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Indigenous CADS: Urgent Need For India and Its Defence Forces

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"Look at the sky. We are not alone. The whole universe is friendly to us and conspires only to those who dream and work".

—Dr. APJ Abdul Kalam

Key Points

- CADS are high tech Aerial Delivery Systems, primarily used for military operations, for precise delivery of payloads from an aerial platform to a predetermined location on ground or water by making use of manoeuvrable capabilities of the Ram Air Parachutes and attached sub systems.
- Presently, CADS are only available in few developed countries. India is importing CADS to cater for operational needs of its defence forces.
- Adequate push is required to develop this system indigenously to enable 'Make in India' Mission and to place India at a higher technological pedestal in the world forum.

Introduction

Controlled Aerial Delivery System (CADS) [1] airdrop technology is a vital capability for rapid deployment of payloads in predetermined location. To deploy Parachute units rapidly, there is a driving need to equip individual payload package with a parachute and guidance & control module so that each system can steer itself autonomously to a predetermined location after release from delivery aircraft. The delivery accuracy of non-steerable (eg. round) parachute systems primarily depends on a combination of 'deployment altitude' and 'wind conditions' encountered during descent. Ram Air Parachutes (RAP), due to their ability to glide and achieve a soft touch down, are occupying

prominent place in airdrop technology as an alternative to round parachutes. CADS are based on such RAP system coupled with all other required sub systems.

What is CADS?

Figure 1: Paratrooper Following an Aerial Delivery System During Operation

Source: https://airborne-sys.com/en/products/cargo-delivery-systems

CADS is an Aerial Delivery System technique , primarily for the Military Operations, for precise delivery of payloads, weighing approximately between 500 Kgs to 4 Ton, to a predetermined location by making use of manoeuvrable capabilities of the RAP.[2]

RAP uses 'Global Positioning System' (GPS) for the coordinates & altitudes and 'heading sensors' for calibrating path direction during its flight.

- GPS is a navigation system that uses satellites, receiver and algorithms to synchronise location, velocity and time data for air, sea and land travel.
- GPS works through a technique called 'trilateration'. Trilateration collects signals from satellites and thereafter processes location information as output.

CADS, with its onboard electronics unit, autonomously steers its flight path using 'waypoint navigation' towards the target location by operating 'control lanyards'.

Description

Aerial delivery and precision landing of military stores is a force multiplier for any Special Military Operation. Presently, heavy payloads are being dropped using a cluster of 'round canopy parachutes'. For this, payload parachute deployment is done at around 380 m altitude and close to desired landing point.[3] The system then lands, depending upon the prevailing wind conditions, near the target. The aircraft needs to fly in the proximity of intended target point at low altitude for successful and accurate delivery of payload. The inherent advantage of CADS is safe delivery without endangering the aircraft. CADS aims to deliver useful payload to the armed forces, in places where delivery by other 'regular' means is either not possible or experiences inordinate delay.

Figure 2: Delivery of Payload at Drop Zone (DZ) by an Aerial Delivery System

Source: ADRDE

Combat team's Rendezvous time at Drop Zone in operations, is crucial and needs to be minimum. Payload and the team are dispatched together using RAPs. While the Paratroopers steer themselves to the target, the load integrated with CADS also gets

directed towards the target simultaneously. The team of Paratroopers and the load makes a touch down near the target within a circular error probability (CEP) of 100 m. This results in quick assembly time which can eventually lead to an effective and fruitful mission.

CADS with its Air-Borne Unit (ABU) steers its flight path towards predetermined target by operating two of its control lanyards based on cross-track error, heading error and altitude. The system uses 'GPS' to get the realtime co-ordinates, altitudes, and 'magnetic heading sensor' to get realtime heading for its entire control operation. The system control can also be overtaken in manual mode by ground operators during terminal phase of flight. The CADS development needs a suitable size parachute and a mathematical model of parafoil/payload system in terms of turn rate, glide ratio, and descent rate with respect to different brake conditions and a control law (CLAW).

