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progress in aerial supply

Supplying our combat forces with the necessary supply items, undamaged, is perhaps the most important aspect of warfare. The vast amount of tonnages required must be moved forward in support of these forces to insure success in battle. In essence, the logistical lifeline must incorporate precision, flexibility, and mobility commensurate with that of the force being supplied.

Present concepts of warfare envision the use of fast, hard-hitting combat units. These units may fight alone, and probably will, or at times may team with larger units. Whichever the case, our problems in providing necessary logistical support are magnified considerably. Vertical envelopment has come of age. Our combat forces will parachute and air-land into these areas, being transported by fixed wing and rotary wing aircraft. Our supplies and equipment, if they are to be delivered in the quantity required where needed and when needed, must, of necessity, travel the same route. It is obvious that the $2\frac{1}{2}$-ton truck cannot keep pace with the modern day aircraft.

The Quartermaster General recognized this problem at an early date. Action was taken to organize and dispatch to the Far East, during the Korean conflict, a Quartermaster Aerial Supply Company. This company air-dropped over 18,000 tons of supplies to all the U. S. Forces during that particular conflict, participated in two airborne operations, and dropped a bridge to the First Marine Division, enabling that unit to escape annihilation in the Chosen

Reservoir on December 7, 1950. Since that time, the Quartermaster Corps supported the French in the Indo-China conflict with personnel, parachutes, and many other items of supply and equipment. Although much has been learned, very much remains to be learned about logistical support of combat troops by air-drop methods.

There are only two methods by which we can support combat troops by air. We can physically land the aircraft on unprepared or prepared fields and offload, or we can drop from the aircraft while in flight. If we could be assured of a landing area wherever we fight, we would prefer to do so, but this cannot be done. Consequently, we must look to air drop as the means of full supply support for such forces.

air-drop systems

By way of background, let us see how the present standard aerial delivery system came into being. Early in 1946, when the initial requirement was submitted for development of a system for dropping large items of equipment ranging in weight from 3,000 to 7,000 pounds, a search of past accomplishments indicated that a T-24 Personnel Carrier, known as the "Snowmobile," had been dropped successfully from bomber type aircraft as early as 1943. However, an evaluation of bomber type aircraft in 1946 produced evidence that this type aircraft was inadequate to accomplish the aerial delivery mission for large items of equipment. In a survey of cargo type aircraft, it was found that the C-82 and later the C-119 aircraft possessed a potential for performing an aerial drop mission but did not possess an aerial delivery system. Many tests were conducted with these aircraft, resulting in a gradual development of current techniques and equipment. It was late in 1949 before the present standard system evolved and was satisfactorily service tested. Today, the standard aerial delivery system is capable of air dropping equipment ranging in weight from 3,000 pounds to 21,000 pounds.

This system is conveniently subdivided into two major kits—the Aircraft Kit and the Aerial Delivery Kit.

The Aircraft Kit consists of those components required to provide the aircraft with an air-drop capability, and the Aerial Delivery Kit consists of those components required to rig an item of equipment for aerial drop. The components of

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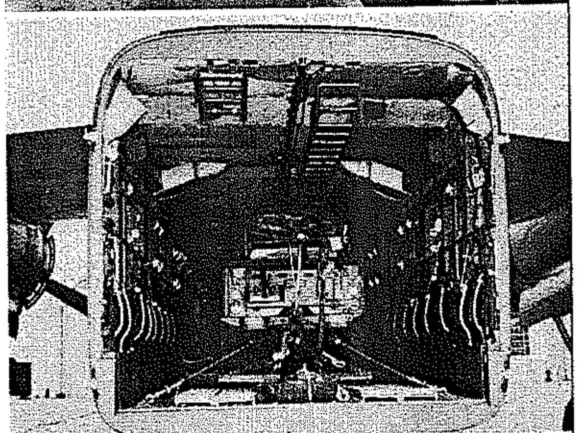
Born in Hudson, Ill., he is a 1946 graduate of Illinois State Normal University, Normal, Ill., receiving a B.S. in education. While at college, he was captain of both the football and wrestling teams. In 1943 he entered the Army and received a commission in 1944, following attendance at Engineers' Officer Candidate School. Subsequently, he served as an Engineer officer, 1944-46; as an Infantry officer, 1947-50; and was detailed to the Quartermaster Corps in 1950. His overseas assignments have included World War II duty in the Philippines, 1945-46; Japan, 1947-49; and Japan and Korea, 1950-51. His decorations include the Air Medal, Legion of Merit, and Commendation Ribbon with Metal Pendant.

