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PROTECTING THE AG PILOT

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So long as certain insects have a greater capacity per unit time than do humans to create population explosions, we'll find ourselves in competition with these tiny rapacious fellow earthlings for available agricultural products.

Additionally, man will wage widespread winged warfare against specific chitinous culprits, so long as aerial applicator techniques remain superior in efficiency and effectiveness to ground applicator techniques.

Man's weapons in this warfare are chemicals, the most potent falling within the chlorinated hydrocarbon and organic phosphate pesticide categories.

Sometimes, just as is the case of conventional warfare, we find that an enthusiastic warrior wounds himself rather than his foe. Let us look at a case in point.

Near Paris, Texas, in August of 1963, a very experienced aerial applicator pilot crashed while at work. A thorough investigation revealed that the pilot was not feeling well on the morning of the flight, and had a headache. Four days earlier, he had accidentally spilled parathion on his clothes while pouring the concentrate from a 55 gallon drum. He neither changed clothes nor washed the skin where it was touched by the chemicals, but continued to work the rest of the day (although a fellow worker encouraged him to take these precautionary steps).

In the next two to three days after getting the chemical on his skin, the pilot, who usually was good-natured and outgoing, became irritable and introverted. It was under these circumstances that he undertook flight on the fourth day. The accident occurred when the plane stalled out of a turn following completion of five swath runs.

"Impaired physical efficiency of the pilot caused by exposure to toxic material" is listed in the Probable Cause ledger for this accident by the Civil Aeronautics Board (Docket 2–2515).

What is the magnitude of the role played by the impairment of pilot proficiency under the circumstances of aerial applicator activities? We note that more than half of the aerial applicator operations last year were concerned with pesticides. Also, from the best figures we can glean concerning total active aerial applicator aircraft in the world, it appears that there are 16,000 airplanes involved (6,000 are estimated to be in Russia and its allied countries, with a similar number in the U.S.).

It is clear, then, that a little carelessness across-the-board, in the handling of the chemicals mentioned above, can have a general adverse impact upon the safety statistics. All of us would prefer to avoid a bad safety record.

Let's see what the accident statistics in aerial applicator operations show us. A detailed review of 113 aerial applicator accidents which were pulled in no particular sequence from our 1963 files containing reports of 304 accidents (of which 24 involved fatalities) has been accomplished.

Each of these 113 accidents has been placed in one of three categories, depending upon where the major responsibility was felt to rest with respect to arranging the circumstances leading to the respective accident.

Major Responsibility for Accident	*Number*	*Percent*
Pilot Factors	75	66%
Aircraft	33	29
Outside Force	5	5
	113	100%

We recognize that for various reasons certain contributory factors in given accidents may never come to light. In general, though, it appears that the investigators accomplished a creditable job, especially in the cases where the pilots were able to give detailed accounts. Incidentally, one gets the distinct impression that aerial applicator pilots, as a group quite seasoned, are very cooperative and candid in reconstructing the events surrounding their accidents. Certainly they are as concerned as anyone in preventing recurrences.

Pilot Factors

1. Stalls out of Turn:

Nine accidents involved stalls out of turns. Most of the pilots who fell victim to this pitfall were experienced, with several thousand hours flight time, much of which was in aerial application.

Attempting to hurry the turn to start another swath appears to be a significant factor here, complicated by fatigue in several cases (producing sloppy flying).

2. Collisions with Objects:

In 22 cases, wires, trees, and other objects were struck. Interviews with surviving pilots indicate that in a number of cases fatigue played a key role in the impairment of their flight proficiency.

In one case, occuring in June of 1963 near Olathe, Colorado, where the pilot flew into a tree during a pull-up, the pilot had been flagging earlier and by accident was exposed to drifting parathion. He experienced certain symptoms, in cluding headaches, and was ill enough to require atropine therapy. This accident points up the fact that these chemicals can adversely affect the proficiency of a pilot, a circumstance which can become clearly apparent under the close-quarters flight conditions of aerial application.

The combined effects on pilot proficiency of fatigue and certain potent chemicals, can be quite detrimental to flight proficiency. Interviews appear to indicate that these two factors, alone or together, continued to affect the aerial applicator safety record during 1963.

3. Exercise of Judgment in Take-off and Landing Areas:

Nine pilots in the group failed to become airborne, or ran off of their landing area, because their selected ground sites were marginal or inadequate under the circumstances of the attempted flights. In the cases of the take-off accidents, the gross-weights were usually too high for the field lengths, ground texture, or air density. Rising air temperature during the day was a factor in several cases. In landing accidents, the available width or length of the terrain was too limited in several cases (occasionally complicated by cross-winds or tail-winds). Once again, in tight operational situations, where peak pilot proficiency is required, fatigue, accidental toxic effects, and certain other factors, seem to make the difference between a successful ground/air or air/ground transition and an unsuccessful transition. Additionally, these factors adversely affect pilot judgment in these matters.

