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CHEMICAL WARFARE PROTECTION FOR THE COCKPIT OF FUTURE AIRCRAFT

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ABSTRACT

Currently systems are being developed which will filter chemical and biological contaminants from crew station air. In order to maximize the benefits of these systems, a method of keeping the cockpit contaminant free during pilot ingress and egress is needed. One solution is to use a rectangular plastic curtain to seal the four edges of the canopy frame to the canopy sill. The curtain is stored in a tray which is recessed into the canopy sill and unfolds in accordion fashion as the canopy is raised. A two way zipper developed by Calspan could be used as an airlock between the pilot's oversuit and the cockpit. This system eliminates the pilot's need for heavy and restrictive CB gear because he would never be exposed to the chemical warfare environment.

INTRODUCTION

The Soviet's recent use of chemical warfare agents and toxins in Afghanistan shows their willingness to use chemical weapons to achieve their military goals. A chemical attack serves two purposes. The first is to cause direct casualties on enemy personnel. The second is to reduce the opposition's performance by forcing him to wear a restrictive Chemical and Biological (CB) protective ensemble while working in a contaminated environment.

Current aircraft have no means of preventing the contamination of the cockpit interior when the airfield has been chemically attacked. Because the cockpit is "dirty" the pilot must wear a heavy protective suit throughout his mission. The current CB ensemble consists of: a MBU-13/P chemical-biological-oxygen mask (CBO), a butyl rubber hood, a CRU-80/P charcoal filter pack, an active charcoal impregnated undergarment, and butyl rubber glove inserts. In order to protect the pilot from liquid contaminants, a plastic overcape and overboots are worn by the pilot until he reaches the aircraft. The CB ensemble reduces pilot performance by decreasing head mobility and peripheral vision, and by increasing heat build-up underneath the CBO and the rubber hood. Although the current CB protection system defeats the first purpose of a chemical attack, it falls victim to the second. This lead to our development of a CB protection system concept which protects the pilot from CB agents in a manner which minimizes the negative impact on pilot performance (see figure 1).

CHEMICAL BIOLOGICAL PROTECTION SYSTEM

The proposed CB protection system consists of an ingress/egress system and a Cockpit Atmosphere Protection System (CAPS). The ingress/egress system would keep the pilot from being exposed to contaminants during his transfer from the protection shelter to the aircraft. The CAPS would maintain a contaminant free environment inside the cockpit.

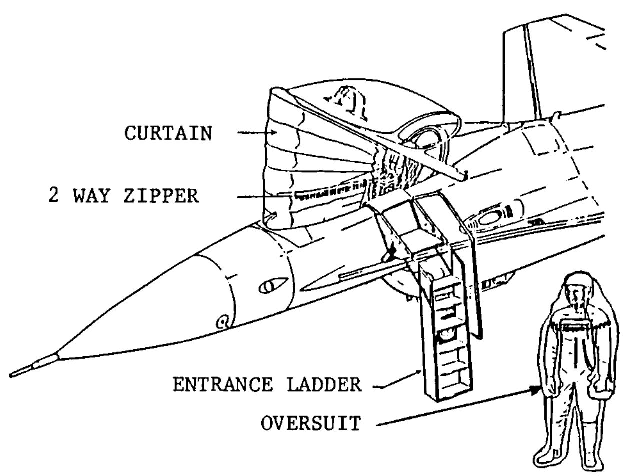

Figure 1. PROPOSED CB PROTECTION SYSTEM

INGRESS PROCEDURE

The new ingress procedure would begin with the pilot entering an impermeable oversuit using a two-way zipper (such as the "Supertab" developed by Calspan for the Army) to form an airlock between the protective shelter and the oversuit. The pilot would then travel out to his aircraft protected by the oversuit. He would then ingress the aircraft by using the zipper to form an airlock between the pilot's oversuit and CAPS. The pilot would ingress and egress the cockpit through a 3' 6" long two-way zipper located on the side of the curtain (see figure 2). Once inside, the pilot would zip the curtain closed and the oversuit would fall off. To egress the cockpit, the pilot would first zip his spare oversuit onto the inside of the curtain. He would then turn the suit inside out, pushing it through the opening in the

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curtain so that it would then be on the outside of the curtain. He would then reverse the ingress procedure and return to the shelter. The use of overpressure insures that no contaminants enter the cockpit through the zipper mechanism. The cockpit air used to provide the overpressure could be cleansed by a catalytic filtration system such as the system being developed by the Environmental Control group of the Air Force Wright Aeronautical Laboratories. The oversuit and the CAPS would protect the pilot from the contaminated environment. This would allow him to fly his mission free from the hot and cumbersome CB ensemble.

