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# REMOTE BASING: PEOPLE'S LIBERATION ARMY LOGISTICS ON THE TIBETAN PLATEAU

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## EXECUTIVE SUMMARY

The People's Liberation Army (PLA) is at the forefront of China's efforts to defend its extensive land border with India and maintain firm control over Tibet. As both China and India have expanded their respective infrastructural and military basing networks along the Line of Actual Control (the sectors of the Sino-Indian border where demarcation remains disputed), significant escalations have occurred, most notably the Doklam Standoff in mid-2017 and the Galwan Valley skirmish in June 2020. For the PLA, providing logistical support and sustainment to troops stationed on the "roof of the world" is a longstanding challenge. Nevertheless, despite the generally difficult geography on the Chinese side of the border, more effective logistical support appears to remain an enduring advantage for the PLA over the Indian Armed Forces.

The Tibetan plateau's high altitude, mountainous terrain, difficult weather, and extreme cold make nearly all aspects of military logistics more difficult. The environment produces a myriad of specific logistical requirements. For example, PLA medical facilities in Tibet must store and supply oxygen to deal with high-altitude illness, which is particularly common among newly deployed troops. To maintain operational readiness in low temperatures, vehicles must be kept in insulated shelters to ensure they can start. Helicopter payload capacity is reduced at high altitude, and as a result, supply runs must be made more frequently. Drinking, cooking, and bathing water for troops needs to be unfrozen and purified. Inadequate local grain, fruit, and vegetable production in Tibet requires the PLA to transport most of its food supplies over long distances, largely from Qinghai Province.

Lack of transportation networks into and within Tibet has also been a major limiting factor on the PLA's ability to project force to the border with India. Very poor or non-existent transportation networks in remote areas forced the PLA to rely heavily on warehousing supplies. However, the recent expansion of road, air, and rail networks, both into and around Tibet, has enhanced the PLA's ability to move towards a more efficient logistical model in the region. The expanding network of "moderately prosperous border villages," some of which are located on territory also claimed by India and Bhutan, has also facilitated a scale-up of PLA forces along the border. The expansion of civilian administration and enterprises across over 600 border villages has also created more opportunities for Military-Civil Fusion and may enable the PLA to better leverage local resources in border counties.

The logistical system in the Tibet Military District (Tibet MD) underwent significant changes with the PLA's reform and restructuring launched in late 2015. As with other military districts, the new Joint Logistic Support Force (JLSF), focused on supporting joint combat operations, assumed considerable logistical capabilities. During the reform process, the former Tibet MD Logistics Support Department was downsized to a Support Department. However, in contrast to other military districts, but in line with the Tibet MDs' special status (along with the Xinjiang and Beijing MDs) as a deputy-theater level command reporting directly to PLA Army Headquarters, the Tibet MD also attained significant new logistical capabilities through the restructuring.

The more extensive array of logistical units under the Tibet MD reflects the unique challenges of providing logistical support to bases and border outposts on the Tibetan plateau. To solve the challenges presented by both the environment and the adversary, PLA logisticians are applying a range of emerging, existing, and old technologies. For example, in areas where road transportation is impossible, PLA border guards sometimes still use pack animals to patrol or move supplies. At the same time, however, the PLA is also increasingly using unmanned aerial vehicles (UAVs) for drops of food or medical supplies in difficult-to-access posts.

Logistics as practiced by the PLA is an expansive undertaking that encompasses a broad array of functions. This report focuses on four areas that are particularly relevant to sustaining the PLA's basing presence in high-altitude areas of the Tibetan plateau: transportation, base construction and engineering, supply, and medical support. In doing so, the report seeks to provide strategic and organizational context for the PLA's logistical support and remote basing network in Tibet. Hence, the development of infrastructure along the border is considered in the context of 1) the oscillation of China-India strategic relations; 2) the PRC's efforts to control its far-western borderlands; and 3) the PLA's ongoing military modernization efforts.

## INTRODUCTION

The People's Liberation Army's (PLA) effort to become a "world-class military" is often viewed through a maritime lens, with Taiwan and a potential Pacific conflict with the U.S. military taking center stage. However, the PLA confronts an equally daunting challenge high on the Tibetan plateau along China's long, still-disputed land border with India. In these areas, the *de facto* China-India boundary, the Line of Actual Control (LAC), continues to shift. Following two major clashes at the border, the 2017 Doklam standoff and the June 2020 Galwan Valley skirmish, the People's Republic of China (PRC) accelerated its longstanding efforts to improve dual-use infrastructure networks and expand its military presence in Tibet and southwestern Xinjiang.[1] In October 2024, Chinese and Indian leaders agreed to disengage from friction points along the LAC and resume patrolling in areas controlled by the respective sides prior to the 2020 escalation.[2] Regardless, the PRC appears committed to developing dual-use infrastructure in Tibet and far-western Xinjiang. The PLA's ongoing expansion of its remote basing presence along China's western frontiers is a key element of building "strong and stable modern border defenses."[3]

This study examines the PRC's evolving approach to supporting military logistics on the Tibetan plateau. The first section offers an overview of the geography along the China-India border, drawing on PLA officers' and experts' observations on why it is a particularly challenging operational environment. The second section briefly overviews the PLA's force structure and logistical support organizations in the PLA Western Theater Command (WTC) and the Tibet and Xinjiang Military Districts (MDs). This section also examines the impact of the PLA's recent reforms on the force's logistical support. The final section of the report surveys four aspects of logistical support that together enable the PLA's expanding remote basing infrastructure in Tibet and southwestern Xinjiang: transportation, base construction and engineering, supply, and medical support.

### SENTRIES ON THE ROOF OF THE WORLD

In August 2016, Chinese Communist Party (CCP) General Secretary and Central Military Commission (CMC) Chairman Xi Jinping wrote a letter to the Gamba Border Defense Battalion [岗巴营官] based in Gamba County, Shigatse Prefecture, where the PRC's border converges with those of India, Nepal, and Bhutan.[4] This battalion is the PLA's highest-altitude border defense post, with an average elevation above 5,100 meters (16,732 feet).[5] In his letter, Xi commended the battalion's troops for devoting their youth to protecting China's border regions and sovereignty, designating the unit a "Model Border Defense Battalion on the [Tibetan] Plateau" [高原戍边模范营].[6] In April 2021, the CMC's Political Work Department designated the Gamba Battalion as an "advanced poverty alleviation collective of the PLA" for providing medical services to local communities.[7] In September 2021, Xi again sent the battalion a letter, this time to mark the Mid-Autumn Festival and National Day holidays.[8] The focus of the PLA leadership on the Gamba Border Defense battalion attests to the importance that Beijing places on border defense in the Xi era.

*Figure 1: Troops from the Gamba border defense battalion attempt to relieve comrades suffering from altitude illness during a 2015 patrol*[9]

The difficult operational environment in the Tibetan plateau poses unique challenges to PLA supply lines, which must support a permanent military basing infrastructure along the long and mountainous border. Due to the difficult topographical and weather conditions, which PLA logisticians characterize as defined by the "two highs" of high altitude and extreme cold [高原高寒], rail transportation remains extremely limited there compared to the rest of the PRC.[10] In Tibet, railways primarily serve to connect Tibet's capital, Lhasa, to the rest of the PRC's rail network. While the Qinghai-Tibet railway, which opened in 2006, increases China's capacity to deploy large numbers of forces to Lhasa, the PLA must rely primarily on road transportation to access the remote border posts along the LAC.[11] As a result, the PRC's recent buildup of air infrastructure and the expansion and upgrading of the road system in Tibet have been key enablers of the PLA's improved abilities to deliver supplies and project force in the region.

From Aksai Chin in far western Xinjiang to Nyingchi Prefecture in Eastern Tibet, PLA troops guard the border with India across vast stretches of territory far removed from the Chinese heartland. This is also an area in which the PRC has long sought to assimilate the indigenous Tibetan population into the Chinese nation. For PLA soldiers, logistics assume critical importance there, particularly in the disputed stretches along the LAC. In this difficult environment, faulty planning can wreck equipment and put troops in danger. Since at least the reforms the PLA initiated in late 2015, the force has sought to develop a more efficient, centralized, informationized, and joint logistics support model. Although logistical support structures in Tibet have been significantly improved overall, given the especially difficult operational environment in the Tibet MD, the PLA continues to assign unique, dedicated logistical support forces to it.

The 2015-2016 PLA reforms centralized sustainment under the newly created Joint Logistic Support Force (JLSF), a deputy theater-level arm of the PLA.[12] This move was an exception to the reforms' general push towards deeper jointness by establishing greater concentrations of authority and capabilities at the theater level.[13] The JLSF provides logistical support to the Western Theater Command through the Xining Joint Logistics Support Center (JLSC) in Qinghai. As in other regions, the Tibet MD Logistics Support Department and brigade-level unit Logistics Departments were downgraded to Service Departments. The JLSF's Xining Joint Logistics Support Center presumably took on some of these functions as part of the centralization of logistical capabilities across the PLA.

However, unlike other MDs, during the reorganizations the Tibet MD itself also *absorbed* significant new logistical capabilities. In late 2015, the PLA transferred the Qinghai-Tibet Logistics Depot from the previous CMC General Logistics Department (GLD) to the PLA Army under the Tibet MD.[14] The Sichuan-Tibet Logistics Depot was also moved from the former Chengdu Military Region to the Tibet MD. These moves resulted in the Tibet MD gaining direct supervisory responsibility for significant new transportation, supply, and medical capabilities in the major overland transport hubs that link Tibet to the rest of the PRC: Golmud, Qinghai, and Chengdu. As a result, the Tibet MD operates supplementary logistical support capacities that are not found in other MDs. This, along with the Tibet MD's higher position in the PLA hierarchy as a deputy theater-grade unit,[15] indicates that the Tibet MD can routinely draw on deeper logistical capacity than other MDs, theoretically allowing for more effective logistical support in remote border areas.

In Tibet, the PLA has historically relied on stockpiling supplies at facilities dispersed along the LAC to maintain readiness.[16] However, three changes indicate that Tibet and Xinjiang are not exceptions from the PLA's broader efforts to transition from a "just in case" logistics support model to a "just in time" approach: (1) centralization of logistical support capabilities; (2) new guidelines placing greater emphasis on optimizing supply chains, and (3) evidence of increasingly efficient supply logistics.[17] As Kevin McCauley noted in 2018, the objective of PLA logistics modernization has been to achieve precision logistics support, a "military version of the business concept of 'just-in-time' logistics."[18] Despite the difficult operational environment along the border with India, the PLA appears to be leveraging improving air, road, and rail transportation networks across Tibet and Xinjiang, as well as applying an expanding array of technological solutions such as drone supply drops and app-based delivery systems, in order to make progress toward a precision logistics support model in the remote border areas of the Tibetan plateau.

