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The Toxicity of a Mist Generated by the Aspiration of Pydraul

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by

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C O N F I D E N T I A L

The Toxicity of a Mist Generated by the Aspiration of Pydraul

Scope

The purpose of this work was to learn whether the replacement of Houghto-Safe 271 by another nonflammable liquid, Pydraul, in the catapult system of an aircraft carrier would give rise to a toxic hazard. The responses of animals to the saturated vapor of Pydraul and to the fog formed by dropping it upon the surface of a heated Inconel were described in a report (Project 49) dated March 11, 1953. The effects of Pydraul when maintained in contact with the skin of rabbits according to the 24-hour sleeve method of Draize, Woodard and Calvery were included in the early report.

Summary

1. Groups of animals, each consisting of 1 cat, 2 guinea pigs, 2 rabbits and 4 rats, survived throughout and after periods of 0.5, 1.0 or 3.25 hours of exposure to the mist of Pydraul in the concentration of 0.21 or 0.26 mg per liter, and when killed for examination, were found to have suffered no gross or microscopic damage to their tissues.

2. Fatalities, preceded by evidences of labored breathing, occurred among guinea pigs, following 2.0 or 4.0 hours of exposure to air bearing the mist of Pydraul in the concentration of 0.45 mg

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per liter. The guinea pigs that died had diffuse toxic lesions in their brain, liver and kidneys, but no alterations of the lungs.

Cats, rabbits and rats survived under the severe conditions which induced some fatalities among guinea pigs, and developed no signs of intoxication (there was an excess of salivation on the part of the cats). When these animals were killed for examination, the livers and kidneys of the cats and rabbits exhibited degenerative changes, but no visceral abnormalities were found in the rats.

Equipment and Experimental Methods

Aspiration of the Material at Room Temperature. The mist was generated by use of a modified atomizer, which was originally designed in the Army Chemical Center, Medical Laboratories. A photograph of the atomizer is shown in Figure 1. A stream of compressed air at a pressure of 24 to 29 pounds per square inch (Table 6) passed from the gauge of a compressor through a drying tower of silica gel before entering the atomizer containing the Pydraul.

The functional portion of the atomizer was composed of two parts each fabricated from stainless steel (Carpenter #303) tubing or rod. The center tubing (20 gauge), which was 10 inches in length and 0.25 inch in outside diameter, had a wall thickness of 0.036 inch. The lower end of this tubing was closed with a stainless steel plate. One inch above the lower end, 4 apertures, each 1/32" in diameter, were drilled horizontally through the tubing at

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points in its circumference which were situated at 90° from each other. A stainless steel collar (1 inch in length and 7/16" in outside diameter), which was fabricated from a rod, fitted over the lower portion of the tubing. The collar contained 4 tubes each 1/32" in diameter and located 90° apart; holes were drilled vertically along the length of the collar.

Because of the viscosity of the Pydraul it was necessary that the vertical and horizontal apertures be placed precisely opposite each other. Immersion of the apertures below the liquid level resulted in a more consistent mist of Pydraul than when the apertures were above the liquid level.

The larger particles of mist were removed by impingement on a glass mantle and returned to the 500 ml glass reservoir below. In the first 3 experiments, air bearing a mist of the Pydraul entered the upper rear of a 223-liter cylindrical steel chamber, described in the earlier report (March 11, 1953), at the rate of 30.9 liters per minute, and at room conditions of temperature and pressure. In 2 later experiments the air-borne mist entered the chamber at the rate of either 45 or 46.5 liters per minute and was diluted and mixed with an uncontaminated supplementary supply of air which entered at the same site at the rate of 28.2 liters per minute.

Each group of animals consisted of 1 cat, 2 guinea pigs, 2 rabbits and 4 rats.

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Sampling and Analysis of Contaminated Air. In each experiment 2 or 3 samples of air were drawn from the chamber, at the rate of 1 liter per minute for 5 minutes, through 2 absorption towers (2.25" x 13" outside diameter), each containing 100 ml of purified hexane. The sample passed through a fritted-glass disc in the first absorber and an impinger in the second.