4. Proficiency:

Four accidents were defintely attributable to a lack of proficiency in flight techniques.

Most aerial applicators appear to have obtained between 2,000 and 6,000 flight hours, and to have learned through various combinations of training and experience how to perform adequately their low level maneuvers.

Some, however, especially the low-time pilots and the pilots who have perpetuated bad flight habits, represent "accidents waiting to happen."

Mr. Joe Fallin of the FAA Academy at Oklahoma City, has pointed out that a large number of pilots are mistaught concerning the proper means of accomplishing a given ground track in turns under wind-drift conditions (a key maneuver in aerial application). Accidents continue to occur where the plane drifts into objects while on a down-wind turn.

The last page of this paper presents this example which we at CARI have administered to many pilot groups consisting of all categories of pilots.

Ninety percent of the pilots in all groups except professional pylon race and stunt pilots place the X at the 6:00 point on the circle. This includes most instructors. The result is that many pilots are deliberately waiting to place their craft in its steepest banked turn until the 6:00 point is reached. This means that they are drifted away from the pylon (the pylon may be real or imaginary) prior to reaching the 6:00 point (due to the fast ground speed at the 9:00 downwind point), necessitating an even steeper bank to get back on their intended ground track.

Actually, the steepest bank should occur at the 9:00 point, and as the plane swings around on its proper ground track, wind correction angle is fed in to maintain the track. The 6:00 point should encompass the maximum wind correction angle. An identical WCA and bank is at 12:00. There is no wind correction at 9:00 or 3:00.

We call this "making the mental image match the maneuver", and find that in many cases the instructors will actually perform the maneuver correctly (steepest bank at 9:00), but explain it to the student incorrectly (steepest bank at 6:00). The result is that the student puts forth his best effort to do the maneuver according to the explanation. Either the individual never masters the maneuver and gets ultimately into trouble, or he gradually unconsciously discovers the proper means of accomplishing the maneuver.

The situation is analogous to the old-time teaching by many that the rudder was the control that turned the plane (although in practice most of those teaching this performed coordinated turns, zealous students would at times be found ruddering the planes around—especially under tight circumstances).

The solution rests in good initial flight training, plus periodic proficiency training. Even seasoned old hands should cross-check each other from time to time.

5. Other

The remaining pilot factors were concerned with such things as allowing the plane to run out of fuel through carelessness, attempting to take-off heavily loaded with the carburetor heat on resulting in inadequate take-off power for the length of the strip, carelessness in taxiing resulting in collision with some object, propping an unattended improperly tied-down craft (which on starting runs amuck), attempting take-off under adverse load and field conditions with the propeller in high pitch, attempting take-off's and landings in the dark, attempting exuberant low level aerobatic maneuver following completion of spray job, attempting "spray formation" flying and becoming caught in the vortex of a colleague's craft, and attempting to fly too slow.

In many of these cases the pilots stated that they had been in a rush and simply made mistakes. The National Pilots Association slogan "If you are in a hurry you are in danger", continues to be validated.

In some cases, preoccupation with financial worries was felt to have produced forgetfulness.

In certain instances, a certain amount of celebration the night before the day of flight, resulted in fatigue, complicated by hangover effects, certainly an adverse circumstances to safe flight. An aerial applicator pilot at work must be quick and alert, and should avoid celebrations on the eve of flights. In this respect, the occupation of these pilots differs from desk occupations. The desk worker can physically appear at work after a night of partying (although he may be very uncomfortable internally) and somehow get through the day. The ag pilot can't coast through the day—he's got to deliver—with a sharp eye and with sharp reflexes. It will pay many times over not to fly if one doesn't feel well—regardless of the reason for the indisposition.

We should note here that several instances of collisions between two taxiing aircraft, or landing aircraft, or one landing and one departing aircraft, occurred during 1963. Vigilance during these operations is of the utmost importance, especially in planes with poor visibility features.

Interestingly, aerial applicator activities encompass the spread of many kinds of chemicals and objects, including, along the Gulf Coast, irradiated screw worm larvae. This work is vital to the Gulf Coast economy. Some cases of susceptibility of certain pilots to become allergic to certain dusts generated by these insects has come to our attention. Dr Robert Dille and I of CARI, together with Dr. Harry Gibbons of the Southwest Region, Dr. Peter Siegel of the Aeromedical Certification Division, and certain Aviation Medical Examiners, have been studying certain of these cases which have taken on the clinical picture of acute asthmatic attacks (some occurring during flight necessitating a forced landing). We are seeking means of testing for individual sensitivity to screw worm fly dust and of preventing in-flight exposure to this substance.

