. The attack profile is usually as follows: employing rockets the height is 60-100 m and distance of 800-1000 m; missile attacks are at a height of 20-100 m and a distance of 2000-4000 m; and machine gun or cannon fire is conducted at a height of several tens of meters and a distance of 1000m. **Figure 2** shows the deployment scheme of an offensive air fire assault group.<sup>83</sup> When attack helicopters employ rockets the safety margin between the ground unit and strike area is 1000 meters; when employing guided missiles the safe distance is 200 meters. When attack helicopters are operating with tank units, the aviation normally strikes targets beyond the tanks' direct fire distance or effective range.<sup>84</sup>

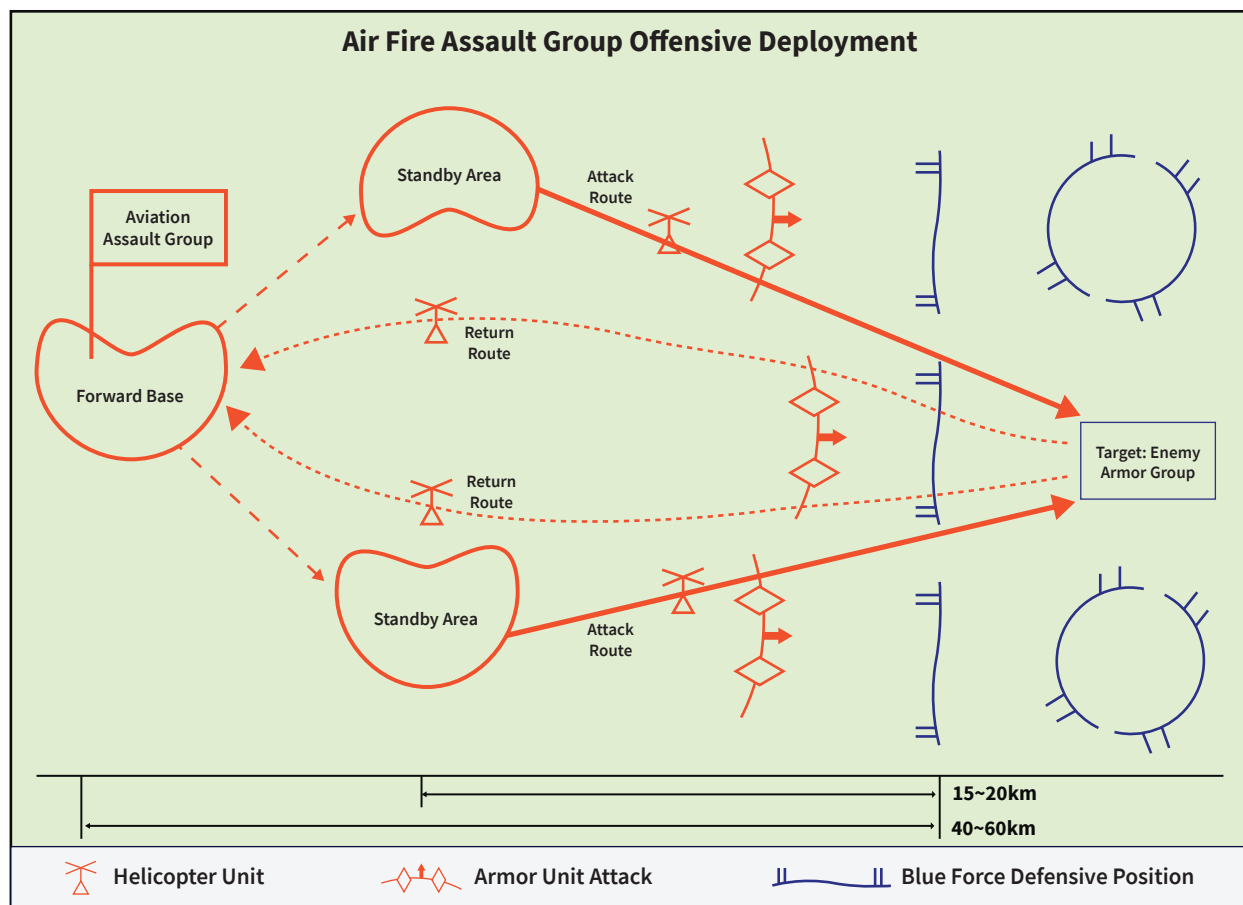


Figure 3: Air Fire Assault Group Offensive Deployment FMSO.<sup>85</sup>

Air fire assault group preparation times for combat dispatch are shown in **Table 4**.

Airframe	Deployment	Squadron	Dadui	Entire Group
Attack Helicopter	First Dispatch	1-5 Hours	2 Hours	3 Hours
	Subsequent Dispatch	15~20 Minutes	25~30 Minutes	35~40 Minutes

## ARMY AVIATION SUPPORT TO GROUND COMBAT

The air fire assault group conducts short-range ground attacks in coordination with ground forces. Attacks are carried out on targets in the enemy frontline, and shallow or medium-depth targets. The air attacks are linked closely with ground combat, allowing the ground unit to directly use the combat effects produced by the aviation fire

strikes. Mobile fire support provided by the air fire assault group strikes enemy command posts, defensive support points, reserve deployments, important weapon positions, and key mobile reserves in the enemy front and shallow depth. A mixed type of formation is mainly employed for these missions, with single-type formations employed against armor threats to the flanks. The air fire assault group follows the ground unit closely and usually does not move beyond the cover

of ground air defenses to ensure survivability.<sup>87</sup>

Attacks at greater depths are designed to weaken the enemy's combat potential rather than directly affect friendly ground maneuvers. Missions are intended to contain, disrupt, or delay enemy operations, and strike important targets in the enemy's tactical and operational depth. Operations are designed to attack key nodes and connections in the enemy's operational system of systems (integrated modular task force) to support subsequent friendly ground operations. These missions can occur during the entire operation including pre-combat, fire preparation, in-depth attacks, and counterattacks against the enemy. Targets include fixed targets such as key weapons systems, logistics, defense facilities, and command posts to disrupt the enemy's combat capabilities and information flow. When the enemy situation is unclear a mixed formation provides flexibility. Single formations are employed against specific known targets.<sup>88</sup>

