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C-130 REAR VISION DEVICE (BUBBLE)

by

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In the late 1970's and early 1980's, Military Airlift Command (MAC) participation in Red Flag, Maple Flag, and other exercises provided strong evidence that airlift aircraft needed a rear vision capability for early warning and defense against air-to-air attacks. This may not be new information to many tacticians, but fresh thinking on this old idea marked a turning point for MAC.

The USAF Airlift Center (ALCENT) developed and tested three devices for providing rearward vision. The first device was a standard HC-130 observation door as used in search and rescue operations. The second device was a 180 degree field-of-view (FOV) bubble mounted on the cockpit overhead escape hatch. The third device was similar to the second, but it provided a 360-degree FOV.

The test was titled MAC Project 15-48-81. The three devices were tested at various exercises and in special sorties against fighters from Langley AFB, Virginia. The test director also consulted members of 47 Squadron, RAF Lyneham (C-130), to benefit from their experiences with observation cupolas. The test findings, published in August 1983, confirmed that the 360-degree FOV bubble proved to be the best of the three devices for warning against air-to-air attack and for observing the attacking aircraft during evasive maneuvers. 25 * Cupolas, * Vision, * Jet transport aircraft

In 1987, the Commander in Chief, Military Airlift Command (CINCMAC) elected to procure and deploy bubbles with all MAC C-130 units to include the Air Force Reserve and the Air National Guard. Each C-130 squadron was slated to obtain three bubbles. Since that decision, about one third of the required devices have been fielded.

A great deal of experience has now been gained through bubble operations. That experience can be conveniently divided into three parts: equipment, training, and tactics. The remainder of this paper will discuss those three topics and the future of the rear vision device program.

* Rear vision devices, C-130 aircraft.

EQUIPMENT

The C-130 bubble, shown in figure one, is manufactured by the plastics shop of the 438th Military Airlift Wing at McGuire AFB, New Jersey. The plastic cupola itself is made from heated and free-formed plexiglass. The rest of the hardware is made in a jig created from a surplus C-130 overhead escape hatch ring.

The bubble is fitted with a ring shaped plenum for defog air and ventilation. Once the bubble is mounted in the aircraft, the defog ring may be connected to an air conditioning duct by a short hose.

Experience indicates that the bubble works best with a few pieces of support equipment. The observer needs some protection in the form of a helmet, body restraint, and a good handhold. The helmet is standard crew issue, but the matter of a handhold and restraint is pretty much left up to individual observers. Some observers report using an ordinary cargo tiedown strap to build a sort of web. Others use a restraining harness which is standard aircraft equipment. Project 15-48-81 suggested adding a handhold to the front face of aircraft station 245, but to date, this has not been done.

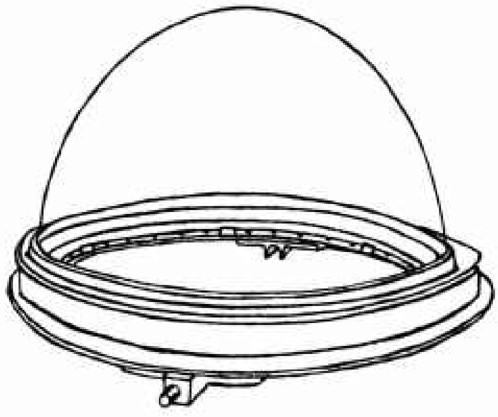

FIGURE 1
C-130 REAR VISION
DEVICE

Aircrew coordination is greatly facilitated when the observer can monitor the radios. The instructor intercom panel or a Y cord from the navigator's intercom is preferred for the observer's headset connection. If an intercom panel is added for ready access by the observer--so much the better. Stretching an intercom cord from the cargo deck is not desirable since most loadmaster intercom panels do not allow radio monitoring. There have been a couple of intercom lash-ups devised to allow the loadmaster (the most likely observer) to monitor all the radios and not just the intercom; however, these special intercom hookups are all local techniques and not in widespread use.

Finally, if the observer is to spend any appreciable time in the bubble, it must be distortion free. Bubbles with visual defects have proven to be annoying and fatiguing. A pair of sunglasses or a dark visor is also a necessity.