Development Approach

Likely Developing Agency[4]

The Aerial Delivery Research & Development Establishment (ADRDE) is a pioneer Research & Development lab of DRDO for the Design and Development of Aerodynamic Decelerators and Aerostat Systems. The charter of duties of the establishment includes development of Paratrooper Parachute Systems, Aircrew Parachute Systems, Ammunition Parachute Systems, Brake Parachutes, Recovery Parachute Systems, Aerial Delivery Parachute Systems, Heavy Drop Systems, Inflatable Systems, Airship Technologies, Aircraft Arrester Barrier Systems, Controlled Aerial Delivery Systems etc.

Development Process[5]

Research and Development of CADS has been going on in ADRDE for over a decade's duration now, with a wing especially dedicated towards its development. In its initial phase, for the theoretical model, three approaches were adopted:

- Wind tunnel testing on scale down model of RAP at IIT Kanpur.
- Theoretical model development at IIT Mumbai.
- Developmental flight trials of CADS in different configurations.

The feasibility study was carried at IIT Kanpur to develop a suitable model to conduct wind tunnel experiments. In consultation with the ADRDE team, a 'semi rigid model' of 15 cell RAP was fabricated to generate wind tunnel data for various asymmetric and symmetric deflections of controlled surfaces. However, it was felt necessary to involve a model of CADS parafoil/payload and to simulate its behaviour in different conditions. This was later attempted at IIT Mumbai.

The developed model was validated using theoretical data sets and simulation response was created. Wind tunnel data generated from the IIT Mumbai experimentation proved vital in validating the model. The same model was also used at Aeronautical Development Establishment (ADE), Bangalore to validate against the trial data. The model was also taken into account for refining the generic control law developed at ADE, Bangalore. The CLAW developed was test flown in the CADS.

Specifications and Features

Figure 3: An Aerial Delivery System During Flight

Source: https://airbornesys.com/en/products/cargo-delivery-systems

CADS is a state of art technology which can be of immense use and a force multiplier to the elite Special Forces of the three Services. With adequate number of such systems inducted into the Services, the operatonal efficiency of the Defence Forces would increase and the Battle Tactics would improve.

CADS comprises of Parachute System, Air Borne Unit and Payload. The Parachute system consists of drogue parachute and main parachute. After drop from the aircraft, drogue chute stabilises the system, and aids in safe opening of the RAP. The RAP once, fully deployed, provides glide and manoeuvre capability; ABU uses this manoeuvrability and steers the system towards target by pulling the parachute control lanyards via actuation system. Para Flight Control Computer (PFCC) initiates control action based on the current data available from GPS and heading sensor. Additionally, the system has a 'manual override' mode feature, thereforethe system could be flown manually, especially in the terminal phase of flight by the ground station operator.The system witnesses a soft touch down at target owing to RAP's features, thus safely delivering sensitive battle load to Paratroopers in the Combat Zone.

Present Status: Latest Trials and Demonstrations

As claimed by ADRDE, CADS for 500 kg All Up Weight (AUW) has been successfully developed by them. Flight trials have been conducted from various altitudes and offsets. CADS-500 has also been successfully demonstrated and flown at various locations and terrains in the country. A recent flight demonstration of CADS-500 was successfully carried out on 18 December 2021 as part of 'Azadi Ka Amrut Mahotsav' [6] celebrations, commomorating 75 years of Independence.

Figure 4: Demonstration of Indigenous CADS-500

Source: Annotated by Author

The system was para-dropped from AN32 aircraft and then steered to the pre-designated landing point in autonomous mode. Eleven paratroopers of the Indian Army and the Indian Air Force was tasked with chasing the CADS-500 in air and landed simultaneously.

Future Plans for CADS[7]

After successful development of CADS-500, DRDO is planning for development of a similar kind of system for delivery of heavier payloads that is upto 4 ton within a CEP of 100 m. A newer concept is also emerging wherein the heavy load is released at a reasonable offset and altitude, well beyond the danger zone and is made to travel at faster rate of descent using CADS allied technology. Once the system reaches the vicinity of its intended landing area, the RAP opens the conventional round canopy to activate a soft touch down of the system.