Long supply lines have made it difficult to ensure that troops stationed on the Tibetan plateau have access to quality nutrition, particularly fresh meats and vegetables. Until recently, for example, vitamin deficiencies were reportedly common among troops stationed in the Tibet MD.[19] The PLA is now leveraging improved transportation networks, as well as improving logistical capabilities and supply chain efficiency, in order to provide deliveries of fresh vegetables, fruit, meat, and even seafood to troops stationed in remote areas. According to Zhao Yawei [赵亚伟], director of the Tibet MD Logistic Support Department's Material Supply Division, fresh pork from China's inland can now reach troops stationed on the Tibetan plateau within three days.[20] A 2024 *People's Daily* article reported that even the troops of the Gamba Border Defense Battalion are

able to regularly enjoy their favorite dishes, such as shredded pork with fish sauce and chopped pepper fish head.[21]

While this report focuses on PLA logistics support to remote bases and border outposts, in the PRC, border defense is viewed as demanding cooperation between civilian and military authorities; it is, in other words, a component of China's Military-Civil Fusion (MCF) strategy.[22] Moreover, in Tibet, many of the roadways and airports were originally built for military supply before eventually allowing both military and civilian applications. The development of dual-use infrastructure through the expansion of a network of "moderately prosperous border villages," for example, supports the PLA's ability to sustain its remote basing network by creating a network of supply nodes and other infrastructure that could be used to support a larger troop presence in the event of unrest in Tibet or a conflict with India. A total of 624 of these villages were built from 2018 to 2022.[23] Broadly speaking, they support the expansion of party and state bureaucracies to remote areas of the Tibet Autonomous Region (TAR). The growing presence of party and state capabilities in the region benefits the PLA in a range of ways, including improved traffic systems, more effective management of disaster responses, expanded public health capabilities, and expanded access to supplies and services from civilian enterprises.

**Figure 1: Impact of 2015-2016 PLA Reforms on Logistical Support in the Tibet MD**

| **Central Military Commission / PLA** |
|---|
| General Logistics Department (GLD) eliminated; new CMC Logistics Support Department assumes responsibility for overall management of PLA logistics |
| Joint Logistic Support Force (JLSF) established as a deputy theater-level arm of the PLA, responsible for providing logistical support for military campaigns |
| **Military Region/Theater (Southwestern PRC)** |
| Operational command of the Tibet MD transferred from Chengdu Military Region to WTC |
| Xining Joint Logistics Support Center established to provide logistical support to the WTC and Tibet MD |
| WTC Army and WTC Air Force Support Departments created |
| Lhasa Air Base established (joining Urumqi and Lanzhou) as one of three WTC Air Bases |
| **Tibet Military District** |
| Tibet MD upgraded, in May 2016 to a deputy theater-level unit, administratively under and reporting directly to the PLA Army |
| Tibet MD Logistics Support Department eliminated, responsibilities and capabilities divided between new JSLF and Tibet MD Support Department |
| Qinghai-Tibet-Supply Depot transferred from CMC GLD to Tibet MD |
| Sichuan-Tibet Supply Depot transferred from Chengdu MR to Tibet MD |


*Figure 2: Declassified State Department Bureau of Intelligence and Research (INR) map of the China-India border from the 1970s*[24]

The PRC's approach to the border dispute with India is not only shaped by sensitivity to any perceived infringements on its sovereign territory, but also by its determination to control and Sinicize Tibet. After India granted refuge to the Dalai Lama in the wake of the PRC's 1959 invasion, tensions along the disputed border escalated, culminating in the 1962 Sino-Indian War. The PRC has continued to view India's harboring of the "Dalai clique," [25] its control of territory that Beijing considers part of the PRC (Arunachal Pradesh), and its claims to significant territories controlled by China in Tibet and far-Western China (especially Aksai Chin) as a challenge to Chinese control of Tibet.

Infrastructure and logistics have at times been key drivers of the border dispute. Over the past decade, China and India have engaged in what some experts have characterized as an "infrastructure race" to develop transportation and border defense infrastructure along the LAC. As Rajeswari Pillai Rajagopalan noted in a 2016 interview, the PRC's ability to rapidly project force to the LAC has been bolstered "tremendously with the infrastructure built up over the last decade" in the TAR.[26] After the mid-2020 Galwan Valley clash, Deep Pal observed that "changes in border infrastructure on the Indian side in recent years are one major immediate cause" of

tensions, noting that while the PRC has long "enjoyed better infrastructure" near the LAC, "India in 2005 announced a project of 61 roads covering 3,400 kilometers near the LAC, which, once completed, will erode China's traditional advantage."[27]

Indian analysts typically divide the LAC into three geographic sectors: the western sector, the middle sector, and the eastern sector.[28] The western sector includes Aksai Chin, claimed by India and the PRC but controlled by the latter, and the Indian Union Territory of Ladakh.[29] The western sector has approximately 38,000 km$^2$ of disputed territory that both India and the PRC claim.[30] Delhi has maintained its longstanding claims to Aksai Chin, but the region is more accessible from the Chinese side of the border than it is from the Indian. The Askai Chin region is also strategically important to the PRC, because its G219 "sky highway" links Xinjiang and Tibet.[31] Within the PLA, the Xinjiang MD, with support from the WTC, has primary responsibility for operations in Aksai Chin.[32]

The middle sector of the LAC includes small pockets dividing about 2,000 square km of disputed territory, in which the LAC divides the PRC's Ngari Prefecture in Eastern Tibet from the Indian states of Himachal Pradesh and Uttarakhand.[33]


*Figure 3: Map of Tibet's seven prefectures*

The eastern sector of the LAC, which cuts across PRC-controlled Tibet's Shigatse, Shannan, and Nyingchi prefectures and the Indian State of Arunachal Pradesh, which contains 90,000 km$^2$ of disputed territory. In April 2024, the PRC Ministry of Civil Affairs released a list of 30 place names for locations in this area, which it referred to as "South Tibet" (藏南).[34] India promptly rejected the move, with a Ministry of External Affairs spokesperson stating that "assigning invented names will not alter the reality that Arunachal Pradesh is, has been, and will always be an integral and inalienable part of India."[35] In response to these objections, PRC Ministry of National Defense spokesperson Wu Qian [吴谦] stated that the "South Tibet region has been Chinese territory since ancient times."[36]

The Tibet MD, along with its Shigatse, Shannan, and Nyingchi Military Sub-Districts (MSDs), is responsible for border security in the eastern sector of the LAC. The Tibet MD's eight border regiments and several independent battalions are stationed along the PRC's borders with Nepal, India, and Bhutan in Shigatse, Shannan, and Nyingchi prefectures. They report directly to the prefecture-level MSDs where they are stationed. Two of the Tibet MD's three combined arms brigades, both of which specialize in mountain warfare, are also based in Nyingchi prefecture.[37]

Since 2013, the PLA and the Indian Armed Forces have engaged in a string of standoffs and clashes, which are typically triggered by one side opposing the other's efforts to construct roads or establish posts in contested territory. Both the PRC and India intensified their efforts to develop border infrastructure and expand their military presences along the LAC following the mid-2017 standoff between the Chinese and Indian militaries in Doklam.[38] This confrontation stemmed from Indian forces moving to block PLA Army engineers from building a road through the contested Doklam plateau. Three years later, both sides stood down. Tensions persist, though, and both India and the PRC retain not only significant troop presences along the LAC, but also the logistical networks and basing infrastructure necessary to quickly surge forces to the border if tensions rise again. [39]

### A Challenging Operational Environment

The Tibetan plateau presents a very difficult operational environment characterized by extreme cold and volatile weather.[40] Routine patrol, training, or supply missions can therefore be dangerous, even during periods of calm between the Indian and PRC forces deployed in the area. For example, a 2019 *People's Daily* article noted that even when "there is no fighting on the [China-India] border, soldiers still make sacrifices."[41] The article recalls the unfortunate fate of Lu Yonggang [陆永刚]. In 1995, Lu, a 19-year-old soldier from Yunnan Province stationed in Tibet, got lost during a routine patrol, suffered acute pulmonary edema, and died.[42] Lu was reportedly the 22nd border patrol soldier to have died at the Kunmujia Sentry Post [昆木加建哨] since the outpost was established in 1962.[43]

Due to the high elevation of the Tibetan plateau, personnel arriving from elsewhere in China are also at significant risk of high-altitude illness (HAI) and need time to acclimate to the altitude.[44] As a result, acclimatization times must be factored into personnel readiness. Troops arriving from the near-sea-level elevations of the Chinese heartland require multiple days to acclimate. As Aidan Milliff notes, "soldiers take days to acclimatize to any altitude above 2,400 meters (7,875 feet), slightly higher than Santa Fe, New Mexico."[45] During the 1962 Sino-Indian War, the Indian Army rushed some troops directly to the front without giving them time to acclimate. As many as 15 percent of those soldiers experienced pulmonary edema, a major cause of fatalities on the Indian side during the conflict.

In a paper published shortly after the Doklam standoff in 2017, two professors at the PRC Army Military Transportation Academy [陆军军事交通学院] in Tianjin discussed the unique challenges of sustaining logistical support along the Sino-Indian border.[46] They focused on the following major impediments to supporting military operations in the Tibetan Plateau:

- **Poor road conditions and vast distances**: Except for the national highways, road conditions are generally poor. In mountainous areas, roadways often have many curves,

steep inclines and declines, and uneven surfaces. This, along with muddiness or barriers such as fallen trees, makes accidents in these areas more frequent.

Even on routes with national highways and good road conditions, the distances between major supply centers and the border are enormous. For example, a unit traveling by truck from Lhasa to Pangong Tso in western Tibet to the nearest rail depot in Hotan via highway G219 would take around 30 hours to traverse 1,111 kilometers (~690 miles).[47] Traveling from the northern fringes of Pangong Tso to Kashgar in far-western Xinjiang would take around the same amount of time.