The content of Pydraul F-9 in the air so collected was determined by measuring, by means of a Beckman spectrophotometer, the ability of the solution to transmit ultraviolet radiations of wave-length 246 mμ. A curve relating the transmission at 246 mμ of known concentrations of Pydraul F-9 in hexane over the range of 4.7 to 71 micrograms per ml was shown in Figure 5 of the report of March 11, 1953.

Experimental Results

The fate of each animal exposed to air laden with a mist of Pydraul F-9 in 5 experiments is shown in Tables 1 to 5, and the data are summarized in Table 6.

Experiment No. 1 (4.0 hours, 0.45 mg/l). The cat, rabbits and rats survived throughout and following their exposure for 4 hours to air bearing a mist of Pydraul F-9 in the concentration of 0.45 mg per liter (Tables 1 and 6), but both guinea pigs died on the 13th and 22nd days, respectively, after that on which they had been exposed. Except for salivation by the cat and dyspnea on the part

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of the guinea pigs, no signs of intoxication were observed. The fur of the animals was moist, but no irritation of the eyes was observed. The 2 guinea pigs lost 25 and 31 per cent of their initial weight, respectively, but only transitory losses in weight occurred among the remaining animals (Table 1).

On microscopic examination of the tissues of the guinea pigs, which died in the second and third weeks, respectively, after their last period of exposure, nonspecific toxic changes were found, consisting in severe diffuse degeneration of the brain, liver and kidneys, and pulmonary hyperemia. The cat and one of the rabbits showed similar changes in slight to moderate degree, but the viscera of one of the rats were normal except for slight inflammatory lesions of the lung and kidneys which resulted from intercurrent infection.

Experiment No. 3 (2.0 hours, 0.45 mg/l). One cat, 1 guinea pig, 2 rabbits and 4 rats, which were exposed for 2 hours to air laden with a mist of Pydraul in the concentration of 0.45 mg per liter, survived during and after the period of exposure, but the other guinea pig died 39 days later (Tables 2 and 6). The signs of intoxication were similar to those mentioned previously. Losses in weight on the part of all of the animals, except the guinea pigs, were negligible. The surviving guinea pig had not recovered its initial weight completely, in 52 days after the period of exposure.

The tissues of 1 rat and 1 guinea pig that survived were normal, as were those of the cat, except for slight fatty change in the liver.

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One of the 2 rabbits had lesions of infectious origin in the brain, heart and kidneys. The guinea pig that died after a delay of 39 days, had diffuse degeneration of the brain, liver and kidneys, slight pulmonary edema and hyperemia of the other viscera.

Experiment No. 5 (3.25 hours, 0.21 mg/l). All members of this group of animals, with the exception of 1 guinea pig, survived during and following exposure for an initial period of 2.25 hours to air bearing Pydraul F-9 in the concentration of 0.21 mg per liter, and an additional period of 1 hour, continuous with the initial period, during which the concentration was 0.105 mg per liter of that (Tables 3 and 6). The cat exhibited some excess of salivation, and one of the guinea pigs developed labored respiration, but no other signs of intoxication were observed. Except for the one guinea pig which died on the 17th day after that of the exposure, the losses in weight on the part of the animals were small and transitory.

When the surviving animals were killed for examination, the tissues of the cat, 1 rabbit and 2 of the rats were found to be normal. The guinea pig that died was found to have multiple pulmonary abscesses, in association with degenerative changes in the other viscera. The other guinea pig had inflammatory (infectious) lesions of minor consequence in the lungs and also in the kidneys.

Experiment No. 4 (1.0 hour, 0.26 mg/l). All of the animals of a group composed of 1 cat, 2 guinea pigs, 2 rabbits and 4 rats survived, without any signs of intoxication, during and following their

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exposure for 1 hour to air containing a mist of Pydraul F-9 in the concentration of 0.26 mg per liter (Tables 4 and 6). The losses in weight sustained by the animals were small and transitory.

When those animals were killed for examination, their tissues were found to be essentially normal, their being a scattering of minor inflammatory (infectious) lesions in certain of their viscera.

