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INTEGRAL TRANSPORTATION SYSTEMS IN MILITARY TRANSPORT AIRCRAFT SUPPLY

1. INTRODUCTION

Aircraft transport is any transport of goods, equipment and soldiers by aircraft, which serves to maintain or expand, i.e. increase the combat actions, and can have various objectives: 1. support to landing operations, consolidating and expanding of "bridgehead", 2. support to encircled forces to sustain them until evacuation or arrival of reinforcement for recovery, 3. support to resistance forces leading guerrilla war, etc.

Significant advances in cargo air transport, apart from the usual cargo handling after landing, have been achieved in the Landings of Allied Forces, in preparation and landing on the Normandy shore.[1]

The Allied landing operation within the Market Garden operation in 1944 with the aim of capturing the bridges along the operative line in direction of the Rhine and establishing the "bridgehead"¹ behind the Rhine, has been a failure in general, but the limited success of the U.S. 82nd Airborne Division has shown all the possibilities of airborne landing operations.

A very successful operation in air supply of encircled forces was the one supplying the U.S. forces in Vietnam encirclement in the military base Khe San.[3]

The mentioned examples offer the beginnings of modern air supply to the battle area, both regarding support to airborne landing or support to the encircled forces. It was then that the methods of airdrop in "taxiing" and in "low-flying" had been applied for the first time. Today, they have been improved and included in the regular methods of delivery.

The Russian achievements in design and usage of military transport aircraft are also worth mentioning, as well as the methods of destining and supplying which they have developed and that at a certain time had been even more advanced than the methods developed by the western Allies.

1. "Bridgehead" is a term used to describe the initially occupied territory after crossing a river or landing from the sea

2. AIRCRAFT SUPPLYING THE BATTLE AREA

Transport aircraft have originally been designed so that they could carry containers, pallets, trailers, most of the land vehicles, and even other aircraft (most often helicopters) - (which was rarely the case with civilian aircraft, except in the former USSR where almost every aircraft was originally designed to meet both military and civil requirements).

Loading openings were designed already as ramps, and the aircraft floor was designed with the appropriate strength and dimensions for Ro-Ro loading-unloading.[4]

The design technology development of wide-bodies as well as the application of aerodynamic solutions of such aircraft has enabled the construction of fuselages whose outer form allowed the interior to be designed wide and high enough for transporting even the biggest land vehicles, trailers, containers. The strategic transport aircraft, and large military helicopters are also designed to accept pallets and containers of land and sea traffic standards (Aircraft C-160 Transall, C-130 Hercules, An-12 and helicopters Skycrane, Mi-10). With helicopters there was and has been the possibility for transportation of cargo by undercarriage lifting, but this method is not very suitable for battlefield transport conditions (except in emergency) and it's not suitable for long-range flights in severe weather conditions.[5]

2.1. TYPES OF AIRCRAFT

The military transport aircraft can be divided into:

2.1.1. Modified civilian aircraft and helicopters[4]:

- Modified for transporting cargo only,
- Modified for transporting cargo and troops,
- Modified for transporting cargo, troops, paratroopers and parachuting cargo.