the aircraft kit include a system of floor-mounted conveyor sections for ease of loading or unloading the equipment to be dropped. Any load placed in the aircraft must be tied down to meet minimum flight restraint factors (figure 1). Standard tie-down chains are used to restrain present equipment loaded for aerial drop. The sides of the aircraft cargo compartment are fitted with buffer panels which prevent direct contact of the load with the sides of the aircraft cargo compartment should any lateral movement of the load occur during the aerial drop sequence. The extraction parachute assembly consists of a small weight inserted into the aircraft glider tow release, a pilot parachute, and an extraction parachute.

The Aerial Delivery Kit consists of a non-load-bearing platform constructed of wood to which the load is rigged with tiedown webs. Shock pads and crash frames are placed between the load and the platform to absorb and distribute the forces of ground impact. The platform is provided with a smooth lower surface which permits easy movement of the load over a system of conveyors and, upon ground impact, aids in preventing toppling.

Since the platforms are not load-bearing, the equipment being dropped is modified by installing special brackets for use in attaching parachute suspension slings. A cluster of large-diameter main recovery (as distinguished from extraction) parachutes is used to lower the equipment to the ground at a safe terminal velocity. Parachute ground releases are employed in the suspension system to release the parachutes from the load upon ground impact to prevent dragging or overturning of the load in moderate ground winds.

The aircraft kit and the aerial delivery kit are "married" together after the aircraft has been loaded by attaching the extraction para-



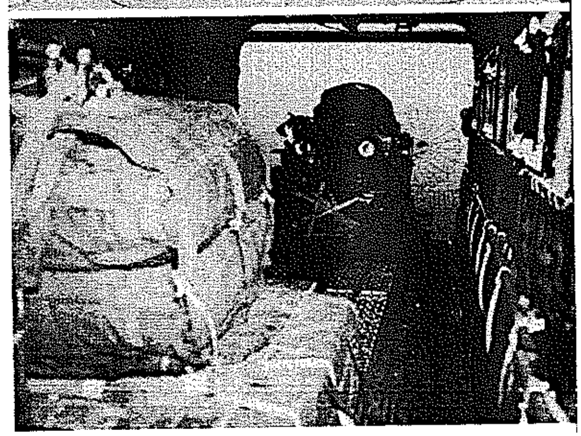
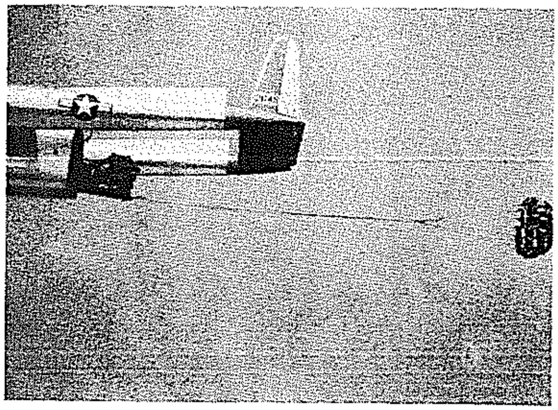


Figure 1. A 1-ton truck, rigged on its aerial delivery kit, being loaded into C-119.

Figure 2. Truck rigged in aircraft prior to actual drop. Note wheel skate roller conveyors on floor.

