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USAF OEHL Consultative Report

ENVIRONMENTAL EFFECTS OF CHAFF

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I. Definition of Problem

A. This report is in response to a request from HQ USAFE/SGPA concerning the environmental impact of the operational use of chaff. The primary areas of interest were:

1. Effects of chaff ingestion on jet aircraft.

2. Environmental impact studies to include wildlife.

3. Monetary claims related to chaff incidents.

B. There is not a great deal of information available on any of these subject areas. The following is a summary of the information that has been located to date.

II. Discussion

A. Definition of Chaff. The term chaff as used in this context refers to aluminum coated fiberglass strips or cylinders. The optimum size and shape of the elements vary with the wavelength of the radar signal it is designed to interfere with. The size and relative configuration of each element should not significantly affect the environmental impact.

B. Chemical Composition. Most of the reference material that we have obtained originated with the U. S. Navy. Navy specifications typically require the use of type E glass monofilament coated with aluminum of 99.0% or greater purity. A secondary coating, generally stearic acid /($CH_3(CH_2)_{16}$ COOH)/, is applied to the chaff elements to aid in dispersal (2). According to the DoD specification for fiberglass, the chemical composition of type E fiberglass is:

Component	Percent by Weight
B_2O_3	5-10
CaO	16-25
Al_2O_3	12-16
SiO_2	52-56
MgO	0-5
$Na_2O + K_2O$	0-2
TiO_2	0-0.8
Fe_2O_3	0.05-0.04
F_2	0-1.0

C. Distribution of Chaff. Various techniques are utilized to distribute chaff. The eventual environmental impact is going to be a function of such things as the method of release, height of release, and wind patterns. Several studies referenced used calculated expected ground concentrations of chaff. But since there are so many variables, a realistic concentration cannot be calculated. In most of the biological studies, chaff exposure is many times greater than would be expected to occur during operational usage.

D. Effects on Land.

1. Human exposure. There is no documentation of adverse effects on humans from exposure to chaff. The only significant impact would be a nuisance exposure.

2. Animal exposure. Limited information is available. One study conducted by the Canadian Department of Agriculture (6) was with calves fed up to 0.25 ounces of aluminum coated fiberglass chaff every day for two weeks. At the end of the fourteen-day feeding period, no evidence of digestive disturbance or other clinical symptoms were noted. Calves fed chaff appeared to achieve the same weight gain at the same rate as control calves which were not fed chaff. Blood samples taken at the beginning and end of the test showed no deviation from normal. Post-mortem examination of the calves showed no lesions of pathological significance attributable to the chaff, and a detailed histological examination revealed no abnormalities throughout the entire digestive system or in the major organs, including the brain. Some small fragments of chaff were found trapped between the keratinized villi of the reticulum, but these fragments did not appear to provoke any cellular reaction. Since no adverse effects on the calves were noted in the acute study, no long term exposures were conducted. One significant observation noted was that calves would reject chaff when it was scattered in their daily ration. They consumed it only when it was thoroughly mixed with their feed and sweetened with molasses. Due to the apparent unpalatability, it is unlikely that other animals (domestic or wild) would selectively feed on the chaff. A letter in our files from the Chairman of the Department of Dairy Husbandry at the University of Wisconsin, College of Agriculture, described a similar study using cattle and goats (5). In the Wisconsin study, animals avoided consuming intact chaff. In order to test the oral toxicity, it had to be ground and incorporated into their feed. Their conclusions were that chaff presented no hazard to the health of farm animals.

3. Effects on soil.

a. Aluminum is fairly widespread in the environment and is a major element in many primary and secondary soil minerals. It is directly involved in the cation exchange capacity of soil, specifically in the exchange acidity. The quantity of aluminum leached out of the chaff would have to be exceedingly high, much higher than could possibly result from the operational use of chaff to have any detectable effect on soil quality.

b. Stearic acid is biodegradable and is used as a carbon source for microorganisms in many laboratory experiments. Its presence would have no adverse effect on the environment.