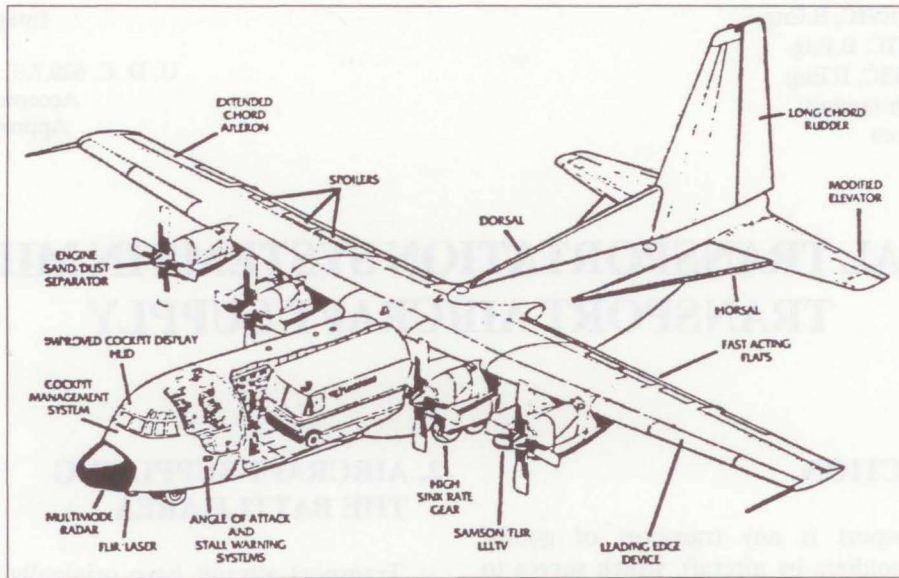


Figure 1 - C-130 J Hercules Aircraft

Source: Karl Schwartz, Hercules Forever, Flug Revue, Flugwelt International, Bonn, January 1996

2.1.2. Specific-purposes designed civilian and military cargo aircraft and helicopters:

- Aircraft with side openings for loading/unloading,
- Aircraft with front or rear, or front and rear openings for loading/unloading Ro-Ro cargo and for airdropping paratroopers and cargo, as well as for transporting soldiers.

Further division of transport aircraft into subgroups is possible. A subgroup that can carry a limited number of small-sized standard containers, a subgroup which can carry all the standard ISO containers (this division coincides approximately with the classification on aircraft of tactical and operative-strategic levels), as well as a subgroup that can carry all the standard containers, but also non-standard cargo whose dimensions exceed the dimensions of the largest containers (C-5 Galaxy, C-17, An-124, An-225).

Transport helicopters are divided into three subgroups: those that carry cargo and passengers in the cabin or transport undercarriage lifted cargo of various forms, helicopters that have rear opening with ramp for loading/unloading of Ro-Ro cargo, soldiers and for airdropping paratroopers and cargo (Mi-26) and helicopters that carry containers as open cargo, not undercarriage-lifted, but secured to the structure externally (Mi-10, Skycrane).

Due to the specific features of the military application of transportation means, there is an increasing tendency to combine several transport branches in a single transport mission.

The development of fast-acting units requires even faster and shorter ground handling times. The tendency is to have the equipment combat-ready

upon arrival at destination immediately after unloading or the soonest possible.

The cargo that has to be transported for certain operations varies substantially and often those means that transport only standardized cargo cannot be used. Still, in spite of the variety, within numerous and different military technology, although not in all armed systems, some basic standards of dimensions, volume and mass that enable the application of integral transport systems have been achieved.

3. PALLETS AND CONTAINERS

Container and pallet, that have over a longer period of time been regularly used to carry cargo in bulk and to standardize cargo transport, are beginning to acquire new significance and new forms in the military application. The civil standards are not easy to apply in military transport. They present a limitation rather than an advantage.

The form of pallets and containers has been determined by the form and freight area capacity of civilian aircraft.

The majority of the civilian transport aircraft have been designed for transporting passengers and luggage, and by modifying them they have been later designed into aircraft for mixed transport of cargo and passengers or aircraft for transporting cargo only. The area within the aircraft and the loading openings did not match the dimensions of vehicles and vessels, which resulted in special forms and dimensions of air transport pallets and containers.

Military transport aircraft are designed in such a way that their loading/unloading possibilities, form

and freight area capacity meet the requirements of transporting military equipment and troops, and for specific features of airborne landing.

C-17 aircraft fully meets the requirements imposed by the fast-acting units who have to act globally - anywhere in the world. The takeoff-landing capabilities enable delivery almost directly into the battle area or to captured runways in an airborne "bridge-head". It can take off and land on unprepared runways. Its capacity and dimensions allow for transportation of combat tanks such as M-1 and self-propelled multiple rocket launcher MRLS. With this aircraft the U.S. Air Force has achieved quick transport i.e. fast acting with light armoured and mechanised brigades anywhere in the world.