Figure 3. Load being extracted from aircraft by pressure exerted from extraction parachute as transmitted to the extraction bar, the attachment to the platform.



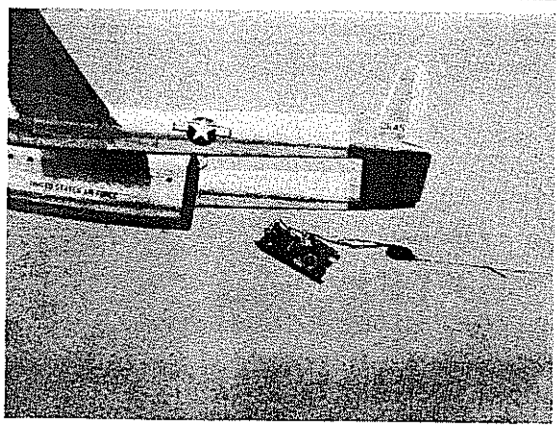


Figure 4. Load extracted from aircraft. Note extraction bar detaching itself at bottom of platform.

Figure 5. Extraction bar (extreme right), detached from platform, is connecting link between extraction parachute (out of picture) and main canopy just behind load.

Figure 6. A ¼-ton truck being lowered to ground by 100-foot diameter main canopy. Upon ground impact, canopy will automatically be released.

chute assembly to the platform of the load being dropped. The navigator for the air-drop mission guides the aircraft to the drop zone and, utilizing the Computed Air Release Point (CARP) system, calculates the air release point for delivery of the equipment to a predetermined point on the ground. Meanwhile, the removal of all but a few webbing restraints used to secure the load for takeoff and flight to the drop area is effected. At the air release point, the pilot actuates the glider tow release dropping the deployment weight which, in turn, deploys the extraction parachute. The force of the inflating extraction chute cuts the last tiedowns and the load is extracted, as illustrated in figures 2, 3, 4, 5, and 6.

As the platform leaves the aircraft, a mechanism mounted on the platform (known as the extraction bar) detaches the extraction chute from the platform, and the extraction chute then acts as an anchor parachute, deploying the cluster of main recovery parachutes which lowers the equipment safely to the ground.

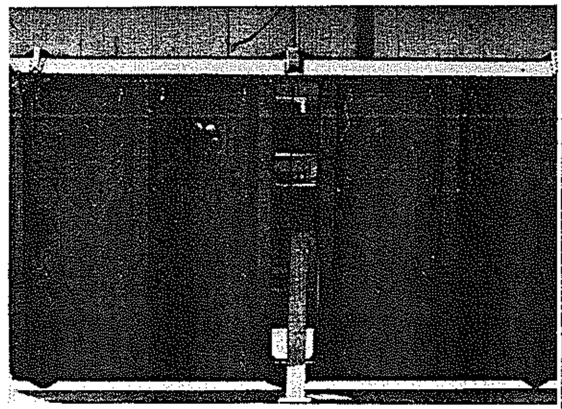
a promising new system

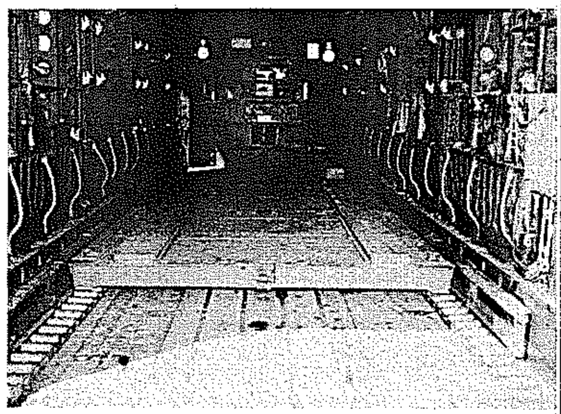
We now come to the discussion of a new system presently under development, expected advantages of which are indicated by performance tests. In this system the platforms are of the stressed metal load-bearing type, are uniform in width, and are universal for a specific load range (figure 7). Three sizes of platforms have been developed to meet weight range requirements of 3,500, 7,000, and 16,000 pounds. It will be necessary only to tow or drive the equipment upon the platform and secure it in place with tiedown devices. The shock absorbers (air bag decelerators) are contained within the platform, precluding complicated rigging procedures now experienced. This capability will greatly reduce the amount of training and literature required to out-line pre-drop techniques. The combination of efficient shock absorbers and anti-toppling devices incorporated into these platforms permits dropping in ground winds up to 35 mph. This performance provides for increased service life of the platforms.