Experiment No. 2 (0.5 hour, 0.26 mg/l). All of the animals of another group (1 cat, 2 guinea pigs, 2 rabbits and 4 rats) survived throughout and after exposure for 0.5 hour to the mist of Pydraul F-9 in the concentration of 0.26 mg per liter. Their losses in weight were negligible.

The cat and 1 guinea pig, when killed on the 8th day after that of the exposure, were found to have slight fatty changes in the liver, but their remaining viscera were normal. One rabbit and 1 rat had extensive infectious lesions of low grade in brain, heart, liver and kidneys.

Discussion

Houghto-Safe 271, as determined in terms of its glycol content by the method of Bricker and Roberts (Anal. Chem. 21:1331, 1949), was found to be present for a few minutes in the concentration of 50 micrograms per liter at the "blow-off" sight gauge in the pump room of the U.S.S. Lake Champlain, in which Houghto-Safe 271 was being used as a hydraulic fluid in the catapult and elevator systems.

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Ordinarily the concentrations of the Houghto-Safe 271 on the carrier were many times less than that found at the "blow-off" site.

In the foregoing experiments animals have been subjected to exposure for more than 3 hours to concentrations of Pydraul F-9 which were several times higher than the highest concentration of Houghto-Safe 271 which occurred (for a few minutes) in the pump room of the U.S.S. Lake Champlain. The essentially harmless effects of such experimental exposure to Pydraul speak for themselves.

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Table 1

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to the Mist of Pydraul in Air

(Experiment No. 1)

Concentration (mg/l)	Duration of Exposure (hours)	Identification Number	Initial Weight (kg)	Changes in Weight Expressed As Percentage of Initial Weight		Fate	Length of Survival After Exposure
				Loss Resulting from Exposure	Subsequent Gain		
0.45	4.0	Cat A-568	2.920	0.0	8.8	Survived	Killed 9 days
		Guinea Pig B-866	0.844	31.2	-	Died	22 days
		Guinea Pig B-867	0.725	25.5	-	Died	13 days
		Rabbit J-942	3.292	0.7	3.2	Survived	Killed 9 days
		Rabbit J-943	3.064	2.9	4.7	Survived	Killed 9 days
		Rat N-297	0.259	5.4	11.6	Survived	Killed 9 days
		Rat N-298	0.224	3.1	12.5	Survived	Killed 9 days
		Rat N-299	0.222	1.4	9.5	Survived	Killed 9 days
		Rat N-600	0.242	4.1	8.7	Survived	Killed 9 days

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Table 2

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to the Mist of Pydraul in Air

(Experiment No. 3)

Concentration (mg/l)	Duration of Exposure (hours)	Identification Number	Initial Weight (kg)	Changes in Weight Expressed As Percentage of Initial Weight		Fate	Length of Survival After Exposure
				Loss Resulting from Exposure	Subsequent Gain		
0.45	2.0	Cat A-570	2.664	0.0	12.6	Survived	Killed 8 days
		Guinea Pig B-870	0.800	13.4	6.6	Survived	Killed 52 days
		Guinea Pig B-871	0.693	34.2	-	Died	39 days
		Rabbit J-594	3.132	1.5	4.7	Survived	Killed 8 days
		Rabbit J-960	2.938	0.1	9.2	Survived	Killed 8 days
		Rat N-605	0.230	0.0	3.0	Survived	Killed 8 days
		Rat N-606	0.217	0.0	9.2	Survived	Killed 8 days
		Rat N-607	0.220	0.0	6.8	Survived	Killed 8 days
		Rat N-608	0.241	0.0	3.7	Survived	Killed 8 days

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Table 3

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to the Mist of Pydraul in Air

(Experiment No. 5)