4. Effects on plants. The function of aluminum in vegetation is rather uncertain, and there are differences of

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opinion as to its importance (1). It is a minor constituent of plant materials varying in concentration from 0.01 to 0.1%, depending on species and geographic distribution. There is no reason to anticipate that an elevated uptake of aluminum as a result of the operational use of chaff would have any adverse effect on plant life.

E. Effects on Aquatic Environment.

1. Studies performed in 1976 by Venezky (2) showed that after thirteen days there was no appreciable increase in the levels of Al, Cd, Cu, Fe, or Zn in Chesapeake Bay water spiked with chaff. In fact the only increase noted was in the low part per trillion range. Based on these findings, it is unlikely that there would be any significant impact on any body of water.

2. Effects on aquatic life. The U. S. Navy contracted a study on the effects of chaff on six different aquatic organisms: a benthic polychaete worm, Neris succine; various life stages of the American oyster, Crassostrea virginica; the blue mussel, Mytilus edulis; the blue crab, Callinectes sapidus; the filter feeding menhaden Brevoortia tyrannus; and the killifish, Fundulus heteroclitus. These species include different organisms of ecological and commercial significance. All of the organisms were exposed to much higher than anticipated environmental levels of chaff from normal operations with no significant mortality. The investigators concluded that the use of chaff as currently being performed by the U. S. Navy would have no environmental impact upon the Chesapeake Bay ecosystem where their operational tests were taking place. Considering the initial results, no additional toxicity testing was deemed necessary. The authors recommended that the chaff test program over Chesapeake Bay be allowed to continue. According to sources at the Naval Research Laboratory in Washington, D. C., the EPA approved the continued operational testing of chaff in the Chesapeake Bay area by the Navy.

F. Effects on Aircraft. The evaluation and interpretation of chaff data pertaining to operational uses of aircraft are not within the purview of this Laboratory. During our literature search for ecological data on chaff, we obtained a report entitled, "Chaff Ingestion Test Report" (4). The following abstract is taken from that report.

> "The purpose of the test was to determine the effects of the ingestion of countermeasures chaff on small gas turbine engines and other components of Army aircraft. The test was conducted in two phases. For phase I, the T63 and T53 engines were mounted on a Modular Engine Test System and using a specially configured dispenser, a controlled amount of chaff was fed directly into them. The engines were operated without filters to create worst-case conditions. For phase II, four target aircraft (OV-1C, AH-1G, UH-1H, and OH-58A) were placed abreast on a hard surfaced area. A controlled amount

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of chaff was dispensed from an airborne UH-1H helicopter above and upwind from the aircraft and the prop blast from an OV-1C was used to force the chaff into the target area where the aircraft were positioned. The findings from both phases of the test showed that chaff build-up within the engine is clearly visible during hotend inspections; aluminum chaff has a greater tendency than aluminum coated fiberglass chaff to enter and adhere to aircraft inlet screens, ducts, airframe compartments, and cabin areas; aluminum coated fiberglass chaff has a greater tendency to follow the airflow over the aircraft surfaces than aluminum chaff, both types of chaff have a tendency to cling to grease on all parts of the aircraft exposed to the airflow; engine instruments and performance give clear indications of problems as the chaff build-up reaches advanced stages; the T63 and T53 engines decrease in performance as the ingested chaff reaches the advanced stages of internal build-up; no adverse effects were noted on airframes, electronic equipment, or weapons systems; and solvents presently prescribed for cleaning gas turbine engines will not remove aluminum oxide build-up on engine components. Test conclusions were that those Army aircraft tested, as currently configured, can safely operate in a chaff environment of operational density as was approximated in the test; and following the continuous ingestion of large amounts of chaff, engines show a gradual degradation of performance."

G. Legal Implications. The Staff Veterinarians at the Laboratory provide opinions to the Air Force in claims against the Government that involve the health of animals. During the early 1960s there were several claims filed that alleged the loss of cows from the ingestion of chaff. It was a legal opinion of the Staff Veterinarians, based on their experience and the available literature, that in no case was the cause of death or illness attributable to chaff ingestion. There have not been any requests for this type of evaluation for well over ten years according to our files. Contact with the Claims and Tort Litigation Branch of the Judge Advocate General's Office (HQ USAF/JACC)

REFERENCES

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