The hazard to air crews has been eliminated by incorporation of a restraint and automatic release system which also provides restraint and guidance during extraction of the load.

Now, recalling the appearance of the cargo compartment when fitted with skate wheel conveyors for the standard aerial delivery system, figure 8 shows the side rail aerial delivery system installed in the C-119 aircraft. This system consists of two rows of roller conveyors at the extreme sides of the cargo compartment and a restraint and guidance rail adjacent to the heater ducts. The conveyors and rails extend the length of the cargo compartment and are mounted to the floor cargo tiedown fittings. An obvious advantage of the system is that it provides a clean floor for maximum utility of the aircraft. Figure 8 also shows a platform in the cargo compartment. This platform is being restrained by the side rails and mechanism contained within the platform. The rail is a right angle extrusion which mounts to the floor tiedowns with a special bracket. The vertical flange of the rail is provided with regularly spaced holes throughout its length. The platform is fitted with pins which engage the holes in the rail at any desired position to meet the optimum aircraft center-of-gravity loading condition. The stressed platform rides on the roller conveyors and under the projecting flange which provides vertical restraint.

It is necessary only to load the stressed platform into these rails and engage the pins with the rails to restrain the load in the aircraft.





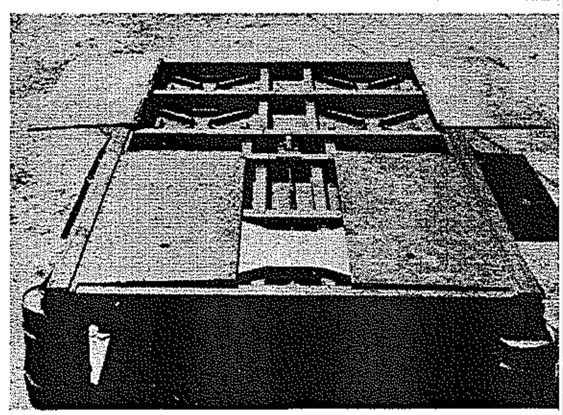
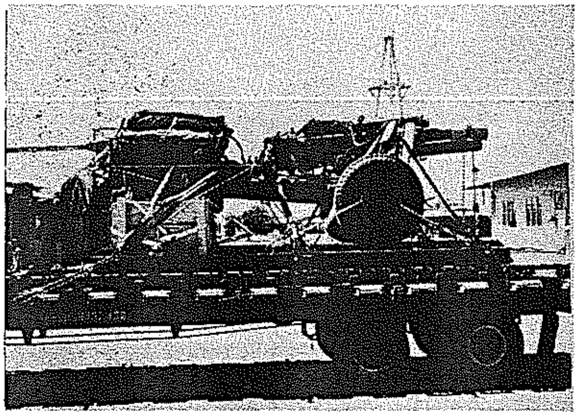
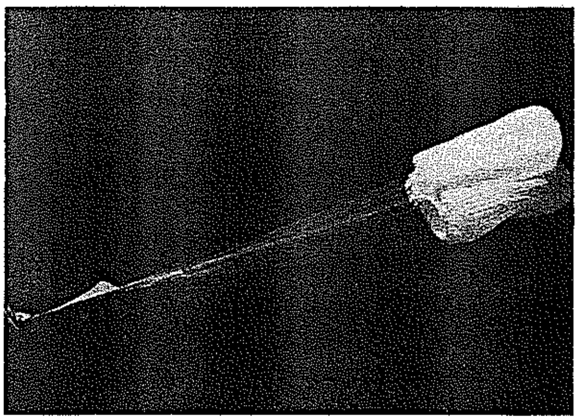


Figure 7. Bottom view of the 3500 lb. stressed platform, showing the self-contained energy dissipators (air bags).