- **Natural disasters:** Disasters are frequent and roadblocks are common. In the summer, thunderstorms can lead to landslides and mudslides. In the winter, landslides and even avalanches can occur in the mountains. Roads are often covered with snow and ice. This makes already complex road conditions more difficult and dangerous, and the vehicles transporting supplies more difficult to operate.
- **Complex meteorological conditions and low-efficiency logistical support:** Low temperatures and high winds slow transportation networks; breathing difficulties result in reduced physical fitness and limits on movement; high-altitude illness may occur; vehicle fuel consumption increases; and vehicle engines may not start in extreme cold.

In addition to the physical challenges that soldiers face when operating at high altitudes, PLA logistics experts note that the reduced oxygen content in the atmosphere reduces the performance of vehicles and equipment. Because railroad penetration in the area is minimal and road conditions extremely variable, even routine patrol operations become much more difficult in these regions. According to Pan Xinmao [潘新毛], formerly of the Operational Theory and Regulations Research Department of the PLA Academy of Military Sciences [军事科学院原作战理论和条令研究部], the "lack of oxygen can reduce the power of vehicles and weapon platforms by about 30 percent, increase fuel consumption by 30-40 percent, limit driving speed by 40-50 percent, reduce load capacity by 10-20 percent, and increase the rate of equipment failure rate by 15-25 percent."[48] Such limitations apply not only to ground vehicles but also to helicopters, which have reduced lift at high altitude.[49]

### BORDER CONSTRUCTION AND DEVELOPMENT

Since the PRC's 11th Five-Year Plan (2006-2010), the PRC has undertaken a program of "enriching the people and stabilizing the border."[50] Xi has continually promoted economic and infrastructure development in Tibet and Xinjiang. The current TAR five-year plan (2021-2025) lists "protecting the sacred land and ensuring border consolidation and security" as priorities.[51] The plan explicitly links the development of Tibet's border areas with the consolidation of border security, stressing the need to "coordinate economic development and national defense construction."[52] The TAR Five-Year Plan lists the following as priority areas for border infrastructure development:

- **Transportation:** Improve traffic flow, increase the construction of rural roads in border areas, achieve full coverage of road networks in border towns and villages, and vigorously develop general aviation infrastructure.

- **Electrification:** Accelerate the extension of the main power grid and improve the comprehensive energy security capabilities of border areas.
- **Water infrastructure:** Increase the construction of key water source projects in border areas and improve water conservancy facilities for flood control, drought resistance, irrigation, and power generation.
- **Smart border defense and inspection:** Promote the construction of smart border defense and border inspection; accelerate the construction of border inspection infrastructure at ports of entry and exit; and improve the inspection capabilities, customs clearance efficiency, and service levels of ports of entry and exit.
- **Communication networks:** Achieve full coverage of communication networks along national and provincial roads, border counties, border patrol counties, and border passages.
- **Civil air defense**: Strengthen the construction of civil air defense engineering facilities.
- **Meteorological observation:** Increase the density of meteorological observation stations in border areas; strengthen the co-construction and sharing of border meteorological facilities, data, and resources; and enhance the meteorological monitoring, forecasting, and early warning service capabilities in border areas.
- **Public security:** Strengthen the construction of law enforcement agencies in border towns and improve police capabilities.

Along with the above priorities, the TAR Five-year plan also includes a section on "strengthening the construction of material support capabilities" in border areas. Priority areas include:

- **Food security:** Promote the construction of emergency reserve centers for grain and foodstuffs in border areas; improve emergency food supply processing capabilities; accelerate the construction of food and material informatization; and build a resource-sharing and fully functional reserve facility network.
- **Energy infrastructure:** Strengthen construction of refined oil and natural gas reserve infrastructure; study and establish an energy reserve system; and initially form an energy reserve system that organically combines enterprise reserves with government reserves such that they complement each other.

In his work report delivered to the Second Session of the 12th TAR People's Congress on January 7, 2024, Deputy Party Secretary and TAR Chairman Yan Jinhai [严金海] stated that "consolidating the border" and "building a solid national security barrier" would be priorities for the coming year.[53]

In 2024, the Tibet Autonomous Region announced significant institutional reforms by merging local government departments in counties that have smaller populations, a change which some Indian analysts think will strengthen the PLA's logistics capabilities along the border. According to Zhang Yongpan [张永攀], a research fellow of the Institute of Chinese Borderland Studies of the Chinese Academy of Social Sciences: "by merging certain departments, the efficiency of government operations can be enhanced, thereby minimizing waste and optimizing resource allocation."[54] More to the point, Zhang noted that these reforms will allow for greater focus on border management. Notably, the reforms resulted in the creation of the first "County Border

Construction and Development Bureau" [县边境建设和发展局] in Gar County, Ngari Prefecture in far-western Tibet.[55] A significant PLA presence is concentrated there near Demchok ,which is in Indian-administered territory also claimed by China.[56] The PLA's Gunsa Air Force Station and National Highway 219, which connects Xinjiang and Tibet, both pass through the area. Some Indian analysts argue that the concentration of administrative resources across border counties may strengthen the PRC's ability to facilitate the development of border villages and transportation networks along the LAC. For example, in an article for the Indian think tank Centre for Land Warfare Studies, Tenzin Yountzen observed that "Gar County is central to Beijing's strategic interests in the Western Sector of LAC for securing critical areas such as Demchok."[57]

**BORDER DEFENSE**

Securing China's land frontiers and consolidating control of the borderlands is a core element of the PLA's mandate to protect China's national sovereignty and territory. The 2019 PRC Defense White Paper describes "safeguarding national territorial sovereignty" along China's lengthy land and maritime borders as a foremost mission of "China's Armed Forces in the New Era."[58]

The 2020 edition of the PLA National Defense University's *Science of Military Strategy* (SMS) addresses the PLA's overall approach to frontier defense in more detail, including the requirements for implementing effective border defense.[59] The SMS explicitly notes that the battlefield in border areas is often characterized by remote and difficult terrain with limited transportation, making logistical support difficult. The SMS identifies the frontier defense forces and forward-deployed mobile units as the main forces responsible for guarding PRC's borders.

Xi Jinping has strongly emphasized border defense needs in western China. In July 2024, for example, at a Politburo study session on "promoting the construction of modern border, sea, and air defenses,"[60] he stressed that border defense is an "intrinsic requirement of national defense and military modernization," and a necessary precondition to achieving a high level of development and security.[61] He further noted that effective border defense, including planning and supply, requires close coordination between the multiple levels of military and government bureaucracies. Xi's repeated emphasis on linkages between border defense, stability, development, and civil-military integration has been reflected in both national and regional five-year plans. In Tibet, in practice the PRC's program of border enrichment and stabilization has entailed the parallel expansions of 1) transportation, energy, and communication infrastructure networks; 2) border villages; and 3) the PLA presence in TAR counties along the border with India.

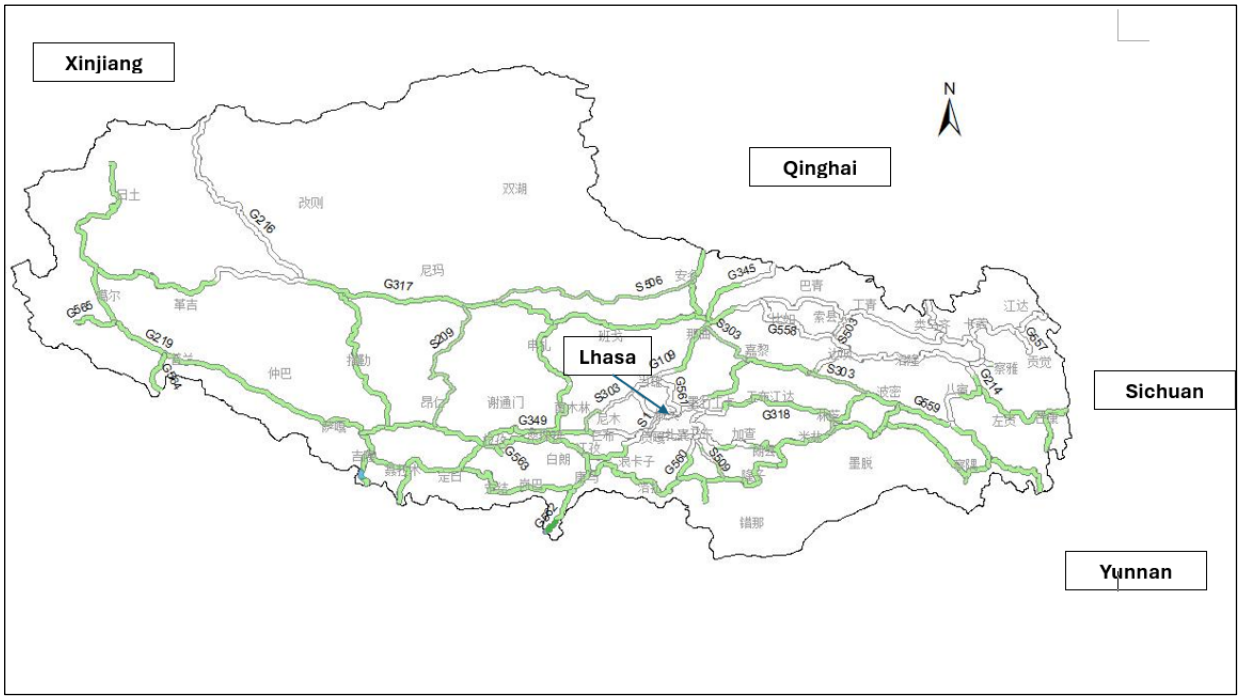



*Figure 4: Map of Tibet's Major Highways*[62]

## EXPANDING TRANSPORTATION INFRASTRUCTURE ACROSS TIBET

The current 14th Tibet Autonomous Region Five-Year Plan (FYP) (2021-2025) calls for "creating a comprehensive three-dimensional transportation network."[63] This transportation network shapes the PLA's approach to logistics in the region. It consists of air and rail routes connecting the main population centers in Tibet to the rest of the PRC, and roads (in various conditions) serving as the main transportation routes within Tibet, particularly in remote border and pastoral areas.