3.1. DELIVERY PALLET

In supplying the goods and equipment to the battlefield the following can be used:

1. ordinary wooden pallets,
2. aircraft metal pallets
3. special single-use pallets with shock absorbers for dropping by parachute and airdrop in "taxiing" and "low-flight".

Pallets for air cargo transport (LD) are not always suitable for methods of supplying the battle area. If conventional cargo handling equipment of any airport is used for unloading, then aircraft pallet may be used without limitations. It is, however, worth noting that in delivery performed by large military aircraft with unloading ramp very often even the usual standard wooden pallets found also in civil integral transport systems can be seen.

There are also special pallets for delivering the goods into the battle area for unloading:

1. in "taxiing",
2. in "low-flight" - dropping by parachute,
3. by parachute without special means for slowing down,
4. by parachute with ground impact absorbers using "retro-rockets",
5. by parachute with ground impact absorbers using "retro-rockets", in "low-flight",
6. pallets with polymeric (rubber) bag for delivery of liquids (fuel, water, etc.) of all types (numbered 2, 3, 4, 5). Pallets numbered 2, 3, 4, 5 and 6 are often made including a parachute.

Almost all special pallets are made as single-use and most often serve primarily to carry and protect goods from the moment of paratropping from the aircraft until the ground impact, and rarely to carry the cargo in various types of transport. All these pallets have a certain way of reducing the ground impact, and are permanently deformed and damaged in the action.

The pallets may soon be manufactured out of a disassembling component which will be destroyed by the ground impact, absorbing thus part of the impact energy, and a component that like an ordinary pallet serves for carrying and further handling of cargo.

To reduce the ground impact and avoid damaging the means (or goods) being dropped from a certain level above ground, "retro-rockets" are turned on, thus providing the pallet with zero speed at the moment of ground impact (Fig. 2). Just in case, the pallet is fitted with bags that get filled with compressed air after the pallet has been dropped out of the aircraft, and they form a so-called cushion to reduce the impact. Such a system has been developed and is used in tactical drills by the Russian army. The West has accepted this Russian airborne landing system, but it is being further developed so that cargo could be dropped at low levels of about 100 meters.

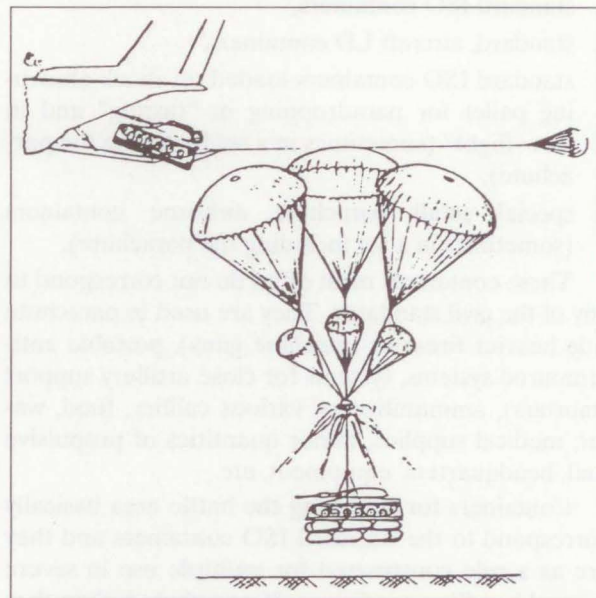


Figure 2 - Schematic drawing of airdropping (delivery) of an armoured vehicle from the aircraft applying the triple-parachute system.

Source: Egbert Torenbeek, Synthesis of subsonic airplane design, Moscow, 1983 (Russian translation)

In the case of defined quantities of cargo for air delivery, they can be palletized immediately upon leaving the warehouse, and transported on these pallets by all kinds of land vehicles before being loaded into the aircraft. "Life expectancy" of a pallet or its shock absorbing component terminates with the ground impact in the area of delivery. The tendency is to produce "single-use" pallets of cheapest possible material. For their construction wood, cardboard, simple polymers and cheap aluminum alloys are used.