The aerial applicators' world is diverse, complex, and challenging for all concerned.

Aircraft:

Due to the hard-hitting, rapid-paced, nature of aerial applicator work, and to the fact that certain flights must be made on very short notice, we note that at times corners are prone to be cut which can very likely result in accidents.

Not infrequently marauding insects determine the moment in time of undertaking to spray in what might be thought of as defensive warfare. This is the worst type of situation, since such short notice for preparation prevails, and so many farmers want immediate action within a short span of time.

Anticipation and a continued state of preparedness are wise characteristics of the aerial applicator operator. The accident factors attributable to the aircraft appear as follows.

Aerial applicator aircraft are, in general, designed especially for maneuverability and load carrying capabilities. The new generation agricultural aircraft, with their crashworthy structure, their considerably delethalized cockpits, their shoulder harnesses, and their slow-flight characteristics, are a tribute to the engineering accomplishments of today's manufacturers. These aircraft are paving the way for similar safety achievements in the future light aircraft not intended for aerial applicator use. The record shows that these new generation aircraft are enabling the pilots to survive (frequently with no or only minor injuries) some severe impacts which would surely be fatal in non-aerial applicator aircraft.

1. Engine or Propeller Failure:

Twenty eight cases of engine failure necessitated forced landings. This group does not include improper fuel management which we have classified under "pilot factors".

The successful accomplishment of many of the forced landings after low altitude engine failures is a tribute to the skill of the pilots in general engaged in aerial applicator work.

Operator "human factor" maintenance errors included such items as an improperly installed propeller which lost a blade in Arizona and the failure to tighten certain spark plugs resulting in a power loss in South Carolina. Other causes of power failure included several cases of water contamination of the fuel (the fuel was improperly stored by the operator and the pilots neglected to drain the sumps), some instances of protracted general neglect of the engines, an instance of maintenance inattention to a deteriorating fuel selector valve, and improper maintenance of failing magnetos.

Four cases of broken crank shafts, three cases of "swallowed" exhaust valves, and several instances of bearing failure or gear fracture (especially in helicopters), point up the demanding nature of aerial applicator activities upon the machinery.

Other failures included an instance of a stuck carburetor float and some instances of detonation and backfiring with engine stoppage. Sometimes the real reason for engine failure remains obscure.

2. Airframe Failure:

In an interesting accident in California, the main wing spar failed during flight and the wings folded over the fuselage. The impact was quite hard but the pilot survived. Many modifications had been made to the craft (within the then approved techniques) including a marked increase in horsepower and hopper capacity, and apparently under the rugged conditions of aerial applicator work, the spar reached its limits.

Two instances of horizontal stabilizer failure (both survived) occurred, the failures apparently assisted by the corrosive nature of certain chemicals.

3. Chemical Ducting Failure:

In July of 1963 near Caldwell, Idaho, a connector hose came loose shortly after take-off and sprayed a mixture containing parathion in the pilot's face. His body become saturated and he lost control of the plane which crashed. His hard hat made a deep dent in the instrument panel. He suffered no fractures and was fortunate in crashing near a water canal. He immediately jumped in, disrobed, and washed off the chemicals. His quick action resulted in no serious poison effects.

Sometimes the ducting failure occurs after an accident, and in September of 1963 near Lambert, Mississippi, a pilot was splashed with a defoliant during and after an accident. The chemical effects of the defoliant almost resulted in his death, for his blood pressure fell to 50 mm mercury and it took six hours treatment in a hospital to get him stabilized and on his way to recovery.

Outside Force:

Under this heading we place those things which were not reasonably under the pilots control, the operators control, or due to the aircraft.

In July of 1963, a sudden high velocity wind caught an aircraft on landing and caused an accident. At least two, and possibly more, whirlwinds caused accidents. A sudden downdraft caused a heavily loaded plane on take-off to have an accident. In September near Sunflower, Mississippi, a cow walked in front of an aircraft attempting to take off and caused an accident.

In previous years, children have thrown fruit in the path of aerial applicator aircraft causing accidents, and hard-shelled beetles have broken the goggles of pilots in two cases necessitating forced landings.

General Statement:

Aerial applicator activities are a safe or as dangerous from the aeromedical standpoint as those engaged in them care to determine.