Until recently, ventilation has been a problem. The observer gets quite warm while sitting in the bubble, and a connection to the aircraft air conditioner has proven inadequate for good air flow into the defog ring. One enterprising squadron recently solved this annoying problem. Instead of connecting the defog ring to an air conditioner outlet, they connect it to the flare port or sextant port with a length of standard oxygen hose terminating in a short length of plastic pipe as shown in figure two. The pipe is inserted into the slip-stream. The end of the pipe is cut at an angle and turned so that ram air is fed to the bubble defog ring. The angled pipe end can also be faced aft to ventilate the bubble by drawing air out. The low pressure of the aircraft air conditioning system is no longer a problem.

TRAINING

The key to successful bubble operation is a trained observer; however, the training is not altogether simple. Royal Air Force and USAF experience both indicate that a single training sortie is insufficient for a person to acquire the necessary skills to be an effective observer. Additionally, periodic practice against aggressor aircraft is needed to maintain the various skills.

Initial training should include scanning techniques, aircraft type recognition, and estimating range to aggressor aircraft. The observer must recognize threat and nonthreat situations, and understand evasive maneuvers useful during various phases of an air-to-air attack.

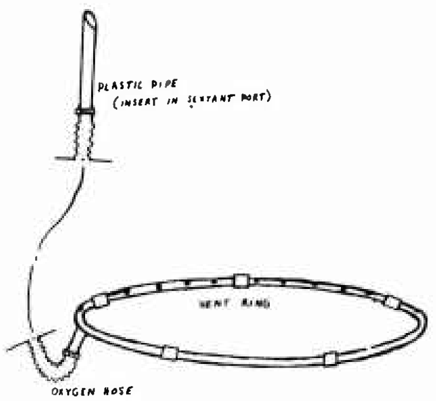

FIGURE 2

BUBBLE DEFOG SYSTEM

Observer training must emphasize crew coordination. The observer learns to pass visually acquired information to the other crewmembers using words. Concise interphone calls such as "Pilot, observer, break left, bandit at 7 o'clock." must be practiced. Furthermore, the observer must learn to time the break maneuver precisely. Calling for a break maneuver too early is a universal observer tendency, but this incorrect impulse can be corrected with training.

If a threatening aircraft flies in the dead 6 o'clock position, it will be blocked from the observer's view by the vertical stabilizer and, on some airplanes, the station keeping equipment radome. In these instances, the observer learns to request a shallow skid from the pilot to re-establish visual contact.

Note that all this scanning, estimating, and advising is done while facing aft during low altitude flight. To many observers, this is initially disorienting and confusing. The observer must overcome the discomfort caused by turbulence, heat, and the unusual viewing direction. One observer technique used to overcome the backwards directions is to write the clock positions and also the words "left" and "right" at the appropriate locations on the plexiglass as shown in figure three.

TACTICS

Specific C-130 tactics are published in a classified chapter of MAC Regulation 55-130. This paper will not discuss those specific tactics; however, there are unclassified sources that offer insight into use of the bubble.

In his book, Airlift Operations In A Hostile Environment, Lt Col John Skorupa identifies a chain of six steps that an attacking aircraft must accomplish in order to shoot down another aircraft. Those six steps are detect, acquire, track, identify, intercept, and attack. If any link in the chain is broken, the attack fails. An airlifter with a bubble and trained observer can increase the difficulty of an attacker's task at four steps in the chain, namely detection, acquisition, interception, and the actual attack--especially if it is a gun attack.

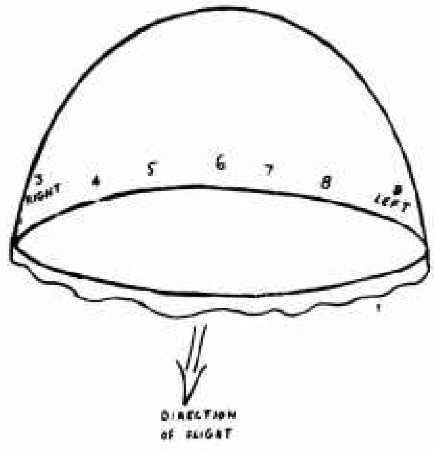

FIGURE 3
COMMONLY USED
MARKINGS

The observer should concentrate his scan on the rear hemisphere; i.e., from 3 o'clock to 9 o'clock. If the observer detects a bogey (unknown aircraft) the pilot can maneuver to decrease the chance of the airlifter being detected. This may mean terrain masking or, perhaps, keeping in the bogey's six o'clock position.

If the bogey detects the airlifter, the acquisition task can still be made more difficult by relying on camouflage at low level and by terrain masking. The observer-pilot team must work together to complicate the fighter pilot's acquisition task.