Figure 8. The 3500 lb. stressed platform installed in the C-119, utilizing the side rail restraint system.

Figure 9. Bottom view of experimental 7000 lb. aerial delivery platform. At front, plywood doors are folded in position for air drop. At rear, plywood doors are extended as if ready for an actual landing.





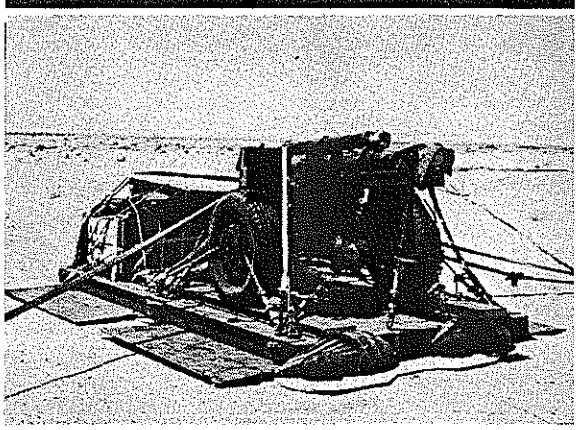


Figure 10. This load will be moved from roller conveyors on cargo vehicle to roller conveyors installed in C-119.

Figure 11. Opening sequence of the G-11 parachute and the attachment to the heavy drop load. Note attachment of suspension sling directly to platform.

Figure 12. Aerial delivery kit, showing open plywood doors and collapsed air bags under platform.

Figure 9 shows the bottom view of the 7,000-pound capacity platform. This platform is fitted with adjustable treadways for distributing concentrated loads to the main load-carrying members of the platform. These treadways may be removed for loading general supplies on the platform. Suspension of the load is accomplished at six points at the outer edges. The projections along the side of the platform extend under the flange of the restraint rails, providing vertical restraint in the upward direction. The pins which engage the rail for fore and aft restraint extend at this point when the manual handle is actuated. The force of the extraction parachute applied to the fitting at this end of the platform retracts the locking pins automatically and then extracts the loaded platform.

The actual sequence of this drop, shown in figures 10 through 12, is similar to the drop of the non-stressed platform as outlined in preceding paragraphs. The deployment weight initiates the actual activation of the load. The pilot parachute is deployed and then deploys the extraction parachute. The extraction parachute, in this deployment action, exerts force on the extraction line which disengages the pins locking the platform to the side rail restraint of the aircraft, allowing freedom of movement of the heavy drop load. As the load leaves the aircraft, the extraction line is detached from the platform. The extraction parachute, acting as an anchor, deploys the main canopy as described for the non-stressed platforms.

Supply drops utilize two primary systems of delivery. These are the monorail delivery and gravity ejection (figure 13).

The monorail delivery system consists of a single rail secured to the top of the fuselage of the C-119 cargo aircraft, and on this rail are installed 20 individual trol-

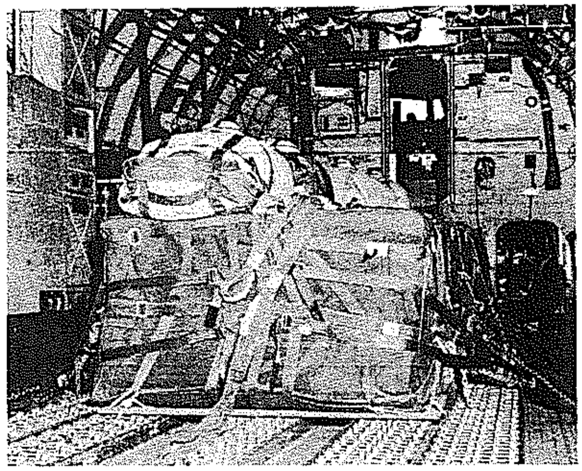


Figure 13. Five A-22 containers with one G-12 each, rigged for drop in C-123 aircraft.