Army aviation provides accompanying air cover support to forces maneuvering on the battlefield. Aviation groups can provide fire cover for the front, flanks, and rear of ground units, and carry out attacks against enemy ground targets encountered. Air fire assault groups conduct ground attack missions supporting ground combat, including fire support to breakthrough operations, conducting patrols, establishing firepower blockades or firepower prevention areas, preventing, or countering enemy counterattacks, assisting maneuver units in the consolidation of ground gains, pursuing retreating enemy units, responding to an unexpected situation, or supporting friendly unit withdrawal. Specific tasks include destroying or suppressing key enemy forces encountered by friendly ground forces and creating favorable conditions for ground combat.<sup>89</sup>

When supporting ground forces' frontal attack groups, the aviation group coordinates with the ground unit and attacks the enemy front and flanks to isolate and interdict enemy forward forces. The air fire assault group will also coordinate with

ground fire support to blockade, suppress, and interdict enemy forces in forward positions or shallow depths. The aviation group will support ground unit penetration of enemy defenses by coordinating strikes in front and on the flanks of the attacking ground unit and support the encirclement and annihilation of the enemy force. The air fire assault group will also prepare to strike any enemy counterattacks. When a ground attack stalls, a reserve assault group can be committed from the forward base or standby areas to strike key targets on the flanks.<sup>90</sup>

---

## UNMANNED COMBAT AERIAL VEHICLE AERIAL FIRE SUPPORT

In addition to PLAAF and Army Aviation fire support, the PLA is integrating UAVs for reconnaissance and ground strikes. The PLA employs a wide variety of reconnaissance UAVs, which are deployed down to the tactical level. The PLA fields UCAVs, which primarily are deployed to the PLAAF. The Army has a BZK-006A/WZ-6A which can carry air-to-surface missiles, and the FX500 which is reportedly capable of carrying either reconnaissance or strike equipment.<sup>91</sup> A PRC press article in September 2023 revealed a new armed reconnaissance medium altitude, long endurance KVD002 UAV system developed for the PLAA. The KVD002 can reportedly carry the AR-1 air-to-ground missile with a semi-active laser guidance system.<sup>92</sup>

Recent PRC articles discuss the use of UCAVs for close air support concluding that UAVs and UCAVs are adaptable, relatively low cost, non-contact, have long battery life, multifunctional, and eliminate the possible loss of a pilot in a manned aircraft.<sup>93</sup> A *PLA Daily* article in 2023 described how the PLA is employing UCAVs to support combat training in the Xinjiang Military District of the Western Theater Command with an armor unit preparing an attack with CAFS support from a UCAV.<sup>94</sup> Another recent confrontation exercise by the Naval Aviation University used UCAVs to detect

enemy targets and conduct precision strikes.<sup>95</sup>

PLA researchers and PRC aviation industry experts were quick to analyze the use of UAVs and UCAVs in the Second Nagorno-Karabakh War between Azerbaijan and Armenia in September and November 2020. UAV/UCAVs were employed largely by Azerbaijan to seize air superiority, conduct reconnaissance, and attack a range of ground targets. Reconnaissance drones and UCAVs at times worked in tandem identifying targets that were subsequently attacked by UCAVs. The reconnaissance UAV would then support a rapid battle damage assessment to support a decision on whether to restrike. However, there was little direct integration of UCAVs with ground force operations during the conflict.<sup>96</sup> Examinations on foreign UCAV employment can promote PLA innovation in CAFS, adding an additional means for supporting maneuver forces.

---

## PRC'S LESSONS FROM ABROAD AND THE FUTURE OF CAS

PLA and PRC scholars have a particular focus on understanding and borrowing lessons from U.S. CAS concepts, including command and control, coordination, the use of kill boxes, unit tracking systems, and bombers in CAS roles.

### Command, Control, and Communications

PLA research on U.S. CAS appears to focus on command, control, and communications. One development is PLA research on U.S. employment of forward air controller (airborne) (FAC (A)), which is viewed as important for future CAS operations. This would be an important development providing flexibility in airborne control by using manned or unmanned aviation.

PLA research has also examined U.S. CAS communications methods and data flow. This includes the variable message format (VMF), a data communication format supported by the U.S. Army tactical internet that transmits command

code information accurately and near real-time with wireless links. Tactical data links are a core of modern communications networks connecting multiple systems and elements including the command and control system with the fire strike system on the digital battlefield. PLA sources make note of the U.S. Tactical Air Control Party Modernization (TACP-M) as a critical element orchestrating CAS and overcoming these issues. The accelerated deployment of high-tech weapons and equipment within the PLA is leading to more innovative theories on CAFS.<sup>97</sup> As a result, close attention is paid to developments in the use of CAS by other countries, particularly the United States. PRC writings note the U.S. military's use of TACP-M in Iraq to reduce the error rate of information transmissions and the occurrence of fratricide.<sup>98</sup>

A recent article in a PRC-defense industry-affiliated journal highlighted the role of data links in enhancing decision-making and combat effectiveness during CAS missions.<sup>99</sup> Analysis in the same journal calls attention to the importance of other U.S. communications and command methods to CAS. The U.S. Link-16 data link is an important component of ground-air coordination and CAS. The tactical data link network provides command guidance, air-ground coordination, and information flow including the battlefield situation. Data links can shorten the time required for CAS missions from initiation to strike<sup>100</sup> as well as improving the accuracy and efficiency of the CAS mission.

