

# The Durachute Vacuum Sealed Rescue Parachute

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## **ABSTRACT**

*The paper describes a new technology for parachute vacuum packing and sealing by the example of the Durachute aircrew emergency bailout parachute, that will be in service for the German Aircraft C-160 Transall and BR-1150 Breguet Atlantic. The Durachute is the civil name of the Thinpack parachute that has been introduced to the US Navy.*

*The Durachute canopy and the suspension lines are vacuum packed and environmentally sealed to protect it from the elements and extend its life. The patented sealing technology provides a long repack cycle of more than 5 years and a canopy shelf life of 27 years, which significantly reduces maintenance time and cost. Due to the vacuum packing the parachute assembly achieved a low weight and small volume and is especially suitable for a seat integrated application.*

## **INTRODUCTION**

The development of the Thinpack parachute was initiated under a research contract of the US Navy in the early 90s. SIMULA International, located in Phoenix/USA, awarded the contract for the development of a newly designed emergency bailout parachute system to replace the NB-8 parachute of the US Navy. The main goals for the parachute design have been a repack cycle of more than five years, an environmentally sealed canopy, a one-size-fits-it-all harness and a reduced weight compared to the used parachutes.

SIMULA has developed a system which meets the required objectives and moreover makes substantial improvements in other areas such as quickness to don, comfort and canopy performance. The Thinpack parachute system has been

qualified and introduced to the US Navy for the use in the P-3 aircraft and the US Air Force is planning to replace their bailout parachutes with the Thinpack. Durachute is the name for the civil application of the Thinpack.

The German Forces are just about to replace their BA-22 parachute, that is used in the C-160 Transall and the BR-1150 Breguet Atlantic aircraft with a modified Durachute system, additionally equipped with a canopy release and a Cypres Automatic Activation Device. Autoflug GmbH, located in Rellingen/Germany, is the SIMULA representative for Europe and is responsible for the German military qualification, as well as for the service and maintenance of all Durachute systems in Europe.

This paper describes the parachute design goals, the design concept, the qualification in the USA and Germany and the concept of the seat integrated parachute.

## **PARACHUTE DESIGN GOALS**

The goals of the US Navy research programme have been:

- Reducing the repack expenditure with the help of a vacuum packed canopy and an extension of the repack cycle to more than five years. Regarding the high number of parachutes in the US Navy (17.000 emergency bailout parachutes) and a repack cycle of 660 days, the repack cycle extension to more than five years significantly reduces the maintenance time and costs.
- Providing an improved harness that fits to all crewmembers from 3 to 97%ile
- A light weight parachute system of less than 17 pounds (7,7 kg). The NB-8 has a weight of 25 pounds.
- A parachute canopy with a descent rate of less than 24 ft/sec (7,3 m/sec)

with a 265 lb suspended mass and a maximum opening velocity of 150 kt.

- The initiation of the parachute deployment shall not require any additional action beyond pulling the ripcord.