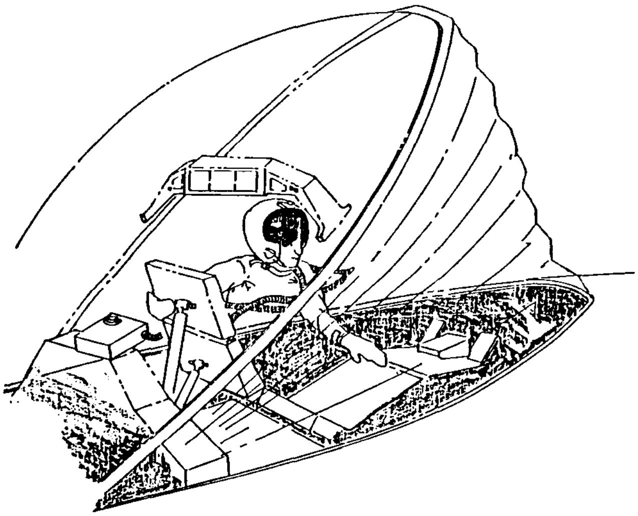

Figure 2. PILOT TRANSFER FROM SUIT TO COCKPIT

OVERSUIT

The oversuit would be designed to protect the pilot from liquid and vapor contaminants during transfer to and from the aircraft. It would be constructed from a lightweight (approximately 6 oz per square yard), flexible, and tough material, which has good CB barrier properties (one possible material is a Saranex barrier film bonded to a Tyvek support material). The suit would be disposable and designed so that one size would fit the 1st through 99th percentile U.S. Air Force pilots. The suit would be large enough so that the pilot could crawl into and out of it easily using a 3' 6" opening across the chest, which would be sealed by one half of the two-way zipper. The pilot would be wearing an advanced flight suit which would provide filtered air during his transfer to the aircraft and some CB protection in case of emergency egress or a leak in the CB protection system.

COCKPIT ATMOSPHERE PROTECTION SYSTEM

The CAPS consists of a RECTANGULAR CURTAIN, a STORAGE TRAY, a STORAGE TRAY LID, INFLATABLE RUBBER SEALS, and a RETRACTION SYSTEM each of which are described below.

The RECTANGULAR CURTAIN (see figure 3) is designed to protect the cockpit from CB agents when the canopy is raised by sealing the edges of the canopy to the canopy sill. The curtain could consist of a thin sandwich (approximately .006 inches 6 oz per square yard) of a nylon polymer film laminated to a support substrate. The curtain unfolds and folds in accordion fashion as

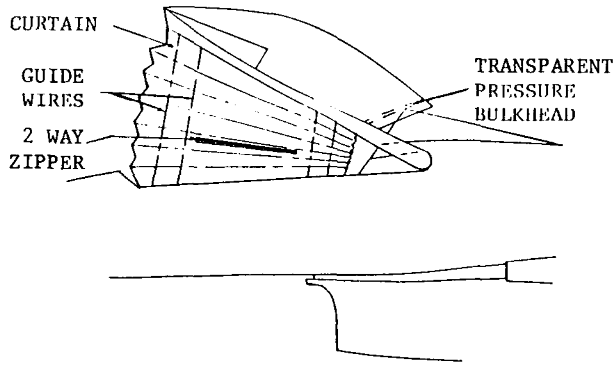

Figure 3. SIDE VIEW OF CAPS

the canopy is raised and lowered. The curtain dimensions were developed using the F-16 cockpit as a baseline. Assuming a 3" limit in folded width the curtain would require 48 panels to seal the cockpit opening. Because the curtain is shorter in the back, the width of the folds would only be 1". The width of the folds along the sides tapers from 3" at the front to 1" at the rear. The curtain is attached at the bottom to the storage tray and at the top to the storage tray lid. To prevent the curtain from billowing out from overpressure, plastic stiffeners would be attached to the inside edge of each curtain fold (see figure 4). The stiffeners would be constructed of a material which was 2" wide and .04" thick. The material would be capable of being creased at the center and folded 180 degrees. The combined weight of the curtain and stiffeners would be approximately 15 pounds.

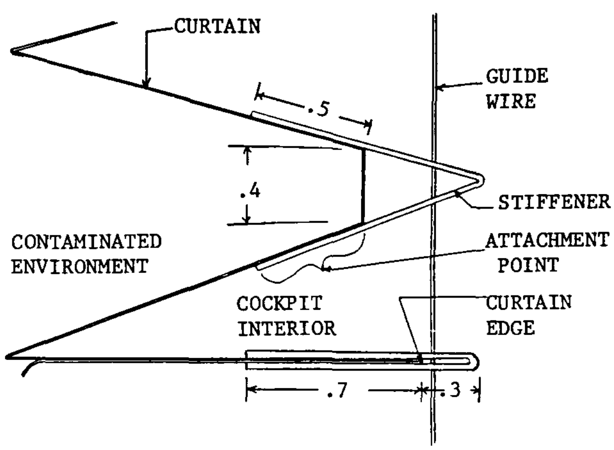

Figure 4. CROSS CUT VIEW OF CURTAIN
(Dimensions are in inches)

