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A PROTOCOL FOR STUDIES OF THE EFFECTS OF HYDROGEN CHLORIDE ON THE RESPIRATORY SYSTEM OF RODENTS AND NONHUMAN PRIMATES

Prepared for:

The Society of the Plastics Industry, Inc.
c/o B. F. Goodrich Company
Department 0020, Building 5-H
500 South Main Street
Akron, Ohio 44318

May 24, 1984

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DEPARTMENT OF
FIRE TECHNOLOGY

TELEX 767357
TWX 910-871 1084

May 29, 1984

Dr. Theodore R. Torkelson
The Dow Chemical Company
1803 Building
Midland, Michigan 48640

Dear Dr. Torkelson:

Enclosed please find one copy of the protocol for the study entitled "A Protocol for Studies of the Effects of Hydrogen Chloride on the Respiratory System of Rodents and Nonhuman Primates," SwRI Project No. 01-7901.

Sincerely,

Hal Kaplan

Harold L. Kaplan, Ph.D.
Manager
Applied Environmental Toxicology

HLK/11b

Enclosures

R&S 117183

SwRI Project No. 01-7901
May 24, 1984

INDEX TERMS
PYROLYSIS
THERMAL DECOMPOSITION
RESPIRATORY PHYSIOLOGY
~~HYDROCHLORIC ACID~~ OK
COMBUSTION GASES
SWRI
SPI
FIRE
FAA
HARTZELL

A PROTOCOL FOR STUDIES OF THE EFFECTS OF HYDROGEN CHLORIDE ON THE RESPIRATORY SYSTEM OF RODENTS AND NONHUMAN PRIMATES

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Approved:

Gordon E. Hartzell, Ph.D.
Director
Department of Fire Technology

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1.0 INTRODUCTION

In recent years the toxicity of hydrogen chloride (HCl) has become a subject of considerable controversy. Particularly controversial questions regarding the toxicity of this gas include: 1) What concentration of HCl in the air will incapacitate humans? 2) Does HCl gas or aerosol penetrate and cause damage to the lungs and result in severe post-exposure effects? 3) What are the effects of HCl inhalation on the respiratory system of humans during exposure? and 4) Is the rodent an appropriate model for predicting the toxic effects of HCl in man?

A number of studies have shown that, on the basis of mortality, HCl is not an extremely potent chemical. Reported LC_{50} values include: 1) 40,989 and 13,745 ppm in rats and mice, respectively, exposed for 5 minutes to HCl vapors and monitored for mortality for seven days post exposure; and 2) 3124 and 1108 ppm in rats and mice, respectively, exposed to HCl vapors for 60 minutes and monitored for mortality for 14-days post exposure (1, 2). Studies at Southwest Research Institute (SwRI) have yielded comparable results, showing that rather high concentrations of HCl are necessary to cause lethality in rats, particularly during exposure.

In addition, in experiments conducted with nonhuman primates (baboons) at SwRI, animals tolerated high concentrations of HCl without becoming incapacitated or losing their escape performance capability. Although post-exposure deaths did occur weeks or months after exposure to concentrations in excess of 1.5 percent, the clinical signs exhibited by animals following exposure were not indicative of severe lung damage and edema which are characteristic of pulmonary irritants such as acrolein. The results of these experiments are not in agreement with claims by some investigators that the RD_{50} concentration of an irritant gas is incapacitating to man within a few

minutes (3, 4). Based on the data with baboons, a short exposure to 309 ppm (RD_{50} concentration in mice) of HCl is likely to be irritating and cause discomfort and even pain, but is unlikely to incapacitate man or even cause severe post-exposure effects.

Although the experiments with nonhuman primates yielded definitive results as to the incapacitating potential of HCl, these experiments were not designed to investigate the effects of this irritant on respiratory response and pulmonary function. These effects need to be investigated in both a nonhuman primate species and a rodent to determine the [redacted] of the rodent as a model to predict potential effects of this gas in man.

2.0 OBJECTIVES

The objectives of the proposed study are:

1) Evaluate the [redacted] of the rodent as a model for determining the pulmonary toxicity of HCl in man;

2) Determine to what extent HCl, at concentrations up to the maximum predicted in real fires, penetrates the respiratory tract and causes significant changes in pulmonary function in nonhuman primates;

3) Evaluate the CO_2 challenge method for assessing pulmonary function as a means of predicting pulmonary toxicity in man.

3.0 WORK STATEMENT

3.1 Materials

Hydrogen chloride for the animal exposures will be Ultra Hi Purity Grade (99.99% HCl) from Scientific Gas Products (SGP). Compressed gas mixtures of HCl in air (if needed) will be certified as to their purity (breathing quality air will be used) by SGP. The CO_2 for the challenge experiments will be purchased also from Scientific Gas Products. It will be premixed to our specifications at 10% CO_2, 20 ± 1% O_2 and the balance nitrogen. It will have the same specifications as SGP's "Biological Mixtures." Breathing air for the animal exposures will be obtained from Liquid Carbonics. It will be the same quality as used for laboratory respirators.