The PLA has also evaluated the U.S. tactical satellite communications system in the context of CAS. Mountainous or urban terrain, harsh weather, and a complex electromagnetic environment can degrade communications including the primarily line-of-sight tactical data link. A tactical satellite communications system can provide over-the-horizon communications.<sup>101</sup> PLA sources also discuss the role of the airborne warning and control system (AWACS) aircraft as an important part of U.S. command in CAS. AWACS aircraft

or Airborne Early Warning & Control (AEW&C) aircraft provide a flexible air command node for the organization and implementation of CAS in connection with other CAS-related organizations. AWACS aircraft provide a command-and-control system for managing and implementing battlefield management and control, especially for immediate requests for CAS. AWACS aircraft can participate in each phase of the CAS mission: mission planning; combat preparation; strike implementation; and effect evaluation.<sup>102</sup>

### **Fire Support Coordination – the Kill Box**

Another topic of discussion is the U.S. use of a kill box to facilitate the coordination of fire strikes. A kill box is a fire support coordination measure in air-to-surface strikes. PRC analysis states that the U.S. military employed kill boxes in Iraq as a CAS technique with Air Force and Navy aircraft conducting strikes. A kill box facilitates the integration of joint fires allowing assigned aviation to execute lethal strikes against surface targets without coordination with ground units and terminal attack control. PRC authors note two types of kill boxes: blue and purple. Both allow air strikes without further coordination while the purple allow ground and maritime commanders to also employ fires in the kill box.<sup>103</sup>

### **U.S. Blue Army Tracking System**

The PRC aviation industry is also developing technologies and equipment that can enhance CAFS capabilities. These include guidance visualization technologies to better understand the environment, and target information such as position, speed, and direction. The U.S. Blue Army Tracking network provides better situational awareness of friendly forces. The update of this system provides satellite updates every 10 seconds and is connected to U.S. Air Force programs through the Link 16 data link. The PLA employs a battlefield situation map displaying the positions of friendly forces and other data available through the command information system at command posts. Other developments highlighted by the PRC aviation industry include

the modular tactical system which is a rugged multi-mission system that provides command and control, situational awareness, precision targeting for dismounted soldiers, and other systems to provide improved communications between services and platforms.<sup>104</sup>

### **Employment of Bombers for CAS**

PLA-affiliated media and scholars discuss the U.S. use of bombers for close air support in Afghanistan and Russia in Syria. PLA theorists note the U.S. use of JDAM to provide long-range, multi-target precision strikes. Bombers have advantages in endurance, dense firepower capability, range, and radius. B-52H and B-1B bombers have advanced targeting pods and active phased array radar to enhance target detection.<sup>105</sup>

### **Persistent Close Air Support**

Studies highlight the technological advancements changing the nature of CAS, as seen in U.S. Air Force research after 2000 on digitally assisted close air support, and since 2010 in the persistent close air support (PCAS) project at the Defense Advanced Research Projects Agency (DARPA). Both efforts involved employing digital and networked means to shorten the time required between calling for and delivering air-to-ground support while improving accuracy and reducing fratricide and collateral damage.<sup>106</sup> PRC sources state the DARPA PCAS project can shorten the time from a request for CAS to strike from 10-30 minutes to less than six minutes and reduce fratricide and collateral damage. The PCAS program enables ground controllers to select and use airborne weapons such as UCAVs. Research on the PCAS program also highlights the role of cross-domain coordination, terminal control, persistent presence, and intelligent decision-making in CAS.<sup>107</sup>

Analysis of the DARPA's PCAS project in PRC engineering journals has highlighted the potential role of UCAVs in close air support. The use of UCAVs allows the ground controller to replace the pilot and become the center of performing



the CAS mission, striking time-sensitive targets promptly. UCAVs can provide a persistent presence to better strike targets of opportunity.<sup>108</sup>

---

## INTELLIGENT TECHNOLOGIES AND THE FUTURE OF PLA CAS

There is evidence the PRC is considering how to integrate intelligent systems into close air support. One article in a PRC academic journal discusses the construction of a close air support intelligent coordinated strike system. This proposed system would coordinate multiple strikes or strikes on multiple targets in a single engagement to significantly improve the effectiveness of CAS operations. The intelligent system would integrate preliminary target information from ground sensors and battlefield situation information from air platforms with networking carried out by data link to support CAS missions in a timely, and accurate manner in a confrontational environment. In future CAS operations, intelligent technology can enhance striking time-sensitive targets, share information, and allocate targets more effectively.<sup>109</sup>

PRC military theoreticians are also examining the introduction of intelligent technologies into UAVs and UCAVs as CAS moves from manned to unmanned strikes which the PLA believes will become dominant in CAS operations. These theoreticians believe that intelligent technologies will allow UCAVs to operate autonomously, conduct coordinated group strikes, and provide persistent presence. Intelligent UCAVs will identify targets more accurately, conduct analysis, and obtain precision targeting information to relay to strike systems or carry out strikes themselves reducing collateral damage and friendly fire. Intelligent UCAVs will shorten the time from requests for CAS to strikes on the target. Employment of intelligent UCAV swarms will increase the firepower applied to the target over traditional CAS capabilities. UCAV swarms will also provide the capability to strike multiple targets simultaneously, as well as

find and strike moving and high-value targets.<sup>110</sup> While evidence of purpose-built systems for CAS missions is limited, the PRC has invested heavily in unmanned aerial systems and loitering munitions that could be adapted for these purposes.

One PLA futurist posits that intelligent or highly autonomous UCAVs will become the future of CAFS support. New materials and radar-absorbing paints or surface materials will increase the stealth and survivability of UCAVs in ISR and strike roles. Paired with improved processing, advances in sensor technologies can make UCAVs in these roles more lethal, and able to operate in groups to conduct multiple strikes against multiple targets or sustained strikes against a single target.<sup>111</sup>

---

## CONCLUSION

The PLA has had a close air firepower support capability since it was first employed in support of the Yijiangshan joint amphibious landing operation in 1955. PLA CAFS capabilities have evolved over time, increasing in sophistication. Modernization of the PLAAF and increased mobility and maneuverability of the ground forces have increased CAFS capabilities as well as the requirements for integrating air support into ground maneuver combat. The deployment of high-tech weapons and equipment within the force is leading to more innovative theories on CAFS.<sup>112</sup> As a result, the PLA pays close attention to developments in the use of CAS by other countries, particularly the United States. Descriptions of CAFS in the Chinese military literature mention support to the PLAN (especially the much-expanded PLAN Marine Corps), however, little has been published on this subject. This might be explained by naval formations requiring air support, but not close air support as ground units do.