Concentration (mg/l)	Duration of Exposure (hours)	Identification Number	Initial Weight (kg)	Changes in Weight Expressed As Percentage of Initial Weight		Fate	Length of Survival After Exposure
				Loss Resulting from Exposure	Subsequent Gain		
0.21 (1)	3.25	Cat A-583	3.214	0.0	16.3	Survived	Killed 19 days
		Guinea Pig B-916	0.692	3.9	-	Survived	Killed 19 days
		Guinea Pig B-917	0.838	15.3	-	Died (2)	17 days
		Rabbit J-1000	3.570	2.4	7.8	Survived	Killed 19 days
		Rabbit K-1	3.879	5.7	10.4	Survived	Killed 19 days
		Rat N-668	0.212	0.9	7.5	Survived	Killed 19 days
		Rat N-669	0.249	3.6	8.4	Survived	Killed 19 days
		Rat N-670	0.239	2.1	4.6	Survived	Killed 19 days
		Rat N-771	0.205	2.4	3.9	Survived	Killed 19 days

(1) During the last hour the concentration was only about 1/2 of this.

(2) Death unrelated to exposure, not tabulated elsewhere.

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Table 4

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to the Mist of Pydraul in Air

(Experiment No. 4)

Concentration (mg/l)	Duration of Exposure (hours)	Identification Number	Initial Weight (kg)	Changes in Weight Expressed As Percentage of Initial Weight		Fate	Length of Survival After Exposure
				Loss Resulting from Exposure	Subsequent Gain		
0.26	1.0	Cat A-587	3.449	1.4	8.1	Survived	Killed 15 days
		Guinea Pig B-914	0.737	0.0	8.3	Survived	Killed 15 days
		Guinea Pig B-915	0.717	0.0	6.7	Survived	Killed 15 days
		Rabbit J-998	3.686	0.0	8.5	Survived	Killed 15 days
		Rabbit J-999	3.815	0.0	2.8	Survived	Killed 15 days
		Rat N-664	0.208	1.9	10.6	Survived	Killed 15 days
		Rat N-665	0.227	4.8	9.3	Survived	Killed 15 days
		Rat N-666	0.204	4.9	6.4	Survived	Killed 15 days
		Rat N-667	0.220	2.3	8.6	Survived	Killed 15 days

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Table 5

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to the Mist of Pydraul in Air

(Experiment No. 2)

Concentration (mg/l)	Duration of Exposure (hours)	Identification Number	Initial Weight (kg)	Changes in Weight Expressed As Percentage of Initial Weight		Fate	Length of Survival After Exposure
				Loss Resulting from Exposure	Subsequent Gain		
0.26	0.5	Cat A-569	3.337	0.0	4.3	Survived	Killed 8 days
		Guinea Pig B-868	0.800	0.0	3.8	Survived	Killed 8 days
		Guinea Pig B-869	0.788	0.0	16.1	Survived	Killed 8 days
		Rabbit J-961	2.374	0.0	7.6	Survived	Killed 8 days
		Rabbit J-962	2.772	0.0	2.1	Survived	Killed 8 days
		Rat N-601	0.244	2.9	5.3	Survived	Killed 8 days
		Rat N-602	0.220	2.3	6.8	Survived	Killed 8 days
		Rat N-603	0.260	0.8	3.5	Survived	Killed 8 days
		Rat N-604	0.226	0.4	4.9	Survived	Killed 8 days

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Table 6

Conditions of Formation of Mist of Pydraul and Summary of Data As to the Fate of Animals Exposed to the Mist

Experiment Number	Amount of Pydraul Aspirated (mg/min)	Gauge Pressure (psi)	Rate of Passage of Air Through Aspirator (converted to room conditions) (l/min)	Concentration of Pydraul Found in Chamber (mg/l)	Duration of Exposure (hours)	Number of Fatalities/Number of Animals Exposed			
						Cats	Guinea Pigs	Rabbits	Rats
1	67.5	29	30.9	0.45	4.0	0/1	2/2	0/2	0/4
3	70.0	29	30.9	0.45	2.0	0/1	1/2	0/2	0/4
5	56.0	24	45.0 (1)	0.21 (2)	3.25	0/1	0/1	0/2	0/4
4	61.6	27	46.5 (1)	0.26	1.0	0/1	0/2	0/2	0/4
2	51.7	29	30.9	0.26	0.5	0/1	0/2	0/2	0/4

(1) An additional supplementary supply of air (28.2 l/min) was passed through the chamber.

(2) During the last hour the concentration was only about 1/2 of this.

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