### PARACHUTE DESIGN CONCEPT

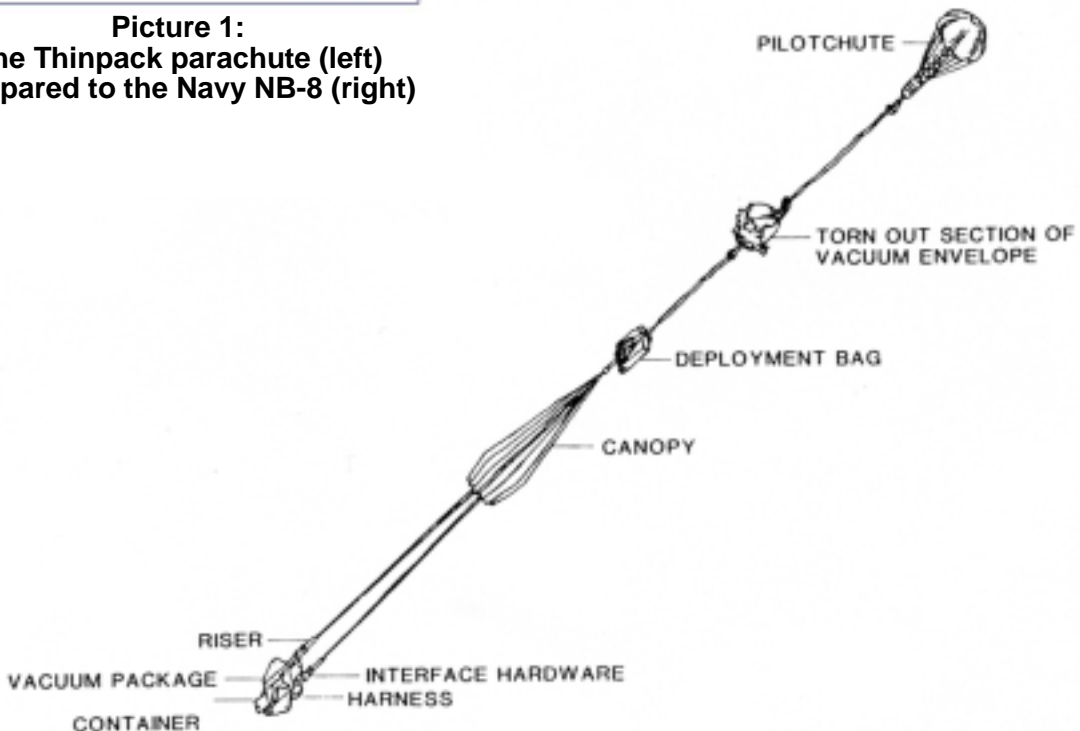
The canopy is packed in a deployment bag and this bag, together with the suspension lines and parts of the two risers, is vacuum-sealed into a flexible, low-permeability envelope. Vacuum-sealing eliminates problems caused by variations in the external air pressure, and, within the envelope, lowers the concentration of reactants deleterious to nylon. Vacuum-sealing also allows the system volume to be reduced, as is apparent in picture 1.



**Picture 1:**  
The Thinpack parachute (left)  
compared to the Navy NB-8 (right)

The sealed canopy is attached to short risers on the harness by means of proprietary hardware specifically developed for this system. This hardware permits the sealed canopy to be treated as a replaceable module of the system. The flexible envelope and modular design permit an alternate canopy to be substituted into the existing system. The system is suitable for either round or ram air canopies.

The pilotchute is packed inside the container, but outside the sealed envelope. It provides the force necessary to tear open the sealed envelope and extract the canopy. The pilotchute is attached to the deployment bag through a bridle consisting of four separate lines. Each of these four lines passes through the sealed envelope near a tear initiator and is attached to a bridle line inside the envelope. These four cords converge to a single cord for extracting the deployment bag. The four separate tear initiators ensure that regardless of the orientation of the jumper, there will be an efficient load path between the pilotchute and at least one tear initiator. The system is designed such that the force developed by the pilotchute at a bailout speed of 90 knots is at least four times the peak extraction force. Picture 2 shows the entire system stretched out just prior to parachute inflation.



**Picture 2: Sealed Parachute System**

The harness and the container are an integral assembly. This design simplifies the donning and reduces weight. The length adjustment in the harness occurs entirely on the front and is in the main lift web of the harness. The harness design is a solid saddle configuration. The total weight of the sealed parachute system is 7.7 kg

### **REPACK CYCLE**

The system has a recommended repack cycle of 5.5 years. The combination of a low-permeability envelope and vacuum packing ensures that degradation of the nylon canopy fabric is virtually stopped.

To demonstrate that the recommended 5.5-year repack cycle is justified, a model was created to calculate the amount of water vapor and oxygen permeating through the envelope material. The model was run using external conditions of 90 percent relative humidity and 23 °C. After 5.5 years, the partial pressure of oxygen within the envelope is only 25 percent of its normal atmospheric pressure, and the relative humidity inside the envelope has risen to only 23 percent from a starting value of 15 percent. The total pressure within the envelope is only 0.27 atmospheres after 5.5 years.