If the observer notes the bogey maneuvering for intercept, timely evasive action can seriously delay the engagement.

It is useful to point out a seemingly obvious bit of information here. It is not likely that a fighter will waste a missile on an unarmed transport if a more economical gun pass will shoot it down. Armed with that knowledge, a C-130 equipped with a bubble has a distinct advantage over a plane not so equipped. The observer-pilot team can maneuver to foil a rear approach by the fighter and significantly complicate a gun attack. If friendly fighter planes are close by, just such a simple delay might prevent an attack. The bogey must concentrate on achieving a stern firing solution against the transport plane while worrying about his own safety.

If a gun pass is unavoidable, the observer-pilot team can still make a shoot down very difficult. Again, I borrow information from Skorupa.

> "A fighter closing on a transport at low altitude and slow airspeed will have to sacrifice much of its potential energy and a portion of its kinetic energy, particularly if it intends to make a gun pass. To use its guns, it must drop to near the altitude of the target and if it does not slow down, the time available to make a gun pass is so short that its chances of success are small. This is so because an air-to-air cannon is only effective at ranges of less than 3,000 to 4,000 feet. Inside 1,000 feet, the fighter employing a cannon runs the risk of shooting itself down as it flies through shrapnel.
>
> Therefore, the window of opportunity is open only as long as it takes the fighter to traverse the range from 4,000 feet to 1,000 feet. A 500-knot fighter overtaking a 250-knot transport would enter and exit the window of opportunity in about 7 seconds. Against a nonmaneuvering target at moderate altitudes, this time would be sufficient for even the least proficient of

fighter pilots, but against a maneuvering target at low altitudes, the available time is much less."

Skorupa goes on to make a fairly convincing argument that a maneuvering transport could not only reduce the window of opportunity to about 4 seconds, but that the fighter will probably not risk multiple gun passes.

> "For example, consider a fighter making a gun pass on a transport that is flying at 300-foot altitude and 250 knots. If the fighter's cannon is inclined above centerline 2 degrees **(author's note: according to Skorupa, this is a common boresight angle for several air-to-air fighters)** and the fighter requires 3 degrees angle of attack to maintain level flight, its cannon will be pointed 5 degrees above horizontal. Therefore, to aim the cannon at a coaltitude target, the fighter must enter a 5 degree dive. (If the fighter starts the gun pass at a higher altitude than 300 feet, it must increase the dive angle by 1 degree for every 69.8 feet above 300 feet. Since a higher dive angle also increases the sink rate of the fighter, little is to be gained so close to the ground). Assuming the fighter begins the maneuver at 500 knots, it has about 4 seconds before it hits the ground."

To reiterate, the observer-pilot team can complicate the detection, acquisition, interception, and attack links in the chain of events required to achieve a shoot down. The added complication may be enough to discourage the attacker, or, if the attack ensues, evasive maneuvers could force a wide enough overshoot to force the fighter to begin the chain all over again. Meanwhile, the transport may be able to use camouflage and terrain masking to get away.

FUTURE PLANS

In there tight budgetary times is always dangerous to make predictions about what equipment may be developed or deployed. Nonetheless, there are a couple of initiatives being worked by the acquisition community.

First, although it was recommended by MAC Project 15-48-81, the bubble has never been fully tested or certified to be pressurized. This is an obvious drawback as long duration "high-low-high" flight profiles can't safely use the bubble. Installing a bubble in flight is dangerous. Those who have attempted in-flight installation report that the low pressure region above the cockpit draws the bubble rapidly into the escape hatch hole with enough force to sever a finger. Efforts are under way to develop and test a bubble using thicker plexiglass or other materials that would safely withstand multiple pressurization cycles at cold temperatures.

Second, a bubble has been designed and partly tested for use on the C-141. This bubble design mounts in the aft side escape hatch and affords a good view of one side and directly behind the aircraft. It would take two such bubbles to protect the C-141.

CONCLUSION

The C-130 bubble is widely, but not universally accepted. There remain people in the airlift community who are skeptical as to the value of the bubble. Aircrews that have used the bubble at Red Flag, Maple Flag, and other exercises almost all favor getting more and improved bubbles. There is also keen interest among those who do not employ C-130s for airlift, such as airborne command posts and tankers.

As stated earlier, the bubble development is a revisit of an old idea. Many lessons, once common knowledge among aviators, are surely being relearned.