PLA close air firepower support appears to have a simpler and streamlined command and coordination system compared to U.S. close air support. While CAFS is not as closely integrated with ground maneuver as U.S. CAS, it does directly

support tactical ground combat. With the increase in PLA precision capabilities and research on U.S. CAS command, coordination, and communications, CAFS will likely become better integrated with ground maneuver and approach the U.S. definition of close air support.

While the nearness of Air Force strikes to friendly forces is partially dependent on the type of munition employed, current PLA CAFS appears intended for relatively deeper tactical targets. Army Aviation will strike targets closer to friendly troops, more closely integrating fires with ground maneuver. Greater CAFS integration with ground maneuver in the future will increase as the PLA continues its CAFS modernization and research.

PLA research is directed primarily at U.S. CAS organization, weapons and equipment, and

command and control. It is likely that the PLA will adopt features of U.S. CAS operations but will not copy them entirely. The PLA is also incorporating UAVs and UCAVs into CAS operations. PLA theorists believe that integrating intelligent technology into UAVs and UCAVs is the future of CAFS operations.

PLA CAFS capabilities will continue to evolve, significantly improving ground combat operations. Enhanced CAFS can further the PLA's quest for integrated joint operations, as well as improve joint firepower, ground force maneuver, and combat capabilities. However, the PLA will have to overcome continuing issues with jointness within the force to achieve this level of combat capability.



**The Foreign Military Studies Office (FMSO)**  
U.S. Army Training and Doctrine Command (TRADOC G-2)  
Ft. Leavenworth, KS 66027

[HTTPS://FMSO.TRADOC.ARMY.MIL](https://fmso.tradoc.army.mil)

*The Foreign Military Studies Office (FMSO) at Fort Leavenworth, Kansas, is part of the US Army Training and Doctrine Command G-2, whose mission is to understand, describe, assess and deliver the conditions of the operational environment. For over 30 years, FMSO has conducted open-source research on foreign perspectives of the operational environment, emphasizing those topics that are understudied or unconsidered. FMSO's products are integral to critical thinking in the Army's leadership, analytic communities, and military education, and wherever there is a professional interest in what "they think they think."*

## ENDNOTES

- 1 Liu Jinjun [刘进军], Introduction to Ground-Air Coordination Operations [陆空协同作战概论]. (Beijing: PLA Press, 1996), 97-110
- 2 Figure 1: Zhejiang Province and the Yijiangshan Islands, map, Source: Combination of "Zhejiang in China.svg" CC BY-SA 3.0 [https://commons.wikimedia.org/wiki/File:Zhejiang\\_in\\_China.svg](https://commons.wikimedia.org/wiki/File:Zhejiang_in_China.svg) and "Map Zhejiang adm.png" CC BY-SA 4.0 [https://upload.wikimedia.org/wikipedia/commons/6/64/Map\\_Zhejiang\\_adm.png](https://upload.wikimedia.org/wikipedia/commons/6/64/Map_Zhejiang_adm.png)
- 3 Cong Shengli and Wang Mingliang [丛胜利, 王明亮], Aviation Operations in the Battle of Yijiangshan Islands [一江山岛战役中的航空兵作战], Military History [军事历史], Issue 1 2003, 16-21; Liu Chun, Zhang Jun, Cui Zechen, and Wu Jiafeng [刘纯, 张峻, 崔泽晨, and 吴家锋], Research on Close Air Support Operations in the Battle of Yijiangshan Islands [一江山岛战役中的近距离空中支援作战研究], Trainer [教练机], No. 4 2020, 36-40
- 4 People's Liberation Army Military Terms [中国人民解放军军语], (Beijing: Military Science Press, 2011), 975
- 5 Ibid.
- 6 Ibid.
- 7 Ibid.
- 8 Ibid.
- 9 People's Liberation Army Military Terms [中国人民解放军军语], (Beijing: Military Science Press, 2011), 976
- 10 Ibid.
- 11 People's Liberation Army Military Terms [中国人民解放军军语], (Beijing: Military Science Press, 2011), 981
- 12 People's Liberation Army Military Terms [中国人民解放军军语], (Beijing: Military Science Press, 2011), 985-986
- 13 Liu Chun, et al [刘纯], Study of Direct Action and Close Air Support [引导打击与近距离空中支援作战分析], Fire Control and Command Control [火力与指挥控制], Vol. 44, No. 9, September 2019, 7-8
- 14 Cai Shoucheng [蔡寿成], New Changes in Direct Air Support to Ground Combat [航空兵直接支援地面战斗的新变化], National Defense [国防], 15 September 1988, 29
- 15 Liu Jinjun [刘进军], Introduction to Ground-Air Coordination Operations [陆空协同作战概论]. (Beijing: PLA Press, 1996), 97-110
- 16 Gao Yu, Hu Hui, Xing Li, and Meng Fanna [高宇, 胡慧, 邢丽, 孟凡娜], "Operational Capability Evaluation of Close Air Support for Fixed-wing Aircraft"[固定翼飞机近距离空中支援作战能力评估], Ordnance Industry Automation [兵工自动化], Volume 40, May 2021, 54
- 17 Zhang Ze, Wang Ying, Yue Longfei, Hu Dongyuan, Yan Mengda, and Jin Yang [张泽, 王瑛, 岳龙飞, 胡东愿, 闫孟达, and 靳阳], Construction of Information Flow Mode for Close Range Air Support Based on the Super Network [基于超网络的近距离空中支援信息流转模式构建], Fire Control and Command Control [火力与指挥控制], Volume 46, No. 11, November 2021, 20-21
- 18 While a recent PLA video showed a carrier-based J-15 striking surface targets at sea, these aircraft likely have limited utility in these roles due to take-off weight limitations for fuel and ordnance due to PLA Navy's 'ski-lift' type carriers. See: "A Certain Unit of the Navy's Carrier-based Aviation: J-15 'Group Attack' [海军舰载航空兵某部: 歼-15 '组团出击']", PLA Daily, <http://www.81.cn/sjydt/16227428.html>
- 19 International Institute for Strategic Studies, The Military Balance 2023, (London: Routledge, 2023); Andreas Rupprecht, Modern Chinese Warplanes: Chinese Air Force – Aircraft and Units, (Houston: Harpia Publishing, 2018), 25-61; U.S. Army Training and Doctrine Command, World Equipment Guide, <https://odin.tradoc.army.mil/WEG>; Yefim Gordon and Dmitry Komissarov, Chinese Air Power, (Manchester: Hikoki Publications Ltd. 2021), 92-97 and passim for additional information on PLA aircraft, munitions and targeting systems; for more information on sensor pods see Windell Minnick, editor, Chinese Air-Launched Weapons & Surveillance, Reconnaissance and Targeting Pods, (North Haven: no publisher information, 2023)
- 20 Yefim Gordon and Dmitry Komissarov, Chinese Air Power, (Manchester: Hikoki Publications Ltd. 2021), 186-187
- 21 Yefim Gordon and Dmitry Komissarov, Chinese Air Power, (Manchester: Hikoki Publications Ltd. 2021), 60-79, 90-91
- 22 According to the latest public estimates the PLA AF has 130 J-11B/BS and PLA Naval Aviation has 72 of the same type. See: International Institute for Strategic Studies, The Military Balance 2023, (London: Routledge, 2023), 241-242; Andreas Rupprecht, Modern Chinese Warplanes: Chinese Air Force – Aircraft and Units, (Houston: Harpia Publishing, 2018), 36-39
- 23 "PLA Guided Bombs Technical Report APA-TR-2009—0808" Air Power Australia, [updated April 2012], <https://www.ausairpower.net/APA-PLA-GBU.html>; Windell Minnick, editor, Chinese Air-Launched Weapons & Surveillance, Reconnaissance and Targeting Pods, (North Haven: no publisher information, 2023), 28,34-38, 71, 75-84; for more information on air-to-ground munitions see Yefim Gordon and Dmitry Komissarov, Chinese Air Power,