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The STORAGE TRAY (see figure 5) could be formed of a single molded plastic tray which would be impermeable to chemical agents and weigh about 4 pounds. The storage tray would be inserted into a recessed groove in the canopy sill. The width of the bin would be 4" at the front of the sill and 2" at the back and would vary linearly from 4" to 2" along the sides. The depth of the bin could be 3.5" and would depend on curtain thickness. The seal insert would attach the storage tray to the bottom of the recessed groove in the canopy sill. The small indentation at the bottom of the storage tray is the guide wire channel and along its length are sockets which would hold the guide wire rollers in place. To the right of the guide wire track is the curtain attachment strip.

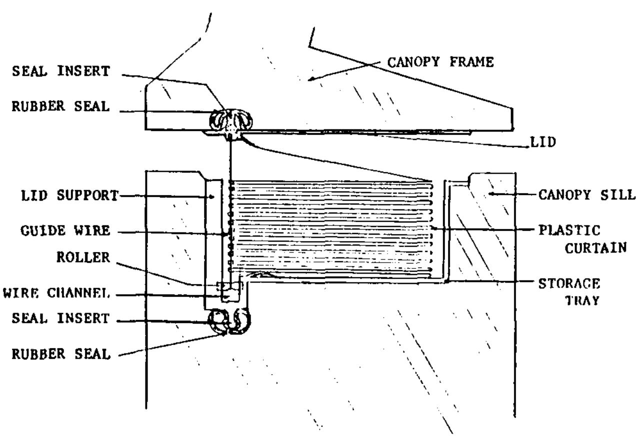

Figure 5. CROSS SECTION OF CAPS

The STORAGE TRAY LID could be formed of a single piece of 1/16" thick hard molded plastic, which would also be impermeable to chemical agents and would weigh about 1 pound. When the CAPS is not in use, the primary purpose of this piece is to serve as a lid to the curtain storage tray and is secured to the storage tray by the tension in the guide wires. When CAPS is in use, the storage tray lid serves as the means by which the curtain and guide wires are connected to the canopy.

The INFLATABLE RUBBER SEALS could be made of a butyl rubber and would weigh approximately 2 pounds. The seals could be rounded on their outer surface and have two hollow channels, one on each side. When the channels are pressurized by a CO2 cartridge which is attached to each seal, the seal squeezes the seal insert. The beaded shape at the end of the seal insert prevents it from pulling loose. One seal would be placed in the storage tray recess of the canopy sill and the other would run around the canopy edges.

The RETRACTION SYSTEM would consists of guide wires, guide wire rollers, and a tensioning mechanism. The guide wires could be made of nylon and would be capable of withstanding 50 pounds of tensile force. Two guide wires would be located on each side of the curtain. The wires would be anchored to the lid on one end, pass through grommets on the stiffeners, go around the rollers, pass through the wire channel, and attach at their other end to the tensioning system. The purpose of the guide wires is to ensure that the curtain folds properly into the storage tray. They would also support the curtain and prevent excessive billowing due to over-pressure or wind. The tension system could consist of either an electric motor and take up reels or some type of spring tension system. The total weight of the tension system is estimated to be 10 pounds.

OPERATION

While the aircraft is in a safe environment, the inflatable rubber seal in the canopy frame would be left deflated. This would leave the storage tray lid attached to the storage tray, allowing normal ingress and egress. Once the aircraft has been exposed to contaminants the inflatable rubber seal inside the canopy frame would be pressurized by its CO2 cartridge before the canopy is raised. The CO2 cartridge can be activated from either the inside or the outside of the cockpit. The storage tray lid is now firmly attached to the canopy frame. As the canopy is raised the lid pulls the plastic curtain out of the storage tray and the curtain stiffeners slide up the guide wires. As the canopy is lowered the guide wires insure that the curtain folds into the storage tray properly. The seals would remain pressurized until there is time to decontaminate the aircraft and replace the CAPS.

CONCLUSION

The CAPS would be a light weight (approximately 35 pounds) device which would prevent contaminants from entering the cockpit. The CAPS has the advantage of remaining passive until CB agents are detected, when it can be activated by the push of a button. CAPS can be removed and replaced quickly and easily when the aircraft has been decontaminated. CAPS makes use of a double zipper mechanism which, when combined with an impermeable oversuit, allows the pilot to transfer safely from a protective shelter to the cockpit. This means the pilot could transfer to his aircraft without ever being exposed to the CB environment which would defeat the first purpose of a chemical attack. The CAPS would allow the pilot to maintain the same performance level he had before the airfield was contaminated, defeating the second purpose of a chemical attack.

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