While the PRC is working to develop road and rail links between Tibet, Sichuan, Yunnan, and Xinjiang, the primary land transportation corridor connecting Tibet with the rest of the PRC still runs through Qinghai Province to the northeast. The land transportation links along the "Qinghai-Tibet strategic corridor" [青藏战略通道] are: the Qinghai-Tibet Highway, which is part of China National Highway 109 (G109), and the Qinghai-Tibet railway.[64]

At a 2022 Chinese Academy of Engineering (CAE) research seminar on the security of the Qinghai-Tibet strategic corridor held in Golmud, Qinghai, CAE Academician Du Yanliang [杜彦良] stated that the route "is the most convenient land transportation corridor from Lhasa to Beijing," calling it a "lifeline" for Tibet.[65] Another speaker, Wang Shuangjie [汪双杰], a national engineering survey and design master and chief engineer of China Communications Construction Company, Ltd. (CCCC) [中国交通建设], said that the Qinghai-Tibet Channel handles more than 85 percent of the material and services supplied to Tibet. Ren Huiqi [任辉启], a CAE academician and researcher at the PLA AMS's National Defense Engineering Research Institute [国防工程研

究院], said that the Qinghai-Tibet strategic corridor is crucial, and planning for its development must fully account for the needs of national defense and Military-Civil Fusion.

The PRC has also constructed several other highways to better integrate Tibet into its regional and national development plans. China National Highway 318, which travels from Shanghai to Zhangmu on the China-Nepal border, includes the Sichuan-Tibet Highway. This notoriously difficult road travels from Chengdu across Eastern Tibet to Lhasa, and on to the border. PLA soldiers were heavily involved in building the road, which took almost two decades from 1950 to 1969. During the construction, over 3,000 PLA troops lost their lives, and it remains a dangerous road. China National Highway 219 runs along the entire length of China's western and southern borders from Kom-Kanas Mongolian ethnic township in Xinjiang to Dongxing in Guangxi.[66] The highway is particularly important to support the Xinjiang MD's and WTC's ability to move supplies and forces south from logistical hubs to their deployments in Aksai Chin.[67] China National Highway 214 travels from Xining, Qinghai to Jinghong, Yunnan passing through Chamdo Prefecture in eastern Tibet.[68]

In January 2024, TAR Chairman and Deputy Party Secretary Yan Jinhai [严金海] highlighted the expansion of road linkages in two county-level border jurisdictions, Milin City [米林市] and Cuona City [错那市], as emblematic of China's 25-year campaign to "strengthen the border and enrich the border people."[69] Milin City is in Nyingchi Prefecture in eastern Tibet, near the Indian-controlled territory of Arunachal Pradesh that China claims as "South Tibet." Cuona County is in Shannan Prefecture near the border with Bhutan. Yan emphasized that access to paved roads has now reached 97 percent in Milin City and 87 percent in Cuona City, while also noting that, partly due to infrastructure improvements, kindergarten access is now above 95 percent in both locations.[70]

According to the *China Statistical Yearbook*, under Xi, the total length of highways in Tibet has nearly doubled, from 65,198 kilometers in 2012 to 122,712 kilometers by the end of 2023.[71] Nevertheless, given its huge size, road penetration in Tibet lags significantly behind other regions and provinces within the WTC's jurisdiction. For example, Chongqing Municipality alone, which has a land area about 6.7 percent the size of TAR, has a more extensive roadway network than Tibet. Chongqing boasts 186,598 km of total highway.[72]

The expansion and improvement of road networks in Tibet have been essential to enabling the PLA to scale up its presence and enhance its ability to promptly project force to the border areas. For example, in 2020, a station master with the Sichuan-Tibet Army Depot stated that it used to take a month to travel along the Sichuan-Tibet highway line, but that due to the continuous upgrading of roadways, the journey can now be made in two days.[73]

**Limited but Growing Rail Linkages**

The PRC's development of railroads across Tibet's harsh terrain has been even more limited than the construction of road networks. The section of the Qinghai-Tibet railway connecting Lhasa with the heartland of China via Golmud in Qinghai Province was completed in 2006. In 2014, it was extended to Shigatse Prefecture.[74] In 2021, the Lhasa-Nyingchi Railway in southeastern Tibet was also completed following five years of construction.

*Figure 5: A passenger train on the Qinghai-Tibet railroad, Lhasa*[75]

While Tibet's railroad transportation networks have more than doubled from 531.5 kilometers in 2012 to 1,118 kilometers in 2023, rail coverage is limited compared to the rest of China.[76] For example, Beijing, which has a land area that is about 1.3 percent the size of Tibet, has a more expansive railway network. Nevertheless, both national and TAR leadership appear determined to expand Tibet's railway network. In December 2022, the TAR Development and Reform Commission published the "TAR 14th Five Year Plan, Medium- and Long-Term Railway Network Plan" [西藏自治区"十四五"及中长期铁路网规划] that establishes the target of having 4,000 km of railway in TAR either completed or under construction by 2025, with 5,000 km of railway online by 2035.[77] Specific projects slated for completion in 2025 under the current FYP (see Figure 6) include the Sichuan-Tibet railway section linking Ya'nan, Sichuan and Nyingchi prefecture, extending the Tibet-Qinghai line to Lake Paiku on the border with Nepal, and completing the Bomi-Ranwu section of the Yunan-Tibet railroad.

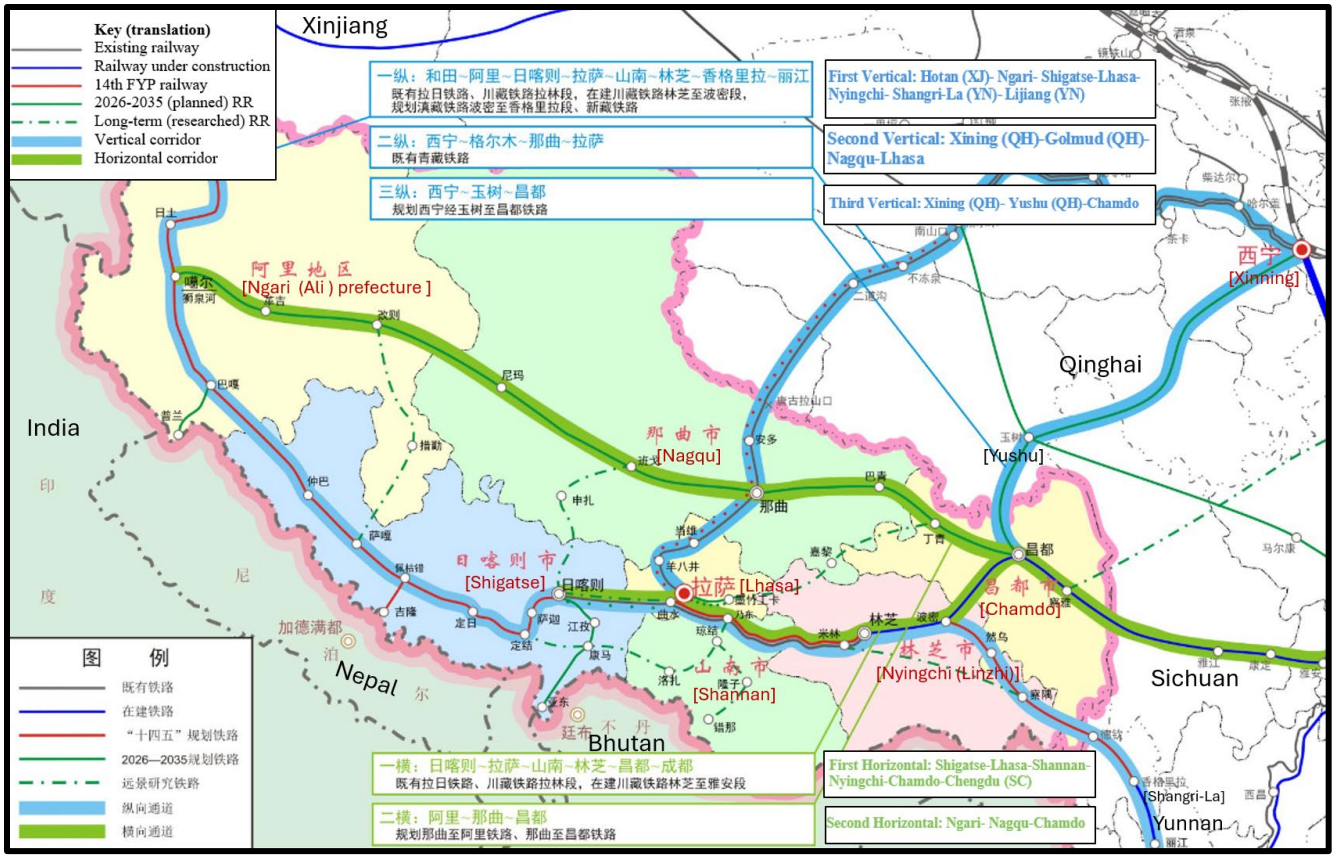



*Figure 6: Map modified from TAR 14th Five Year Plan, Medium- and Long-Term Railway Network Plan showing current and future railroad development in Tibet from 2021-2035*[78]

**Expanding Dual-Use Air Transportation Infrastructure**

As tensions with India rose in conjunction with the 2017 Doklam standoff and the 2020 Galwan Valley skirmish, the PRC worked to expand dual-use aviation infrastructure in the far west. According to data from Center for Strategic and International Studies' China Power Project, from 2017 to 2023, the PRC constructed or upgraded at least 37 military or dual-use airports and heliports in Tibet and Xinjiang.[79] Due to the general lack of rail infrastructure in those border areas, air linkages are vital to the PLA's ability to project force in the region. Air links enable relatively rapid transportation, and they also furnish the PLA with additional bases from which to undertake intelligence, surveillance, and reconnaissance against the Indian military.

Since 2017, the PRC has undertaken upgrades at all five of Tibet's major airports. Perhaps the largest-scale upgrades have occurred at Shigatse Peace Airport [日喀则和平机场], around 150 km north of the China-India border. That airport hosts PLAAF forces.[80] Satellite imagery of the base has revealed J-11 fighters and WZ-7 high-altitude long endurance drones on its tarmac. Furthermore, the PRC is expanding its network of heliports, with five more facilities under construction across the TAR as of 2022.[81]

## PLA Force Structure and Logistical Support in Tibet

### PLA Force Structure in Tibet: The Western Theater Command and the Tibet Military District

The WTC is responsible for defending the PRC's far-western provinces of Gansu, Sichuan, and Qinghai, as well as Chongqing municipality and the Ningxia, Xinjiang, and Tibet Autonomous Regions.[82] However, due to their sensitive locations and key roles in PRC foreign policy and national security, the status of PLAA forces in the Tibet and Xinjiang MDs is unique. Along with the Beijing MD, Tibet and Xinjiang are the only deputy theater-grade MDs in the PLA. As a result, while the Tibet and Xinjiang MDs are operationally subordinate to the WTC, they administratively report directly to PLAA Headquarters.[83] This means that, while the WTC directly oversees all PLA units based in Gansu, Sichuan, Qinghai, Chongqing, and Ningxia, the headquarters of the Xinjiang and Tibet MDs hold direct command over units in their areas of operation.[84] Moreover, the Tibet and Xinjiang MDs are Deputy Theater-level commands, equivalent in grade to the WTC Army (ground force).