FMSO.TRADOC.ARMY.MIL

- 353-374 or Windell Minnick, editor, Chinese Air-Launched Weapons & Surveillance, Reconnaissance and Targeting Pods, 5-103
- 24 Kevin McCauley, "Putting Precision in Operations: Beidou Satellite Navigation System," Jamestown Foundation, China Brief, Vol.14, Issue 14, 22 August 2014 [https://jamestown.org/program/putting-precision-in-operations-beidou-satellite-navigation-system/#.U\\_jzMpV0xhE](https://jamestown.org/program/putting-precision-in-operations-beidou-satellite-navigation-system/#.U_jzMpV0xhE); "China to build integrated positioning, navigation system based on next generation of BDS by 2035," Global Times; 27 April 2023, <https://www.globaltimes.cn/page/202304/1289884.shtml>
  - 25 J-10 Strikes, Bright Sword in the Sky [歼十出击 亮剑长空], PLA video, 4 April 2022, [http://tv.81.cn/jq360/2022-04/04/content\\_10145896.htm](http://tv.81.cn/jq360/2022-04/04/content_10145896.htm); Wang Guiyun and Zhan Boqin [王国云、詹伯钦], "In mid-April, An Aviation Brigade of the Air Force in the Southern Theater Organized Live Ammunition Target Training" [4月中旬, 南部战区空军航空兵某旅组织实弹打靶训练], PLA Daily, 7 May 2020, [http://www.81.cn/jfjbmap/content/2020-05/07/content\\_260680.htm](http://www.81.cn/jfjbmap/content/2020-05/07/content_260680.htm)
  - 26 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 289-290
  - 27 Hu Xiaomin [胡孝民] and Ying Fucheng [应甫成] editors in chief, Study on Joint Firepower Warfare Theory [联合火力战理论], (Beijing: National Defense University Press, 2004), 190-191; Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 290-291; Qiao Zhongwei and Tang Zhongliang, editors [乔忠伟 汤中良], Army Combined Arms Battalion Combat [陆军合成营战斗], (Beijing: Military Science Press, 2014), 113-114
  - 28 Ibid.
  - 29 "Implementation of System Communication, Data Communication, and Situation Communication in Ground-Air Joint Training in the Southern Theater Command" [南部战区陆空联训实现系统通数据通态势通], PLA Daily, 3 December 2017, [http://www.81.cn/jfjbmap/content/2017-12/03/content\\_193339.htm](http://www.81.cn/jfjbmap/content/2017-12/03/content_193339.htm)
  - 30 Qiao Zhongwei and Tang Zhongliang, editors [乔忠伟 汤中良], Army Combined Arms Battalion Combat [陆军合成营战斗], (Beijing: Military Science Press, 2014), 113-114
  - 31 "Implementation of System Communication, Data Communication, and Situation Communication in Ground-Air Joint Training in the Southern Theater Command" [南部战区陆空联训实现系统通数据通态势通], PLA Daily, 3 December 2017, [http://www.81.cn/jfjbmap/content/2017-12/03/content\\_193339.htm](http://www.81.cn/jfjbmap/content/2017-12/03/content_193339.htm)
  - 32 Huan Kunlun [黄昆仑], "A Brigade of the 72nd Group Army Pays Close Attention to Operational Requirements and Promotes the Extension of Joint Teaching and Training to the End [第七十二集团军某旅紧盯作战需求推动联战联训向末端延伸], PLA Daily, 25 September 2023, [http://www.81.cn/szb\\_223187/szbqxq/index.html?paperName=jfjb&paperDate=2023-09-25&paperNumber=01&articleid=916101](http://www.81.cn/szb_223187/szbqxq/index.html?paperName=jfjb&paperDate=2023-09-25&paperNumber=01&articleid=916101)
  - 33 Peng Bingen [彭兵根] et al, Air and Ground Integration: Forging a Pair of Swords [空地一体: 铸就合璧双剑], PLA Daily [解放军报], No. 7-19, 19 July 2009, 2
  - 34 Figure 2: Component Air Command and Control Agencies for Close Air Support, image, FMSO.
  - 35 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 290
  - 36 People's Liberation Army Military Terms [中国人民解放军军语], (Beijing: Military Science Press, 2011), 981
  - 37 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 293-294
  - 38 "A Certain Base of the Western Theater Air Force Enhances Terminal Execution Capability of the Joint Operational System of Systems – Army Guides are Active in the Air Force Training Ground" [西部战区空军某基地提升联合作战体系末端执行力—陆军引导员活跃在空军演兵场], PLA Daily, 10 February 2022 [http://www.81.cn/jfjbmap/content/2022-02/10/content\\_309058.htm](http://www.81.cn/jfjbmap/content/2022-02/10/content_309058.htm)
  - 39 Dai Xiangyuan and Ren Fan, 14 pilots serve as acting infantry platoon leaders, China Military Online, 20 August 2019, [http://eng.mod.gov.cn/news/2019-08/20/content\\_4848588.htm](http://eng.mod.gov.cn/news/2019-08/20/content_4848588.htm)
  - 40 Chen Dianhong [陈典宏], A Brigade of the 75th Group Army Explores a New Way to Cultivate Air-Ground Integration Talents [第75集团军某旅探索空地融合人才培养新路], PLA Daily, 21 August 2019, [http://www.mod.gov.cn/power/2019-08/21/content\\_4848611.htm](http://www.mod.gov.cn/power/2019-08/21/content_4848611.htm)
  - 41 Li Qian and Lian Xin [李倩, 廉鑫], The Joint Tactical Guide Goes to the Training Ground [联合战术引导员走向演兵场], PLA Daily, 11 January 2023, [http://www.81.cn/jfjbmap/content/2023-01/11/content\\_331588.htm](http://www.81.cn/jfjbmap/content/2023-01/11/content_331588.htm)
  - 42 Xiang Yong, Li Benxue, and Tao Li [向勇, 李本学, 陶李], New Quality Iron Fist Shocks the Battlefield [新质铁拳震沙场], Lei Feng [雷锋], February 2019, 36; Ji Xiaoning, Liu Xuejun, Tang Zongwei, Zhao Jun and Pan Zheping [纪小柠, 刘学军, 唐宗伟, 赵军, 潘浙平], Research on Manned/Unmanned Coordination in Close Air Support Combat [有/无人协同近距空中支援作战研究], Fire Control and Command