leys, each capable of carrying 500 pounds. To these trolleys are attached the individual 500-pound aerial delivery containers equipped with parachute for actual drop purposes. This system requires 8½ seconds to deliver 10,000 pounds from this particular aircraft. The containers are released at a release point located on the rail just above what are called "paratainer" doors. The aerial delivery container released from this rail falls through the paratainer doors and the parachute is deployed by means of a static line attached to the internal portion of the aircraft.

The gravity system employs the use of A-22 containers (2200-pound capability) and G-12D parachutes, 64-foot diameter, capable of carrying 2200 pounds. The A-22's are placed in the aircraft on roller conveyors and the G-12D parachutes, by means of static lines, are attached to floor tiedown rings. In flight, the A-22 containers are secured in the aircraft by means of C-2 chain tiedown and a webbing arrangement at the rear of the aircraft. The actual dropping of gravity type loads is accomplished as follows: In flight, just prior to arriving over the drop zone, all chain tiedowns are removed, leaving the webbing attachment at the rear. This webbing attachment will restrain the load until actual drop is to be made. The system of activation is comparable to heavy drop extraction in that the deployment weight is utilized to activate a release parachute; the release parachute, through a series of three knives, will cut the webbing attachment restraining the A-22's. With this release of restraint, the A-22's, being placed on rollers and with the normal drop attitude of the aircraft having an inclined plane to the aircraft floor, will roll out the open rear door of the aircraft, the G-12's being activated by static lines.

In addition to the system just mentioned, several component feasibility studies and developments are being conducted.

Airbag decelerators, utilized with the developmental aerial delivery platform, are being studied to improve their operational efficiency. The chief difficulty here is the development of materials possessing sufficient strength without sacrificing flexibility at low temperatures and a means of positive extension of the bags during platform descent.

As a sequel to this program, a feasibility study will be conducted on decelerators other than airbags. The objective of this program will be a reduction in cost over the air-bag decelerator. Load-arresting devices and new energy-dissipating materials will be investigated.

Closely associated with the above program is a new feasibility study of requirements for possible development of expendable aerial delivery platforms.

Very little has been said up to this time about cargo parachutes, and it is interesting to note that formal requirements have been included in requirements for aerial delivery platforms. From a performance viewpoint, present cargo parachutes meet all present and most of the future requirements for airdrop missions. From a cost viewpoint, much is desired. A study program is planned to investigate fabrication methods and techniques which will permit the efficient combination of low cost materials for possible application in construction of parachutes. An interesting new material being investigated in this field is "mylar" film.

There is a present capability to air-drop vehicles, weapons, and general cargo weighing up to 21,000 pounds. This system possesses many limitations which will be overcome by adoption of the developmental systems which provide an improved universal capability and, in the future, plans are under way to extend the operational range to provide a high- and low-altitude capability and to study methods of reducing costs of the medium-altitude system.

We fully realize that we have not reached the ultimate in air-drop techniques or systems to date. We are looking constantly for more economical retardation devices and rigging equipment. We want to reach the ultimate objective of expendability for these items. You have noticed the numerous items required for such air-drop operations. We must recover these items on the drop zone, if possible; if not, we lose costly and hard-to-replace items.

We want to save manpower in the rigging, loading, recovery, and maintenance areas.

In the area of supply drops, we have and will in all probability continue to air-drop items as packed for export. We believe that new packaging techniques will enable us to do this at reduced costs and with increased efficiency.