Existing Technologies of Aerial Delivery System Worldwide

Various high end technologies with regard to Aerial Delivery of stores, exists in the world. Prime holders of these technologies are the developed nations like US, UK etc. India with its large economy and equally large Armed Forces is well-poised to develop this industry in the country and support its friendly foreign countries too. Certain state of art technologies existing worldwide with respect to Aerial Delivery Systems are given below:

Table 1: Existing Technologies of Aerial Delivery System Worldwide[8]

MicroFly II		• Improved military mission capabilities without compromising safety or increasing training requirements. • The MicroFly II is an autonomous equipment delivery system that emphasises ease of use, flexibility, and low cost. • Keeps the unit intact and in control of its equipment through the entire insertion phase of the operation. • Can be used with any Ram-Air canopy including the Airborne Systems Intruder (RA-1), MC-4, MC-5 or others based on mission requirements.
FireFly		• The system's guidance, navigation and control software analyses its environment in real time, thus ensuring accurate payload delivery. • Carries unmanned payloads upto 2,200 lb (1000 kg). • Can be dropped from altitudes upto 24,500 feet. • Flies 25 kilometers or more depending on environmental conditions.
DragonFly		• Featuring a fully elliptical RAP canopy, it has repeatedly demonstrated the ability to land within 150 meters of a designated Impact Point. • Compatible with the current US JPADS Mission Planner (JPADS MP). • Selected as the Cargo Delivery System of choice for US 10,000 lb Joint Precision Aerial Delivery System (JPADS 10k) Program.
Jtrax Mission Planner (MP)		• JTrax Mission Planner (MP) is aproprietary software that allows the Jumpmaster to quickly determine the Release Point (RP) for personnel and Guided Precision Aerial Delivery System (GPADS) drops. • It is operated in three simple steps: a) Select the parachute system and AUW. b) Select the Impact Point (IP) and exit altitude. c) Select the aircraft to be used.

Jtrax Navaid		• The Navaid improves safety and increases effectiveness of military jumpers by providing accurate navigation for even the most demanding missions. The jTrax Navaid system includes: a) One pilot unit; b) One display screen. c) One support board or a harness; d) One back-up compass (optional).
Unicross		• Airborne Systems designs and manufactures low cost cargo parachute that can be utilised as a one-time system or repacked and reused as necessary. • Is easy to assemble or make repairs in the field without sewing. • Eliminates the requirement to recover the deployment bag into the aircraft with the release-away static line. • Reduce costs on assembly, training and maintenance.

2K1T		• This unique one-time use parachute complements the 2K FireFly system and is part of the Airborne Systems family of GPADS. • Eliminates maintenance, training and rigger support, as it is delivered packed ready for deployment requiring only simple rigging to the payload. • Lower cost of equipment due to innovative use of fabric material and construction methods. • A pre-packed ready-to-use parachute to go with the FireFly AGU and autonomous navigation software.

FC Mini		• Improve military mission capabilities without compromising safety or increasing training requirements. • The FC Mini is a smaller version of the FlyClops 2K, for payloads between 200-500 lbs. • Parachute and AGU can be stored up to 5 years prior to use • Lightweight- (11 lbs or 4.9 kg) • Delivered ready to use. • Max release altitude of 24,500 ft MSL (7468 m)
FlyClops 2k		The FlyClops 2K is a complete system— an alternative and low cost option to our standard FireFly 2K system. • Supports operational payloads between 700 – 2,200 lb (317.5 – 998 kg). • Lightweight- (77 lb or 35 kg). • Delivered ready to use.

Source: Annotated by Author

Application

CADS provide fully autonomous and precise delivery of payloads during day and night with manual override feature during entire course of flight. Aerial delivery is a pre- requiste for any military operation in the present scenario. With the ever changing and fluid battle conditions, delivery of stores at pre-designated locations could change the entire dynamics of operations. Recent conflict in Ukraine has witnessed extensive requirement of such high tech delivery systems. Although, the technology of CADS is not new to the world, however indigenisation of equipment is a big scientific leap for the country. It is imperative that all the potential users must understand the capabilities of these systems, study their respective futuristic requirements and participate in its indigenous development. Requirement of autonoumous and precise delivery of stores at far flung areas should be studied by non military stake holders too. Development and Supply chain establishment of such high end technology systems, if set right and smoothened in the country, would furthur improve the quality of system to make it more user friendly and mission specific. It would also reduce the

financial burden on the country owing to the present imports of such systems from foreign countries at exorbitant prices. There is an urgent requirement of stopping all imports of such high end technological equipments and develop them in the country to enable 'Make in India' and support '*Atmanirbhar Bharat Abhiyaan*' of India.

End Notes

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