- Control [火力与指挥控制], Vol. 48, No. 1, January 2023, 181-182
- 43 Guo Ming [郭明] editor in chief, Lectures on the Science of Special Operations [特种作战学教程], (Beijing: Military Science Press, 2013), 52, 104, and 113-116; Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 294; Liu Chun, Zhang Jun, Cui Zechen, and Wu Jiafeng [刘纯, 张峻, 崔泽晨, and 吴家锋], Research on Close Air Support Operations in the Battle of Yijiangshan Islands [一江山岛战役中的近距离空中支援作战研究], Trainer [教练机], No. 4 2020, 39; Chen Dianhong and Xu Haojie [陈典宏 and 许浩杰], A Certain Army Brigade in the Southern Theater Command Invited Officers and Soldiers from Multiple Branches of the Military to Participate in the Research of Fighter Aircraft Modification [南部战区陆军某旅邀请多军兵种单位官兵参与战机改装攻关], PLA Daily, 2 March 2023, [http://www.81.cn/jfjbmap/content/2023-03/02/content\\_334727.htm](http://www.81.cn/jfjbmap/content/2023-03/02/content_334727.htm)
  - 44 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 290
  - 45 Ibid.
  - 46 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 291-292
  - 47 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 292
  - 48 Ibid.
  - 49 Qiao Zhongwei and Tang Zhongliang [乔忠伟 汤中良] editors, Army Combined Battalion Tactics [陆军合成营战斗], (Beijing: Military Science Press, 2014), 9, 13, 20, 207; Hu Xiaomin [胡孝民] and Ying Fucheng [应甫成] editors in chief, Research on the Theory of Joint Firepower Warfare [联合火力战理论研究], (Beijing: National Defense University Press, 2004), 190-191
  - 50 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 292-293
  - 51 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 293
  - 52 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 294
  - 53 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 290; Tang Yi, et al [唐奕], Characteristic Analysis of Typical Targets in Close Air Support and Research on Use of Arial Bombs [近距离空中支援典型目标特性分析及航空炸弹使用研究], Aerodynamic Missile Journal [飞航导弹], Issue 8, August 2021, 84-90; Qiao Zhongwei and Tang Zhongliang, editors [乔忠伟 汤中良], Army Combined Arms Battalion Combat [陆军合成营战斗], (Beijing: Military Science Press, 2014), 146
  - 54 Liu Jinjun [刘进军], Introduction to Ground-Air Coordination Operations [陆空协同作战概论]. (Beijing: PLA Press, 1996), 44-46
  - 55 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 419
  - 56 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 427
  - 57 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 427 and 431; Qiao Zhongwei and Tang Zhongliang [乔忠伟 汤中良] editors, Army Combined Battalion Tactics [陆军合成营战斗], (Beijing: Military Science Press, 2014), 57; People's Liberation Army Military Terms [中国人民解放军军语], (Beijing: Military Science Press, 2011), 734 and 736
  - 58 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 428; Liu Jinjun [刘进军], Introduction to Ground-Air Coordination Operations [陆空协同作战概论]. (Beijing: PLA Press, 1996), 46-47
  - 59 Tu Luyou [涂禄友] editor, Fundamentals of Artillery Tactics [炮兵战术基础], (Beijing: National University of Defense Technology Press, 2001), 290; Liu Jinjun [刘进军], Introduction to Ground-Air Coordination Operations [陆空协同作战概论]. (Beijing: PLA Press, 1996), 48-49
  - 60 Liu Jinjun [刘进军], Introduction to Ground-Air Coordination Operations [陆空协同作战概论]. (Beijing: PLA Press, 1996), 49-50
  - 61 Liu Jinjun [刘进军], Introduction to Ground-Air Coordination Operations [陆空协同作战概论]. (Beijing: PLA Press, 1996), 51
  - 62 Ibid.
  - 63 Liu Jinjun [刘进军], Introduction to Ground-Air Coordination Operations [陆空协同作战概论]. (Beijing: PLA Press, 1996), 51-52
  - 64 Liu Jinjun [刘进军], Introduction to Ground-Air Coordination Operations [陆空协同作战概论]. (Beijing: PLA Press, 1996), 52-53
  - 65 Andreas Rupprecht, Modern Chinese Warplanes: Chinese Army Aviation – Aircraft and Units, (Vienna: Harpia Publishing, 2019), 57-86
  - 66 Andreas Rupprecht, Modern Chinese Warplanes:



- Chinese Army Aviation – Aircraft and Units, (Vienna: Harpia Publishing, 2019), 24-30
- 67 Xu Hui [徐辉], A Comparative Study of Military Rotary-wing Aircraft Ground Support with Close Air Support [军用旋翼机对地支援与近距空中支援比较研究], Trainer [教练机], No. 1 2021, 57-62
  - 68 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 1-2; Qiao Zhongwei and Tang Zhongliang [乔忠伟 汤中良] editors, Army Combined Battalion Tactics [陆军合成营战斗], (Beijing: Military Science Press, 2014), 86-87
  - 69 Ma Chengqun [马成群] editor, Director's Review of Combined Battalion Tactical Exercise [合成营战术演习导演评], (Beijing: Tide Press, 2010), 13; Qiao Zhongwei and Tang Zhongliang [乔忠伟 汤中良] editors, Army Combined Battalion Tactics [陆军合成营战斗], (Beijing: Military Science Press, 2014), 81 and 207
  - 70 Chen Dianhong and Xu Haojie [陈典宏 许浩杰], A Southern Theater Army Brigade invited Officers and Soldiers from Multiple Services to Participate in Research in Fighter Aircraft Modification [南部战区陆军某旅邀请多军兵种单位官兵参与战机改装攻关], PLA Daily, 2 March 2023, [http://www.81.cn/jfjbmap/content/2023-03/02/content\\_334727.htm](http://www.81.cn/jfjbmap/content/2023-03/02/content_334727.htm)
  - 71 A 79th Group Army Brigade Explores a New Method of Ground-Air Communication [第79集团军某旅探索空地通联新模式], PLA Daily, 13 April 2022, [http://www.81.cn/jfjbmap/content/2022-04/13/content\\_313512.htm](http://www.81.cn/jfjbmap/content/2022-04/13/content_313512.htm); Lu Xuefei et al [吕雪飞], Kong Zhou, the Commander of the Second Battalion of a Certain Brigade of the 74th Group Army made Friends for the Exploration of Air-Ground Coordination [第74集团军某旅合成二营营长孔洲为探索空地协同广交朋友], PLA Daily, 17 August 2019, [http://www.81.cn/jfjbmap/content/2019-08/17/content\\_240981.htm](http://www.81.cn/jfjbmap/content/2019-08/17/content_240981.htm)
  - 72 Qiao Zhongwei and Tang Zhongliang [乔忠伟 汤中良] editors, Army Combined Battalion Tactics [陆军合成营战斗], (Beijing: Military Science Press, 2014), 113- 114
  - 73 Huan Kunlun [黄昆仑], "A Brigade of the 72nd Group Army Pays Close Attention to Operational Requirements and Promotes the Extension of Joint Teaching and Training to the End [第七十二集团军某旅紧盯作战需求推动联战联训向末端延伸], PLA Daily, 25 September 2023, [http://www.81.cn/szb\\_223187/szbqxq/index.html?paperName=jfjb&paperDate=2023-09-25&paperNumber=01&articleid=916101](http://www.81.cn/szb_223187/szbqxq/index.html?paperName=jfjb&paperDate=2023-09-25&paperNumber=01&articleid=916101)
  - 74 Qiao Zhongwei and Tang Zhongliang, editors [乔忠伟 汤中良], Army Combined Arms Battalion Combat [陆军合成营战斗], (Beijing: Military Science Press, 2014), 146
  - 75 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 8-9
  - 76 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 10-13
  - 77 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 57
  - 78 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 12-15
  - 79 The PLA has apparently constructed fixed helicopter pads for forward deployment. An example is Nanji Island where 9 helicopter pads were built. See Peter Wood, "China Gears Up Helicopters to Play Crucial Role in East China Sea Dispute," China Brief, Volume XV, Issue 5 6 March 2015, [https://jamestown.org/wp-content/uploads/2015/03/China\\_Brief\\_Vol\\_15\\_Issue\\_5\\_4.pdf](https://jamestown.org/wp-content/uploads/2015/03/China_Brief_Vol_15_Issue_5_4.pdf)
  - 80 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 18
  - 81 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 18-19
  - 82 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 19
  - 83 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 19-20
  - 84 Qiao Zhongwei and Tang Zhongliang, editors [乔忠伟 汤中良], Army Combined Arms Battalion Combat [陆军合成营战斗], (Beijing: Military Science Press, 2014), 146
  - 85 Figure 3: Air Fire Assault Group Offensive Deployment , illustration, FMSO.
  - 86 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 43
  - 87 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 16