In addition to the modeling, three systems were subjected to a series of environmental stresses including shock tests, vibration, rain, high temperature/humidity, acceleration, temperature/humidity shock, sand and dust, pressure/altitude cycling, depressurization, and salt fog. These systems passed all of the exposures except the package drop portion of the shock test. One system developed a vacuum leak following the eighteenth drop. The failed system was subsequently used in an extraction test and performed perfectly. Even a complete loss of vacuum from the sealed envelope does not interfere with successful deployment.

The US Navy currently operates on a repack cycle of 660 days and thus the number of repacks required on each system will be reduced to one-third of the current number. The US Air Force repacks on a cycle of 120 days, the German Forces on

a cycle of 6 months, what even increases the potential costs savings from using sealed parachutes compared to the US Navy.

In addition to an extended repack cycle of 5.5 years, the sealed parachute will have a recommended service life of 27.5 years, approximately twice the service life of the existing units.

### **DEPLOYMENT RELIABILITY**

Both, static and dynamic tests were performed to demonstrate the deployment reliability and have shown that the sealed parachute can be expected to deliver highly reliable and consistent openings.

### **QUALIFICATION**

The Thinpack has been mutually qualified by SIMULA and the US Navy. The parachute system has first been tested according to the FAA TSO C23d requirements and the test procedures spelled out in SAE AS8015B. Those tests were complemented by tests according to some special military requirements. Both FAA and US Navy have certified the Dura-chute/Thinpack parachute system.

### **GERMAN MILITARY QUALIFICATION**

The German military qualification is presently in progress, prepared by Autoflug. It is planned to simplify the qualification process by taking the existing FAA and US Navy qualification and compare it to the requirements of the German military parachute qualification. Only those points that are not covered by the FAA or the US Navy certificate have to be approved in a delta qualification.

One critical issue was the flammability of the parachute system, since German regulations require for parachute container and harness the same flammability characteristics as for personal crew equipment. Such equipment has to withstand a flame temperature of 900°C over 15 sec. No other parachute qualification regulation contains such a requirement. For the acceptance of the used materials it had to be shown that the quality of other, flame resistant materials

sistant materials are worse in terms of strength and life time and a modification of the Durachute by using such materials would decrease the quality. Moreover it was expected, that the FAA qualification have to be renewed, as these modification can be considered as major design change. However the parachute is in use in the US Navy with the same inflammable materials, it was finally accepted by the German authorities.

The certification of the German Durachute is expected for May 2003.

### SEAT INTEGRATION

Due to the small volume of the sealed parachute the Durachute can be fully integrated into fixed-wing and helicopter crew seats. Provisions for the integration of the Durachute have been completed for the E-2C Hawkeye, the EH-101's crew seats and other helicopters.

The Durachute replaces the seat and back cushion of the crew seats with a combined seat and parachute harness, as shown in picture 3. After releasing the parachute from the seat, the crew member is equipped with the parachute and survival kit. This allows easier and faster egress.



**Picture 3:**  
**Seat integrated Durachute and Pilot equipped with Durachute and Survival Equipment**

The Durachute can be equipped with an automatic activation device (e.g. Cypres) for automatic parachute deployment and

a water activated parachute release. The Parachute Survival Equipment is made for high altitude emergency bailout (25,000 feet above ground level). The E-2C aircraft configuration e.g. is equipped with an oxygen system, an automatic activation device, a vacuum sealed life raft and a survival kit. Customized adaptations are possible.

### CONCLUSION

The Thinpack/Durachute emergency bailout parachute system has demonstrated the feasibility of a vacuum-sealed parachute concept. As a viable alternative to standard rescue parachutes the system presents many advantages, e.g. an extended repack cycle of 5.5 years and a longer life time of 27 years, causing substantial reductions of maintenance time and costs. The system has a low weight and a small volume, that makes it suitable for the integration into aircraft crew seats.

### REFERENCES

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### BIOGRAPHIES

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