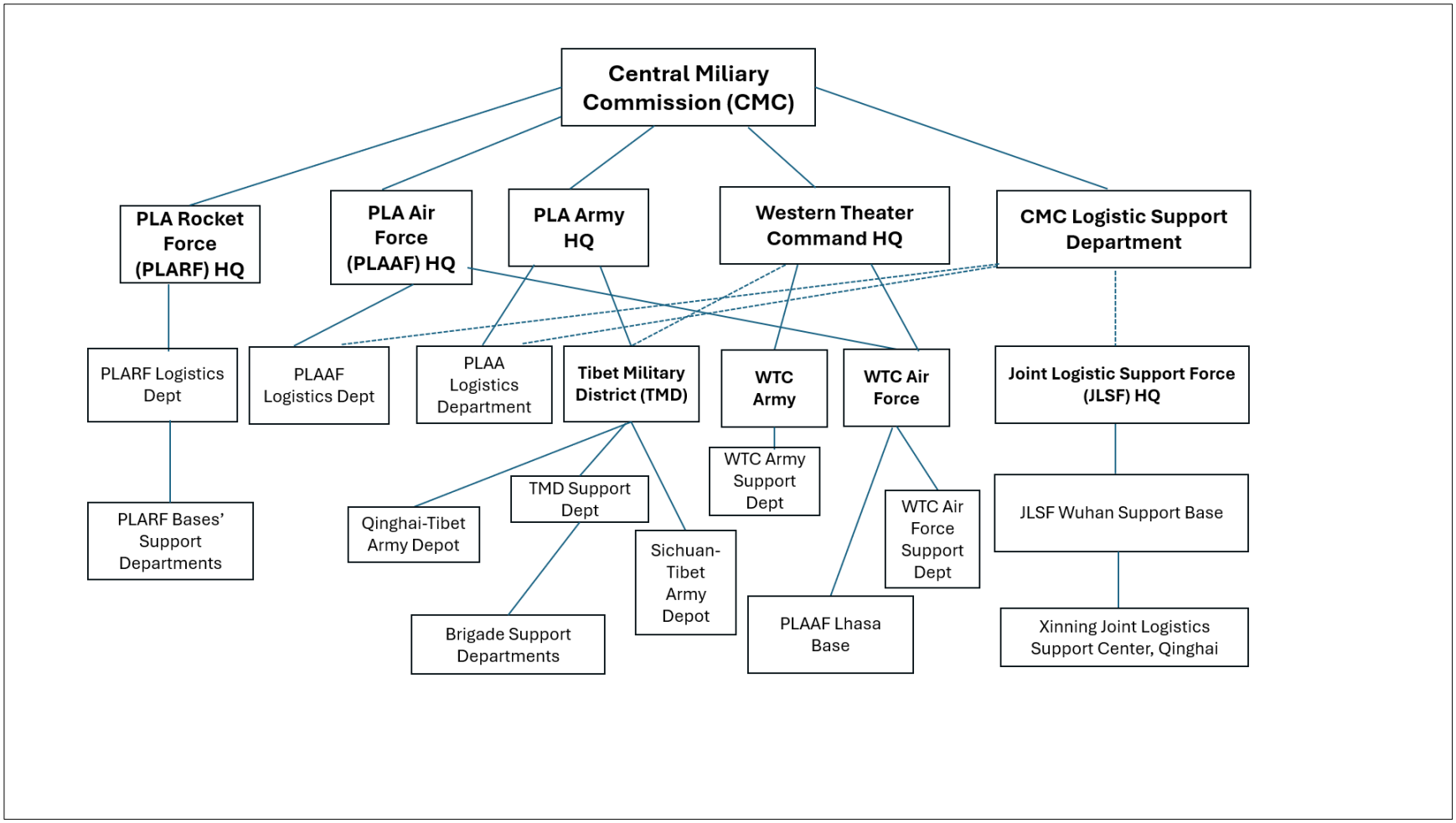
The Xinjiang and Tibet MDs share responsibility for defending the border with India.[85] The Xinjiang MD is responsible for the Ladakh-Aksai Chin sector, the Chinese side of which is partially in Xinjiang, Hotan Prefecture, and partially in Tibet, Ngari Prefecture. The Tibet MD is responsible for China's borders with Nepal, Bhutan, and India in the middle sector, and China's borders with India's Arunachal Pradesh state in the TAR's Shannan and Nyingchi Prefectures.

Despite the uniquely elevated status of the Tibet and Xinjiang MDs, the WTC still plays important roles in both regions, directly commanding WTC Air Force units stationed at PLAAF bases in Xinjiang and Tibet. Like the Tibet and Xinjiang MDs, the WTC Air Force is a deputy theater-grade force.[86] The WTC is also involved in mobilizing forces for operations along the LAC with India. Since the 2013 Depsang standoff with India, the WTC has organized rotational deployments to contested areas around the LAC, such as Aksai Chin, through the "506 Special Mission."[87] These deployments fit into a broader pattern of the PLA employing "maneuver operation" combat units to bolster border defense units stationed at friction points.[88]

### PLA Air Force Lhasa Base

Following the April 2017 "below-the-neck" reorganization of the PLA into 84 corps-grade military units, the Lhasa Air Force Base [空军拉萨基地] was formed.[89] As of 2018, it was under the command of then-PLAAF Senior Colonel Cai Zhihua [蔡自华].[90] State media reported that Cai was promoted to Major General shortly thereafter, presumably to accord with the base's status as a deputy corps-grade unit.[91] Under the new system, the base serves as "the air force's combined command organization" for the "combat campaign direction," presumably meaning the China-India border.[92]

**Figure 7: PLA Logistics Structure in the Tibet Military District**




***Sources:*** *Dennis J. Blasko, "A Baseline Assessment of the PLA Army's Border Reinforcement Operations in the Aksai Chin in 2020 and 2021" China Landpower Studies Center, April 9, 2024, https://ssi.armywarcollege.edu/SSI-Media/Recent-Publications/Display/Article/3735300/ ; George R. Shatzer, et al., PLA Logistics and Sustainment: PLA Conference 2022" (Carlisle Barracks, PA: US Army War College Press, 2023), https://press.armywarcollege.edu/monographs/958; "Newly formed support departments of the five major theater commands of the People's Liberation Army, the Army, the Navy, and the Air Force make their debut" [解放军五大战区陆军、海军、空军新组建的保障部全部亮相], The Paper [澎湃新闻], December 17, 2017, https://m.thepaper.cn/kuaibao_detail.jsp?contid=1909803&from=kuaibao*

### THE TIBET MILITARY DISTRICT AND ITS LOGISTICAL SUPPORT FORCES

The Tibet MD is responsible for defending much of the PRC's disputed border with India, except for deployments in the disputed area of Aksai Chin, which are co-organized by the Xinjiang MD and the WTC. The Tibet MD is headquartered in Lhasa, and is comprised of the following Military Sub-districts (MSDs):[93]

- Lhasa Garrison [拉萨警备]
- Shigatse MSD [日喀则军分区]
- Shannan MSD [山南军分区]
- Linzhi MSD [林芝军分区]
- Chamdo MSD [昌都军分区]
- Nagqu MSD [那曲军分区]


*Figure 8: Map of military sub-districts in the Tibet MD*

In contrast to the Theater Commands, the Tibet MD does not have any Group Armies; it instead has three combined arms brigades and an assortment of supporting units. These include air defense, artillery, electronic countermeasures, engineering, special operations, transportation brigades, and a communications regiment.[94] The three combined arms brigades assigned to the Tibet MD are:

- The 52nd Combined Arms Brigade [合成第 52 旅]: Military unit cover designator (MUCD) 77675, in Bayi, Nyingchi Prefecture[95]
  - This is a light mountain warfare unit with a very long history, dating back to the Chinese Civil War. It was previously a division-level unit that participated in the Korean War, earning the honorific "Baiyun Mountain Regiment" [白云山团].[96]
  - The unit moved to Tibet in 1967, and in 1985 it was reduced from a full division to a single mountain infantry brigade.[97]

    - Forces from this unit participated in the 2017 Doklam standoff with the Indian military.[98]
- 53rd Combined Arms Brigade [合成第 53 旅]: MUCD 77680, in Minling, Nyingchi Prefecture[99]
    - This is a mobile mechanized unit equipped with CSK-181 light tactical vehicles, PCL-161 truck-mounted howitzers, and vehicle-mounted HJ-10 anti-tank missiles.[100]
    - Elements from this unit are likely stationed in Shigatse near the China-Nepal border, potentially with the 2nd Battalion.[101]
- 54th Combined Arms Brigade [合成第 54 旅]: MUCD 77626, in Lhasa
    - This is a heavy armor and mechanized infantry brigade.[102]
    - In 2009, the unit received Type 96A Main Battle Tanks.[103]

In addition to its combined arms brigades and their support units, the Tibet MD has eight border defense regiments, which "retain their pre-reform structure in regiments under the command of prefectural-level military sub-districts" (see the above list of MSDs in the Tibet MD).[104] Border defense units in Tibet appear to include:

- 351st Border Defense Regiment: MUCD 77643, in Xiachayu, Zayu County, Nyingchi Prefecture [林芝市察隅县，下察隅镇][105]
- 352nd Border Defense Regiment: MUCD 77650, in Bayi District, Nyingchi Prefecture [林芝市巴宜区]; may also be present in Milin, Medog, and Bomi Counties, Nyingchi[106]
- 353rd Border Defense Regiment: MUCD 32169, in Milin County, Nyingchi Prefecture [林芝市米林县][107]
- 354th Border Defense Regiment: MUCD 77629, in Longzi County, Shannan Prefecture [山南市隆子县][108]
- 355th Border Defense Regiment: MUCD 77635, in Cona County, Shannan Prefecture [山南市错那县]; also has facilities in Lhozhag County [洛扎县], Shannan[109]
- 356th Border Defense Regiment: MUCD 77649, in Yadong County, Shigatse Prefecture [日喀则市亚东县][110]
- 357th Border Defense Regiment: MUCD 77639, in Tingri County, Shigatse Prefecture [日喀则市定日县][111]
- 358th Border Defense Regiment: MUCD 77646, in Saga County, Shigatse Prefecture [日喀则市萨嘎县][112]

In the organization of the PLA Army (see Figure 2), the PLA Tibet MD's Support Department, brigade, and other unit-level support departments undertake a range of key logistical support functions, including both equipment and vehicle maintenance and materials management.[113] The support departments were also created during the PLA reorganization that started in 2015 by combining equipment and logistics departments at the corps level and below.[114] For example, responsibilities for equipment maintenance are divided. Theater Command- and MD-level support departments handle the collection, reserve, supply, management, and maintenance of ammunition, equipment, fuel, guns, and vehicles.[115] Unit-level organic support forces undertake equipment

support, with civilian or other military support forces providing more specialized assistance with, for instance, new equipment or machinery requiring special skills.