- 88 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 16-17
- 89 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 15-16
- 90 Zhang Zhiwei and Huang Chuanxian [张志伟 黄传贤] editors, Research on Army Aviation Operational Theory [陆军航空兵作战理论研究], (Beijing: National Defense University Press, 2014), 23-29
- 91 Yefim Gordon and Dmitriy Komissarov, Chinese Air Power, (Manchester: Hikoki Publications, 2021), 348-350
- 92 Liu Xuanzun, "PLA Army's newly unveiled armed recon drone likely joined drills around Taiwan Island," Global Times, 21 September 2023, <https://www.globaltimes.cn/page/202309/1298669.shtml>
- 93 Zhao Lulu [赵露露], "Research on Operational Rules for US UAV Close Air Support" [美军无人机近距离空中支援作战行动规则研究], Ship Electronic Engineering [舰船电子工程], Vol. 40, No. 1, 2020, 1-2
- 94 Li Lei et al [李蕾], "An Air Force Staff Officer Visited An Army Training Ground" [陆军演兵场走来空军参谋], PLA Daily, 14 February 2023, [http://www.81.cn/szb\\_223187/szbxq/index.html?paperName=jfjb&paperDate=2023-02-14&paperNumber=01&articleid=662710](http://www.81.cn/szb_223187/szbxq/index.html?paperName=jfjb&paperDate=2023-02-14&paperNumber=01&articleid=662710)
- 95 A College of the Naval Aviation University – Adhere to the Needs of the Troops to Promote Innovation in Teaching and Research [海军航空大学某学院 - 紧贴部队需要推进教研创新], PLA Daily, 18 March 2023, [http://www.81.cn/szb\\_223187/szbxq/index.html?paperName=jfjb&paperDate=2023-03-18&paperNumber=03&articleid=901050](http://www.81.cn/szb_223187/szbxq/index.html?paperName=jfjb&paperDate=2023-03-18&paperNumber=03&articleid=901050)
- 96 See for example Zhang Guangzheng [张广政] et al, "Analysis of Operation Features of UAV in NaKa Conflict and Its Enlightenment" [纳卡冲突无人机作战运用特点分析与启示], Unmanned Vehicles [无人机], 2020 18, 12-16; Huang Xiaojing and Wu Senlei [黄泉警, 吴森磊], Analysis of UAV's Operational Application in NaKa Conflict" [纳卡冲突中无人机作战运用浅析], Unmanned Vehicles [无人机], 2020 18, 17-20
- 97 Gao Yu, Hu Hui, Xing Li, and Meng Fanna [高宇, 胡慧, 邢丽, 孟凡娜], "Operational Capability Evaluation of Close Air Support for Fixed-wing Aircraft" [固定翼飞机近距离空中支援作战能力评估], Ordnance Industry Automation [兵工自动化], Volume 40, May 2021, 51
- 98 Geng Layuan, Mao Yuquan, Ding Xiaoliang, and Wang Yuankun [耿腊元 毛玉泉 丁笑亮 和王源琨], Research on Close Air Support Application Based on the Variable Message Format [基于VMF 的近距离空中支援应用研究], Ship Electronic Engineering [舰船电子工程], Volume 29 No. 7, July 2009, 9-10
- 99 Liu Zijun and Fan Yilong [刘子君, 范义龙], "Analysis Method of Data Link Information Requirements Based on OODA Loop in Close Air Support" [近空支援中基于OODA 环的数据链信息需求分析方法], Modern Navigation [现代导航], Issue 6, December 2020, 431-437
- 100 Wang Hongju [王红举], Research on the Application of Link-16 Tactical Data Link in Close Air Support [美军Link-16 数据链在近距离空中支援作战中应用研究], Modern Navigation [现代导航], Issue 5, October 2019, 351-357
- 101 Wang Hongju and Yan Zhou [王红举 and 闫舟], Research on the Application of U.S. Military Tactical Satellite Communication System in Air Support Operations [美军战术级卫星通信系统在近距离空中支援作战中应用研究], Modern Navigation [现代导航], Issue 1, 2020, 46-51
- 102 Zhang Chi and Ding Yi [张弛 and 丁轶], Research on the Application of AWACS in the System of CAS [预警机在美军近距离空中支援指控体系中的应用研究], Informationization Research [信息化研究], Vol. 46, No 4, August 2020, 42-46
- 103 Wang Zhaohui, Zhang Zhen, and Zhang Xin [王召辉, 张臻, 张昕], Research on the Command and Control Architecture of the U.S. Military Kill Box [美军杀伤盒指挥控制架构研究], Electronics Quality [电子质量], Issue 01, 2020, 48-51; Li Yongqiang [李永强], Modern Close Air Support Operations [现代近距离空中支持作战], Beijing: Aviation Industry Press, 2018, 179-180
- 104 Li Yongqiang [李永强], Modern Close Air Support Operations [现代近距离空中支持作战], Beijing: Aviation Industry Press, 2018, 185-205
- 105 Zhang Lun et al [张轮], Analysis of Bomber Close Air Support Superiority and Development Status [轰炸机近距离空中支援优势及发展现状分析], Fire Control & Command Control [火力与指挥控制], Vol. 47, No. 10, October 2022, 175-184
- 106 Xu Hui [徐辉], "A Comparative Study of Military Rotary-wing Aircraft Ground Support with Close Air Support" [军用旋翼机对地支援与近距离空中支援比较研究], Trainer Aircraft [教练机], No. 1 2021, 62
- 107 Zhao Lulu [赵露露], "Research on Operational Rules for US UAV Close Air Support" [美军无人机近距离空中支援作战行动规则研究], Ship Electronic Engineering [舰船电子工程], Vol. 40, No. 1, 2020, 1-2
- 108 Zhao Lulu [赵露露], "Research on Operational Rules of US UAV Close Air Support" [美军无人机近距离空中支援作战行动规则研究], Ship Electronic Engineering [舰船电子工程], Vol. 40, No 1, 2020, 1-5
- 109 Zhang Mingming, et al [张明明], Research on Requirements of Weapons and Ammunition in Close

Air Support [近距离空中支援作战对武器弹药的需求研究], Science Technology and Engineering [科学技术与工程], Vol. 23, Issue 2, 2023, 440-447

- 110 Kang Daming, Zheng Lu, and Wang Xingyun [康大明, 郑璐, 王幸运], UAV Close Air Support in the Intelligent Era, Analysis of Operational Characteristics [智能化时代无人机近距离空中支援, 作战特点探析], Military Digest [军事文摘], July 2022, 29-32
- 111 Gao Kai et al [高凯], "Gain Insights into Future Air Strikes" [洞悉未来空袭之变], PLA Daily, 29 November 2022, [http://www.81.cn/jfjbmap/content/2022-11/29/content\\_328870.htm](http://www.81.cn/jfjbmap/content/2022-11/29/content_328870.htm)
- 112 Gao Yu, Hu Hui, Xing Li, and Meng Fanna [高宇, 胡慧, 邢丽, 孟凡娜], "Operational Capability Evaluation of Close Air Support for Fixed-wing Aircraft" [固定翼飞机近距离空中支援作战能力评估], Ordnance Industry Automation [兵工自动化], Volume 40, May 2021, 51