It is fortunate that most of these activities take place in the spring, summer and early fall months, and are conducted in relatively calm winds. Almost never does an aerial applicator pilot get caught in instrument flight conditions.

Some aerial applicators, for example the U.S. Forest Service's fire-fighters, must undertake sudden activities under very adverse circumstances. Fortunately, their chemicals (for example, borate compounds) are relatively nontoxic. Recently, a CARI team of scientists has worked with the U.S. Forest Service pilots in Montana, in an effort to pin-point the specific effects of fatigue itself on flight proficiency. Details will be reported later, but one observation is the increased roughness on the controls and sloppiness of maneuvers which accompanies the development of marked fatigue.

For each accident which occured in 1963, there were probably more than a dozen near-accidents, which by the merest margin escaped becoming statistics. Herein lies our fertile ground for safety improvement. Prevent the recurrence of near-accidents! When one has a close call due to pilot factors—hold off flying until the factor is remedied. If rest is the problem, then get some rest.

If an aircraft is developing a mechanical deficiency hazardous to flight—stop—and rectify the deficiency. Actually, an operator should reward an alert pilot who calls a potential defect to the attention of the mechanic. The psychology of this approach will benefit all concerned in the long run.

The operator and the pilot (and if possible the ground personnel) should know the nature of the specific chemicals they use, the preventive techniques in working with the chemicals (gloves, respirator, etc.) the symptoms produced by body absorption, and the emergency treatment in case of contamination.

For example, poisoning by the organic phosphates produces a tendency to sweat more than one should, an increased flow of saliva, an upset stomach with nauseous feelings and vomiting, increased tear formation in the eyes, intestinal cramps, diarrhea, difficulty in breathing (a later stage of the poisoning), difficulty in focusing the eyes on objects and seeing clearly (especially in the distance), irritability, headaches, muscle tremors and a generally bad feeling.

One may experience any or all of the above symptoms, and death can follow. Atropine can be given for emergency, and later, symptomatic treatment, and a "new drug" (actually known and used in other countries, notably Japan, for many years), named Protopam, marketed by Campbell Pharmaceuticals, 121 East 24th Street, New York, New York, can be used as primary therapy. A doctor should administer the atropine and Protopam treatments.

Some pilots have felt that they have built up a resistance to the organic phosphates (parathion, etc.). Possibly, a slight resistance can be developed, but no real resistance can occur.

If one feels the symptoms of organic phosphate poisoning developing, one should knock off for several days and clear his system of the compond. A low blood cholinesterase is clear evidence that the body contains too much of the organic phosphates, since these inactivate the blood cholinesterase (as well as affect other parts of the body) and, thus, tell us of their presence.

Each operator should touch base with a nearby doctor (possibly an Aviation Medical Examiner) who can be aware ahead of time that he may be called upon to treat a possible poison case. This is good and responsible planning.

Among the other chemicals are the chlorinated hydrocarbons (which can cause nervous tensions, anxieties, nausea, dizziness, headache, giddiness and muscular tremors), and the dinitrophenolic compounds (cause sweating, thirst, euphoria, and later fatigue—note: if alcohol is consumed the combined effects can speed the onset of symptoms of blushing, a feeling of heat, rapid breathing and a dropping blood pressure).

In all cases of skin contamination, the first principle of treatment is removal of the chemicals with water. Plenty of soap should be used, and denatured alcohol should be swabbed on an rubbed off of the area. Keep denatured alcohol (or isopropyl alcohol) handy. Use rubber gloves, boots, and aprons when mixing and loading chemicals. Wear a respirator when dealing with the more toxic chemicals.

It appears that aerial application is here to stay. Let's strive through planning, preparation, preventive medicine and proficiency, to achieve the top safety record commensurate with our potentialities and wherewithal.

Note to Physicians and First-Aid Personnel

As a final note, we can observe that a number of the victims of aerial applicator accidents succumb to what is termed "shock". Shock is a a condition which can develop some hours after an individual has survived the initial accident. The initial accident may have involved any one of the following: the absorption by the body of toxic substances, the crushing of muscles or organs by impact forces, internal or external hemorrhage, or severe burns secondary to fire.