In January 2018, state media reported that Major General Zhang Wenlong [张文龙] had been appointed head of the newly created Tibet MD Support Department [西藏军区保障部].[116] Zhang had experience in Tibet, having previously served as the leader of the former Logistical Support Department and as head of the Political Department in the Tibet MD. The Tibet Support Department and its predecessor, the Tibet Military Logistics Support Department [西藏军区后勤部], have organized training exercises to prepare troops for joint logistics in support of combat operations. For example, in 2014, the *PLA Daily* reported on the Tibet Military Logistics Support Department organizing a "logistics support professional skills competition."[117] In the competition, logistics specialists established transportation, warehouse, hospital, and support teams. Training grounds, capable of supporting simulation exercises, were organized for needs such as transportation, medical services, storage, and fuel.[118]

Due to its huge size and difficult operational environment, the Tibet MD is also supported by two additional supply depots, the Qinghai-Tibet Army Depot [青藏兵站部] based in Golmud, Qinghai, and the Sichuan-Tibet Army Depot [川藏兵站部] headquartered in Chengdu, Sichuan. In its 2015-2016 reform and restructuring, the PLA transferred both depots to the Tibet MD, the Qinghai-Tibet Depot from the former CMC General Logistics Department (GLD), and the Sichuan-Tibet Army Depot from the former Chengdu Military Region. Transferring these capabilities to the Tibet MD may have been an effort to more closely integrate these units with logistics support forces at the sub-theater level and below. The transfer is also an exception to the trend toward greater centralization of logistical support forces across the PLA. The concentration of capabilities within the Tibet MD may be due to more intensive logistical support requirements in remote, high-altitude border areas.

The Qinghai-Tibet Army Depot has played a key role in the main supply line connecting the Tibetan Plateau to the rest of the country via Qinghai province. It was previously a directly subordinate unit of the former CMC General Logistics Department.[119] After the PLA's 2015-2016 reorganization, the Qinghai-Tibet Depot was placed under the PLA Army and subordinated to the Tibet MD. At the time of its transfer to the PLA Army, the *PLA Daily* reported that the depot was involved in transportation systems support. This makes sense, given that the Qinghai-Tibet road and rail lines remain the primary supply lines into Tibet.[120] At the time of its transfer, the Qinghai-Tibet Depot had four motor vehicle regiments, 18 supply stations, three large supply chain management stations, two automobile repair shops, two field hospitals, and a communications battalion.[121] In September 2018, a ceremony was held to mark the Depot's founding as part of the PLA Army; then Qinghai Province Deputy Party Secretary Liu Ning [刘宁] attended the flag-raising ceremony for it.[122]

The Sichuan-Tibet Army Depot, which also traces its origins to the 1950s, was previously under the former Chengdu Military Region. The depot was transferred to the PLA Army and placed under the Tibet MD in late 2016. It provides a range of logistical support, including power generation and transportation. Although the primary transportation route into Tibet is via Qinghai, the Sichuan-Tibet Army Depot has a transportation brigade that operates supply convoys along

the more hazardous Sichuan-Tibet Line [川藏线].[123] In September 2022, following an earthquake that knocked out electricity to Moxi town in Luding County in the Garzê Tibetan Autonomous Prefecture of Sichuan, the depot provided emergency power generation support.[124]

*Figure 9: A truck convoy from Sichuan-Tibet Logistics Depot's Transportation Brigade navigates the Sichuan-Tibet Highway*[125]

Another step the Tibet MD took to improve localized logistical support was the incorporation of five new militia teams into Tibet's reserve forces in June 2020. The teams, which *China National Defense News* describes as elite "emergency response forces," were formed from large enterprises or private forces and are embedded in the PLA Army's support chains across the region.[126] They are the: Snow Eagle Air Patrol Team [雪鹰空中巡逻队], the Snow Pigeon Polar Communications Team [雪鸽极地通信队], the Snow Wolf Extreme Climbing Team [雪狼极限攀登队], the Snow Fox Rapid Reaction Alpine Team [雪狐高山快反队], and the Snow Mastiff Plateau Resistance Team [雪獒高原抗击队].[127] Each militia team has different capabilities. For example, the Snow Pigeon Polar Communications Teams can mitigate dead zones in communications transmissions, establish an emergency communication base station within eight minutes, and achieve 24-hour uninterrupted power supply from vehicle-mounted generators in order to support both rapid and long-term emergency response. In 2020, Tibet MD Commander (and as of the time of writing, the current WTC Commander) Wang Haijiang [汪海江] stated that Tibet's challenging natural and transit conditions pose difficulties for regular forces, particularly

in emergency response, and the new militia teams greatly enhance the mobilization, rapid response, and support capabilities of Tibet's reserve forces. [128]

### Roles of CMC Logistics Support Department and the Joint Logistics Support Force

The CMC Logistics Support Department (LSD) is responsible for the overall management of the PLA's logistics, including military facility construction, supply, transportation and distribution, and hospitals. In this capacity, the LSD plays a lead role in advancing the CMC's efforts to develop an effective joint logistics system through centralizing logistical coordination, informationization, and Military-Civil Fusion (MCF).[129]

One example of the CMC LSD's efforts to improve logistical support in Tibet through MCF is its deployment of the "Plateau Express Delivery" [雪域配送] mobile app. Using this app, quartermasters in the Tibet MD can procure food for their units from suppliers throughout China in 11 categories, including fruits, vegetables, meat, seafood, and dairy products.[130] PLA media has invoked the "Plateau Express Delivery" app as an effective example of MCF in practice. According to an August 2021 *PLA Daily* article, the Tibet MD Support Department has worked "with local enterprises to innovate cooperative supply models and jointly develop the app to facilitate food supply distribution for plateau troops."

The 2016 PLA reforms also "separated logistics management responsibilities (resource management and regulatory activities)," which were the responsibility of the CMC LSD, from "combat service support (sustainment activities)," which became the responsibility of the newly created Joint Logistic Support Force (JLSF).[131] Prior to 2016, each MR had its own logistical support department, but following reforms, the successor Theater Commands no longer do. Greater centralization of logistical capacity at the CMC level stems from "the need for supply-chain efficiency and an architecture that would allow scarce resources to be deployed quickly across theater boundaries."[132]

The JLSF operates five Joint Logistics Support Centers (JLSC) that correspond geographically with the Theater Commands. While the JLSCs work closely with the TCs in their respective areas of operations, they are not subordinate to the TCs, instead reporting directly to the JLSF. The JLSF's main base, the Wuhan Joint Logistics Support Base [汉联勤保障基地], manages and oversees the work of the five JLSCs. In a 2016 *PLA Daily* interview, Wuhan Joint Logistics Support Base duty officer Li Junzhen [李军振] described how it interfaces with the JSLFs. Li said that each day, staff "collect and summarize the main work, troop safety management, and social conditions of the five JLSCs through the logistics business processing platform, and work to ensure the combat readiness of all centers."[133] Real-time digital monitoring of depot stocks allows for close tracking of resource allocation for everything from fuel to bedding, in order to ensure efficient and uninterrupted supply.

The JLSC responsible for providing logistical support to the WTC's area of operations is the Xinning Joint Logistics Support Center, which was created as part of the newly established JLSF in September 2016.[134] As with the other JLSCs, the Xinning JLSC oversees a large network of supply depots and warehouses, hospitals, pipelines, and mobile support units.[135]

The Xinning JLSC's approach to military logistics is shaped by the challenging operational environment in the PRC's western regions. In 2023, *People's Daily* reported that it set up a "special

research team to solve the challenge of sustainment in high-altitude and cold areas."[136] In an interview with CCTV, Wang Yuanfeng [王元峰], leader of a brigade support group at the Xining JLSC, emphasized that it selects and trains personnel to operate in an environment characterized by the "two highs" [两高], high altitude and extreme cold.[137] According to Wang, the Xining JLSC pushes its focus beyond survival to sustaining effective combat capabilities in extreme conditions. This has not only tested peacetime training, it has also accelerated the incorporation of the joint logistic support elements into the joint combat system. The Xining JLSC incorporates support functions including military energy supply, health and epidemic prevention, and camp support and equipment maintenance. All these functions are reportedly scalable and can be "rapidly built from the ground up."[138]

## REMOTE BASING: LOGISTICAL SUPPORT METHODS

The PLA has adopted a unique force structure in Tibet and Xinjiang due to their relatively challenging operational environments. For example, any helicopter operating in Tibet will generally take more time to carry smaller loads a given distance than it would at lower elevations. Due to the complex and, in some cases, unique aspects of joint logistics in the Tibetan Plateau, this chapter section focuses on four components of the PLA's logistics functions:

- Transportation
- Engineering and base construction
- Supply
- Medical support

These were chosen due to their evident importance to remote logistics needs, specifically, and based on whether good data was available publicly. This report also excludes equipment maintenance because it operates through a distinct set of bureaucratic channels. It should be noted, however, that the PLA's own definition of logistics is broader than this. In a 2004 article on the CMC General Logistics Department, which oversaw logistical support prior to the 2015-2016 reforms, Dennis Blasko noted that the PLA defines logistics broadly, as encompassing the "supply of materials required for combat, such as food, water, uniforms, equipment, petroleum, oil, and lubricants , ammunition, construction materials, etc.; transportation of personnel, supplies, and equipment over land, sea, and air; medical support; finance; equipment maintenance, repair, research and development, testing, acquisition, and disposal; and building and maintenance of facilities for troops in the field or in garrison."[139]