Parachute-pallets are used for delivery of heavy armoured and personnel carrier vehicles, artillery

and rocket weapons, as well as various containers. Provided the organization is good and the landing area is wide enough, it is theoretically possible to deliver the goods in quantities that match the aircraft capacity for the given mission, with frequency which leaves sufficient time for safe approach of the next aircraft. In order to increase the safety above delivery area which is under enemy's antiaircraft attack, usually dropping by parachutes in "low-flight" is applied. High precision of such airdrop does not require a wide landing area, thus avoiding the possibility of parachuting the cargo into hostile area under adversary control.

3.2. CONTAINERS

For battle area supply by transport aircraft the following can be used:

1. standard ISO containers,
2. standard, aircraft LD containers,
3. standard ISO containers loaded on shock-absorbing pallet for paratropping in "taxiing" and in "low-flight" (sometimes in a set including the parachute),
4. special small parachute airborne containers (sometimes in a set including the parachute).

These containers most often do not correspond to any of the civil standards. They are used to parachute side heavier firearms (machine guns), portable anti-armoured systems, systems for close artillery support (mortars), ammunition of various caliber, food, water, medical supplies, minor quantities of propulsive fuel, headquarters' equipment, etc.

Containers for supplying the battle area basically correspond to the standard ISO containers and they are as a rule constructed for multiple use in severe ground handling conditions. If parachuted, then they are mounted on a single-use absorbing pallet and fitted with parachutes with "retro-rockets". Apart from transporting ammunition, fuel, food, medical supplies etc., the containers have built-in components of communication centres, headquarters, analytic centres, radar control and monitoring cabins, ground control stations of unmanned reconnaissance aircraft (even whole unmanned reconnaissance systems) etc.

4. CONCLUSION

The majority of the future aircraft for supplying battle areas are not expected to substantially increase their dimensions. It will be rather a matter of their redesigning as well as of redesigning the containers, armoured combat and other vehicles, in order to simplify such form of transport and to make it more efficient. This will enable quick rearrangement of highly

mobile units with high firing power, high-level independence and high speed of acting.

In our country also the fast-acting units have a significant place in the defense structure, so that we shall have to develop the organisation and means for their rapid transport in all the three dimensions.

In purchasing military means for fast-acting units, as well as in our own development of military equipment and weapons, transport and traffic engineers should play an important advisory role. The development of integral transportation means such as pallets, containers, and special airborne pallets and containers has to be included in the transportation cycle within the operations of our future fast-acting units.

By mutual adjustments and high standardisation of transport vehicles, integral transportation means and cargo, a rational volume of air fleet will be achieved, the overall combat effect increased, the rearrangement times especially shortened and continuous air supply safety increased.

SUMMARY

Supply of goods, equipment and soldiers by military transport aircraft can serve as a support to airborne landing operation, support to encircled forces, and support to forces leading a guerrilla war. Transport aircraft are designed in such a way as to be able to carry containers, pallets, most of land vehicles and helicopters. Military transport aircraft can be grouped into those that were originally designed for military transport and those that are modified civilian aircraft and helicopters. Supply pallets can be wooden, metal, can be airdropped in "taxiing", "low-flight", and can also be fitted with a parachute or "retro-rocket" for reducing the ground impact. Pallets can among other things carry liquids, heavy combat and carrier vehicles, artillery and rocket weapons and various containers. Pallets are usually permanently deformed at ground impact. Nowadays, high precision of airdrop has been achieved. Containers are used to carry various equipment, food, fuel, weapons, ammunition etc. It is to be expected that the containers, armoured combat and other vehicles will be redesigned so as to provide more efficient transport and fast arrangement of high-mobility units, whereas the form of the future military transport aircraft will not undergo substantial changes. By adjusting and standardising the transportation vehicles, integral transportation means and cargo, the overall combat efficiency will be increased, the arrangement time especially shortened and the air supply safety increased.

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