Following conventional approaches to accident victim therapy, certain individuals appear to respond, but, after a period of a few hours, begin to manifest the following symptoms of the shock syndrome:

1. Pallor of the Skin (this is due to collapse of the veins);

2. Tachycardia (fast heart rate is due to low pulse pressure—the margin between systolic and diastolic blood pressure—and represents an attempt to move more blood through the circulation per unit time);

3. Cold Skin (this is due to the slow filling of the capillary bed due to sympathetic nervous system activity);

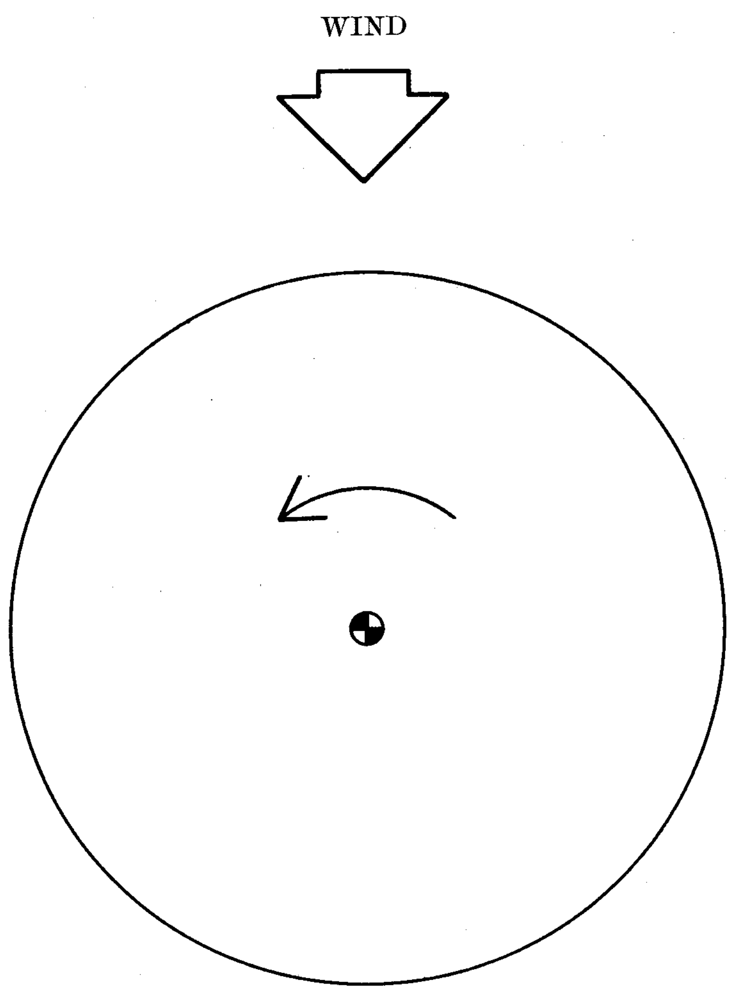
4. Sweating Skin (excessive sweating results from increased activity in the sympathetic nervous system);

5. Oliguria (the low blood pressure results in less urine formation).

There is some strong indication at present that the treatment of shock with noradrenalin as is now generally accomplished, is perhaps unwise. This is because the noradrenalin has the capability of constructing the venous side of the capillary bed, as well as the arteriolar side, producing still greater losses of fluid into the tissues from the blood.

The Civil Aeromedical Research Institute and the University of Oklahoma School of Medicine, in a cooperative FAA-University undertaking, have just completed a five day "Shock Seminar" (November 16–21), where forty scientists conducted experiments at CARI on the specific therapy of shock. Each scientist was able to observe the other's technique and many points were resolved which otherwise would have remained disputed. Some of the most noted physicians, surgeons, physiologists and pharmacologists in the U.S. and Canada participated in this experimental program which is aimed at enabling physicians ultimately to provide more effective treatment to injured survivors of aerial applicator accidents (and other types of accidents).

The results of the symposium will be made universally available to physicians. The utility of using adrenergic blocking agents (opposite in effect to noradrenalin) together with blood, plasma, dextran, or other plasma expanders, will be reported. The new drug, dibenzyline, is a blocking agent specifically studied. Its promising beneficial effects are that it increases the total blood flow to the organs where the blood is needed, it shifts fluid from the pulmonary circulation (which otherwise is in danger of being overloaded with water which causes lung congestion) to the systemic circulation, it results in the reestablishment of urine formation, and it effects a sensitive blood pressure response which gives the physician a good index of the adequacy of the circulating blood volume. Noradrenalin masks this latter effect, and the physician is often hard-pressed to know whether his intravenous fluid infusions are too little, enough, or too much. CARI personnel can provide further medical information on these new advances in improving accident survival. The full report is available: *J. Okla State Medical Assoc.* 59:8, August 1966, pp. 407–485.



To fly a ground track which is a perfect circle around the pylon, remaining at all times the same distance from the pylon, the angle of bank will have to be varied when there is a wind.

Place an "X" on the above circle where you believe the steepest angle of bank should occur.