### TRANSPORTATION

#### Multimodal Transportation

The establishment of the Qinghai-Tibet railway line in 2006 greatly enhanced the PLA's capacity to move troops and material from the rest of China to Lhasa. Recent extensions of the line from Lhasa to Shigatse and Nyingchi prefectures have further enhanced the PLA's ability to project force and enable the PLA to better support operations along the middle and eastern sectors of the LAC. A 2022 *China National Defense News* article marking the five-year anniversary of the decision of the CMC Logistic Support Department and China Railway to "give priority use of the railway system to military personnel" explains how the military arranges the transport of troops and material to Tibet via rail and discusses some of the challenges involved.[140] According to the article, a certain military unit had to transport oversized materials via the Tibet-Qinghai railway. After receiving the request, the Xining JLSC rapidly coordinated with the China Railway Qinghai-Tibet Group Co., making special arrangements to adjust travel schedules in order to the facilitate the PLA unit's transportation needs as quickly as possible. A director of the Xining Military Representative Office stated that, "for emergency transport tasks like this, regardless of whether it is a weekday or a holiday, the procedures can be completed within one day, even though the time specified in the document is eight days."[141]

The same article notes that along the Qinghai-Tibet railway there is an "uninhabited" railway station (without permanent staff) near a training ground that is often used for exercises. Prior to

2017, the difficulty of disembarkation at this station meant that troops could not exit the train safely without assistance from personnel on the platform, and since there were no such personnel, they had to travel with no stops for over 100 km to arrive at the training grounds. However, in 2017, the China Railway Qinghai-Tibet Group Co. built new platforms at the station and began pre-deploying personnel to the station prior to the arrivals of trains carrying PLA troops, which allowed the station to be safely used for disembarkation. The decreased time traveling over difficult mountain roads greatly accelerated the troops' passage to the training exercises, for which they were in better condition as a result.

All drivers confront significant challenges in Tibet. Some remote areas entirely lack roads, and many of the existing roads are unpaved. To address these issues, units in the Tibet MD have both emphasized "realistic training" and sought to retain veteran operators, allowing them to serve in the region for years. According to the *PLA Daily*, one sergeant, who is a seasoned driver and has deferred retirement to work in Tibet for seventeen years without an accident, is known simply as "the living map" by his colleagues for his ability to navigate the region's difficult roadways.[142] A *People's Daily* profile of a border defense unit noted that on remote unpaved roads, with obstacles and difficult weather, drivers rely on Beidou hand-held navigational systems for direction, as well as cameras to mitigate visibility limitations.[143]

The PLA relies on road transportation, usually truck convoys, to move supplies and large equipment around much of Tibet, especially to remote border areas far from rail or air infrastructure. The steep altitudes involved in mountain driving necessitate frequent safety and equipment maintenance checks on trucks' brakes.[144] Moreover, because military vehicles travel at a slower pace than civilian automobiles, they require more rest and maintenance facilities even while travelling on the same roadways.[145]

In January 2023, *Xinhua* reported on the Sichuan-Tibet Logistics Depot Transportation Brigade, also known as the "Iron Cavalry" [铁骑], making the run to transport fuel, food, and other supplies to the front-line border defense units ahead of that year's Spring Festival holiday.[146] In addition to supply trucks, the brigade has a refueling truck and a "multi-functional support vehicle." These support units, along with improvements to the roadway, have shortened the time it takes to run a supply convoy along the route from over a month to about ten days.[147]

In June 2019, an officer with the Political Work Department of the 52nd Mountain Combined Arms Brigade stationed in Bayi, Nyingchi prefecture told the *PLA Daily* that expansions and improvements to the road network have made traveling to other parts of Tibet far easier.[148] The officer noted that they often visit other parts of Tibet for training, and that road transportation used to be "most difficult." Citing the "Linla expressway" [林拉高等级公路] (Lhasa-Nyinchi highway, part of G4218 Ya'an to Yecheng Expressway) as an example, the officer recalled that prior to the opening of the Mila Mountain Tunnel [米拉山隧道], which was completed in April 2019, a large convoy would take a day to travel the short distance between Bayi and Lhasa.[149] Now, soldiers making the run can, per the *PLA Daily*, "have breakfast in Nyingchi in the morning and have lunch in Lhasa at noon. Smooth roads not only mean that people's lives and travel are more convenient and faster, but also that our troops can be more efficient in performing various tasks."

*Figure 10: Picture from the PLA Weibo in 2014 of PLA border guards on yaks patrolling the China-Pakistan border in the Pamir mountains*[150]

Modern armies are now thoroughly mechanized. However, pack animals such as mules, horses, and yaks remain valuable for alpine military operations. In the Pamir Mountains in far western Xinjiang, for example, border defense units patrol areas with difficult rocky terrain using yaks or horses. A 2022 *PLA Daily* article observed that, for the Xinjiang Kashgar MSD's Khunjerab Border Defense Company, yaks are essential for traversing an area in the Pamir Mountains called WufangLanggou [吾甫浪沟], which is known as "The Valley of Death" by locals due to its steep mountains and harsh environment.[151] The article describes a late June 2022 patrol that drove to a pass to load supplies and then rode yaks along the border. On their patrol, the team traveled at altitudes above 5,000 meters and passed over ice formations, glaciers, and rocky slopes. The patrol traversed a road along a cliff so narrow that only one rider and their yak can pass through at a time. In addition to using yaks, PLA media has also reported on border defense units using horses for patrol and supply missions in the Pamir Mountains.[152]

Footpaths and patrol routes in alpine or snowy areas must be routinely checked and inspected because navigating snowy or icy surfaces poses a challenge for troops. Footpaths must be tested for stability to minimize the risk of an avalanche or of becoming trapped in an "ice cellar" or an "underground river."[153]


*Figure 11: Troops in the Tibet MD practice UAV delivery of hot food boxes, the caption roughly translates as "When encountering impassable conditions, the drone team quickly moved the damaged vehicles and supplies forward"*[154]

In addition to presenting challenges to foot soldiers, drivers, and pilots, the high-altitude conditions in the Tibetan Plateau also pose difficulties for unmanned aerial vehicle (UAV) flight. In June 2022, a brigade in the Tibet MD conducted an exercise testing UAV flight at altitudes above 5,000 meters, where thinner air density decreases range and signal degradation is common.[155] As a result, more ground stations are required to effectively use drones in such areas. During the exercise, the troops practiced drone relays involving strings of multiple ground stations. Notably, in the Tibet MD, drones not only serve typical reconnaissance and strike roles, but are also used to deliver food or medical supplies to troops in difficult-to-reach locations. For example, the Tibet MD's Supply Department undertook an exercise in 2020 using a swarm of small drones to deliver hot meal boxes and fresh fruit to soldiers "on the frontlines" (see supply section below).[156]

## Base Location, Construction, and Engineering

In addition to long supply routes and difficult transportation conditions, the PLA confronts several challenges when building and supporting barracks and other basing infrastructure in remote mountainous areas. Limited permanent housing and the difficult environment both limit the PRC's ability to sustain significant numbers of personnel in high-altitude base or border outpost construction. Outpost locations in remote border areas are particularly difficult to construct, as they are often only connected to the main highways by dirt access roads or unmarked trails. Some locations are not accessible by motorized vehicles at all.

### Bases and Facilities

The PLA has built numerous underground tunnels or bunker complexes at border facilities along strategic stretches of the LAC. For example, in September 2024, using satellite imagery from the U.S. intelligence company Black Sky, Indian media reported on the PLA's 2021 construction

of a large facility at Sirjap, where the borders of Ladakh and Tibet meet. The piece quoted an analyst from the company who noted that, "[t]he base hosts an expanse of armored vehicle storage facilities, test ranges and fuel and munitions storage buildings."[157]

In February 2024, CCTV 7 ran a feature on its show *Decoding Honor* [荣誉解码] that focused on the Gamba Border Defense Battalion.[158] The unit, officially named the Second Independent Border Defense Battalion is based in Gamba county [岗巴县] and Yaodong county [亚东县] in Shigatse prefecture, near where the borders of the PRC, India, Nepal, and Bhutan converge.[159] The county also lies due north of the 22-kilometer-wide Siliguri Corridor, also known as the "Chicken's Neck," the narrow strip of land that connects the India's northeastern states with rest of India.[160]


*Figure 12: Location of Gamba County in Tibet*

One of the border posts from which the battalion operates is reportedly dubbed "5592" because it is located at 5,592 meters in altitude, the highest altitude at which the PLA has a permanent presence.[161] The CCTV-7 report showed that the 5592 base appears to have tunnels with heating elements. The base facility has an indoor greenhouse with hydroponic systems for growing lettuce, cabbage, and other vegetables.


*Figure 13: The Ganba Battalion 5592 Base*[162]


*Figure 14: "The highest sentry post of the entire PLA"* [163]

In addition to its main base in Gamba County, the Gamba Battalion also operates at least one other facility, the Chaguola Sentry Post [查果拉哨所], likely located at Chaguola [查果拉] just over the county border in neighboring Yadong County.[164] Satellite imagery indicates the probable location of the Chaguola outpost (28°04'35"N 88°55'21"E), which appears to be the only human-made construction in the area.[165] In front of the base is large red, calligraphic lettering reading "The red flag on the snow-capped mountains will shine forever" [雪山红旗, 永放光彩], a phrase first used by former Chinese leader and CMC Chairman Jiang Zemin in 1990, during an inspection tour of PLA troops stationed in Shigatse prefecture, including the Gamba Battalion itself.[166]

*Figure 15: Google Earth images of the Chaguola Post and surrounding area*

The Chaguola Outpost is also surrounded by uneven, uncovered trenching. The outpost is located on an incline, so these features may be intended to help control erosion. It is connected to the nearest border village Quedanchacun [确丹查村] in Jiru Township [吉汝乡] by a dirt access road.[167] Another unpaved road runs southeast towards the mountains and the PRC's border with Bhutan and India.

The 53rd Mountain Infantry Brigade (MUCD 77680) is probably based at the Tibet MD Naidong Base in Nedong District, Shannan Prefecture in eastern Tibet.[168] An unverified—but typically reliable—compilation of PLA unit and facility locations identified the coordinates of the Naidong Base, and based on commercial satellite imagery, construction of it likely began in early 2021.[169] In satellite imagery from February 2021, covered vehicle ports, a fenced or walled perimeter, and several large construction cranes are visible at the facility. The Naidong base construction coincided with a major buildup of the PLA's presence along the LAC during a period of heightened tensions and border clashes with India. The base is strategically located along provincial-level highway S202, which connects it to Cona County bordering Bhutan and Tawang. From Naidong, S202 stretches a short 10-km drive to China National Highway 349, which runs west and then north to Lhasa. The base is also located immediately up route S202 from the PLA's 41st Hospital [中国人民解放军第 41 医院], which provides medical support to border defense posts.[170]


*Figure 16: Google Earth Imagery of probable Tibet MD Naidong Base in August 2019 and February 2021, respectively*

**Protecting Personnel and Equipment from the Elements**

Because vehicles are more likely to start in temperatures above freezing, insulated, covered vehicle parking facilities, either above ground or partially buried, are important at remote military outposts not only to protect vehicles from the elements, but for readiness purposes. Accordingly, the PLA has developed advanced "tank dugouts" for use on the Tibetan Plateau, which integrate subterranean support systems that are protected from attack.[171] Such shelters not only help shield

tanks from enemy detection, but also provide critical maintenance support, ensuring operational readiness in harsh, high-altitude environments as well as providing habitable rest quarters for personnel. Constructed using large engineering machinery and made of reinforced materials, the dugouts can reportedly withstand both natural and combat-related stressors. The design minimizes visible signs of activity, seeking to maintain a low-profile presence.[172]

In addition to protection and camouflage, a major challenge for remote facilities is efficiently providing adequate heating and electricity for buildings like troop barracks, which are typically large, multi-floored structures. A standard PLA barrack is a three-story building, covering 1886.22 $m^2$ (about 20,300 square feet), with a total height of 10.65 meters (about 34 feet).[173] Their exterior walls are made of 240mm-thick solid brick and surrounded by a 80mm extruded polystyrene board insulation structure. Typically, barracks on the Tibetan plateau use diesel boilers for heating, which require storage and transportation of fuel, but are efficient and reliable.


*Figure 17: Modular solar-powered barracks developed for use in high altitude areas*[174]

However, in 2020, the PLA's Army Engineering University unveiled a new type of modular barracks that uses solar photovoltaic technology for energy generation.[175] The prefabricated structures are made of lightweight components that can be transported by truck, do not require machinery to build, and can be quickly assembled by troops in the field. According to a 2021 CCTV-7 *Military Report* [军事报道] feature, the cabins are insulated and can operate normally at altitudes up 5,500 meters in temperatures as cold as -55°C (-67°F). They are comprised of seven modules, including a dormitory, kitchen, washroom, dry self-cleaning toilets, and heating equipment.[176] In 2024, the PLA reportedly deployed these barracks to frontline border defense forces stationed in Xinjiang, Tibet, and other posts at altitudes over 5,000 meters.[177]

In 2021, the *PLA Daily* reported that the engineering company of an army brigade undertaking exercises on the Tibetan Plateau used solar heating to warm water for a portable shower facility on their training base.[178] According to the article, in addition to its showers, this "sunshine shed" has an adjacent dressing room where troops can warm themselves that registered a sweltering 35 ℃

(95 °F). The portable shower shed also has two large oxygen tanks to improve air quality throughout the facility.

Researchers affiliated with the PLA have also shown an interest in the development of cross-seasonal solar energy storage technology for barracks heating to ameliorate the consistent challenge of energy supply to high-altitude military facilities. A 2024 article by PLA Army Engineering University researchers explored the feasibility of a cross-seasonal energy storage and heating system using solar energy, a step-change energy storage device, and a diesel boiler as an auxiliary power source.[179] In the study, the researchers were able to provide a standard barracks facility with 77.6 percent of its total heating capacity using solar energy in a simulation under conditions akin to Ngari Prefecture in far-Western Tibet. There is, however, no evidence so far that such technology has been deployed in active service.

Water is also a challenge for remote facilities. Despite the abundance of snow and ice, ensuring that supplies of usable water for bathing, drinking, cooking, and heating are available in quantity at such facilities is a persistent challenge in extremely cold, high-altitude conditions. Over the years, the PLA has attempted several methods to supply troops with potable water, including draining spring water from glaciers, installing water purification systems on bases, and boiling ice and snow to obtain water (a labor- and equipment-intensive process).[180] In order to satisfy their base's water needs, soldiers at one remote border post in Ngari Prefecture in Bangda Military Post in Chamdo prefecture, Eastern Tibet, reportedly must extract and carry 50 kilograms (110 pounds) of ice one kilometer every day.[181]

Recognizing this need, in 2020, the CMC Logistic Support Department sought to "further improve the living conditions of officers and soldiers guarding the border by selecting some PLA high-altitude and cold border defense points as areas of focus for a pilot project for digging wells and obtaining water in high-altitude and cold areas," working with both the TAR and Xinjiang MDs."[182] This project aimed to "overcome challenges such as difficulty finding water sources, unstable water volume, and freezing of wells." The project entailed construction of water wells at three locations at altitudes over 5,000 meters and 10 locations at altitudes of 4,000 meters. In order to prevent freezing of the water supplied, the project installed electric heating devices in pipe wells and employed special submersible pumps.

### SUPPLY

Support Departments in the Tibet and Xinjiang MDs are responsible for procurement and delivery of food, ammunition, medical supplies, bedding, and other provisions to bases, including border defense posts.[183] Within the Tibet MD, the Material Supply Division [物资供应处] handles the distribution of food.[184]

Due to limited local resources and transportation, the PLA has historically stockpiled fuel and ammunition at depots and warehouses across the TAR. The recent expansion of air and overland transportation infrastructure in Tibet has enabled the PLA to achieve greater supply chain efficiency in the region by leveraging cross-regional support coupled with technological solutions, such as through the "Plateau Express Delivery" app discussed above.[185]


*Figure 18: PLA troops organize food ordered via the "Plateau Express Delivery" app for delivery to bases in Tibet*

Xi Jinping has also recognized that a well-fed PLA is a more effective force, proclaiming, for instance, "[l]et the soldiers eat well and defend the country more vigorously."[186] Ensuring good nutrition is particularly important in extreme environments. In particular, soldiers must increase their caloric intake to function effectively.[187] In remote posts on the Tibetan Plateau, the PLA has long supplemented its grain stockpiles and food deliveries by constructing heated greenhouse facilities, in which troops could raise fresh vegetables.[188]

Units in Tibet have built and maintained insulated greenhouses since at least the late 1960s, when Wang Dequan [王德全], director of the Political Department of the Lhasa Air Force Command, became concerned that PLAAF personnel working on bases in Tibet were suffering from vitamin and fiber deficiencies due to the lack of vegetables.[189] In response, he directed bases to construct greenhouses to grow cucumbers, potatoes, and radishes. Soldiers were sent out to gather manure and dung to use as natural fertilizers. Bases in Tibet continue to do so, often in cooperation with local residents.[190]


*Figure 19: A soldier with the Gamba "5592" Model Border Defense Battalion tends to vegetables in an insulated greenhouse*

### UAV Supply Drops

Due to the difficulties of moving material across mountainous terrain, the PLA is increasingly using UAVs to transport supplies to remote border facilities. For example, in 2020, the CCTV military channel reported that UAVs delivered meat, eggs, fresh fruit and vegetables, and mooncakes to a border outpost in southeastern Tibet for the Mid-Autumn Festival and National Day holidays.[191] Since the outpost is inaccessible by road, lacking UAV deliveries, troops typically must haul provisions there on foot. One such run usually involves 120 troops and typically takes two to three days, with personnel relaying supplies across difficult terrain.[192]

## MEDICAL SUPPORT

### Treatment of High-Altitude Illness

A persistent challenge for PLA troops stationed at remote bases in the Tibetan Plateau is high-altitude illness, also known as altitude sickness. The average elevation in Tibet is 4,380 meters.[193] Generally speaking, people traveling to altitudes of 4,000 meters or above are at increased risk of high-altitude sickness.[194] The risks are higher for new arrivals who have not had adequate time to acclimate to the thinner air. For example, a 2023 *PLA Daily* article on the experiences of four veteran sergeants in the Tibet MD describes how one officer, Hu Jingming [胡敬明], "awoke to the rapid breathing of a new comrade" and rushed to get oxygen bags to provide relief from altitude sickness.[195] Hu recalled that this was an unexpected challenge, reporting that "the two bags of oxygen were quickly used up, but the new comrade's symptoms did not improve at all." After further oxygen bags were urgently requisitioned, the sergeant recalled "seeing the new comrade start to breathe steadily, everyone in the room felt relieved."

In 2020, the *PLA Daily* also reported that the Tibet MD Support Department had developed a new system to improve the rapid deployment of oxygen and other emergency supplies.[196] The leader of that department observed that Tibet has many defensive positions across a large area, so transportation is inconvenient and it takes a long time for remote bases to receive supplies. Moreover, when the mountains are closed due to heavy snow, it is difficult to replenish emergency supplies as needed. As a result, the Support Department leader noted that the Tibet MD has established a regional coordinated support network system, adjusting the previous system – in which each unit relied on narrow vertical supply chain for support – to form a unified "vertical and horizontally integrated" joint reserve and on-demand oxygen supply system. When remote units encounter a shortage of emergency supplies, they can either be supplemented by superiors in the vertical supply chain or apply for supplemental horizontal allocations from nearby units. The *PLA Daily* article further noted that, while it once took one to two days to deliver emergency supplies to a remote border outpost, following this change it now takes only two to three hours to do so.

## CONCLUSION

The PLA's effort to become a world-class military relies on its success in modernizing its military logistics. However, a lack of transparency and a very limited record of kinetic operations make it difficult to assess the PLA's capacity to sustain major combat operations on China's border. The disputed border with India provides a rare opportunity to observe PLA logistics in the context of military engagements on China's borders. Of course, the PLA would likely engage in conflict with the U.S. military in the Asia-Pacific littoral, a very different operational environment from the Himalaya Mountains, necessitating different capabilities and involving different operational commands. Nevertheless, when gauging the military balance in both theaters, analysts must balance assessments of military capabilities with efforts to understand the logistical capacity of potential combatants for sustainment in a conflict, whether it should break out in the Taiwan Strait or the Tibetan Plateau.

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