3.2 Animal Husbandry

3.2.1 Nonhuman Primates

Twelve young adult male baboons (Papio cynocephalus), approximately 4 years of age and weighing 18±2 kg, will be used for this phase of the study. This nonhuman primate species was selected because it is used as a widely accepted model for man in many areas of respiratory research (5, 6, 7 and 8).

The animals will be acquired from the National Institute of Health's Baboon Breeding Colony at Southwest Foundation for Biomedical Research (SFBR). The Foundation is a sister organization to SwRI and is located approximately 1.5 miles from SwRI. Prior to use in the study, each animal will be examined by the project veterinarian to ensure it is healthy and free of respiratory problems, and will be tuberculin tested and given standard parasite treatment.

The baboons will be housed at SFBR in individual standard baboon cages, which allow ample space for exercise. Housing will be in a

controlled environment with proper ventilation (10-12 air changes per hour), temperature (74°F ± 2°), humidity (50% ± 20%) and a 12-hour light:dark cycle. The animals will be fed once daily with a standard baboon 15% protein ration, and water will be available ad libitum. Cages will be cleaned daily. Routine animal maintenance and care will be provided by personnel of the Department of Laboratory Animal Medicine of the SFBR in accordance with guidelines of the [redacted]

The animals will be transported from SFBR to the Department of Fire Technology for exposure to HCl and for CO_2 challenge tests. Following completion of exposure to HCl, each animal will be immediately washed with water to remove residual HCl and returned on the same day to SFBR. Animals transported to SwRI for CO_2 challenge tests also will be returned to SFBR on the same day. During the experimental phases of the project, animals will be observed daily by trained SwRI technicians and observations will be recorded. For the first three days after exposure to HCl, animals will be observed twice daily or more often if warranted.

3.2.2 Rodents

Young adult male Sprague-Dawley rats (175-200 g) and young adult male Swiss Webster mice (18-24 g) obtained from King Animal Laboratories, Oregon, Wisconsin will be used in this phase of the study. Upon receipt, these animals will be housed in the quarantine facility of the Department of Fire Technology for at least two weeks. During the quarantine period, observations of the health status of the animals will be made to ensure that only healthy animals will be used in the study. At the end of quarantine, the animals will be given a CO_2 challenge test prior to a subsequent exposure to HCl or air and will then be housed in the post-exposure

facility of the Department of Fire Technology for the remainder of the study.

During quarantine and post exposure, the rats will be housed individually in polycarbonate cages (10-1/2 in. w x 19 in. l x 8 in. h) and the mice will be grouped three per polycarbonate cage (10-1/2 in. w x 19 in. l x 8 in. h). Housing will be in a controlled environment with proper ventilation (18 air changes per hour), temperature (74°F ± 4°), humidity (50% ± 20%) and a 12-hour light:dark cycle. Purina Laboratory Rodent Chow (5001) and water will be available ad libitum, except during exposure phases of the study. Bedding will consist of two inches of Anderson's Bed-O'Cobs . Animals will be rotated to clean cages with fresh bedding and clean water bottles and feeders twice weekly. Cages and bottles will be washed and sanitized with Hunter Industrial Chemical's Departure. Animals will be observed by trained SwRI personnel on a daily basis and observations will be recorded. For the first three days after exposure to HCl, animals will be observed twice daily or more frequently as warranted. Maintenance, care and observation of animals will be performed by personnel of the Department of Fire Technology under the direction of the project veterinarian.

3.3 Study Design

3.3.1 Nonhuman Primates

3.3.1.1 Animal Exposures

Groups of three (3) young adult, male baboons will be exposed individually to 0, 50, 500 or 5000 ppm HCl head only for 15 minutes in a 200-L flow through chamber of similar dimensions as the NBS chamber (9). The 5000 ppm and control (0 ppm) levels will be evaluated first. The control will be exposed to air under the same conditions as the experimental groups. Animals will be randomly assigned to the three experimental and one control groups according to a computer-generated randomization system.

3.3.1.2 Respiratory and Pulmonary Function Evaluations

The effects of HCl on the respiratory system of baboons will be studied by monitoring respiratory parameters, pulmonary function using both invasive and non-invasive techniques, and pathological changes.

3.3.1.2.1 Respiratory Parameters

In each experiment, the animal will be restrained, lightly anesthetized with Ketamine (20 mg/kg) to minimize interfering body movements, and will be exposed to HCl gas (or air for control animals) in a head-only mode by means of an acrylic flow-through head chamber. Ketamine will be used here because it does not interact with the respiratory centers of the brain and thus does not affect respiration. Chamber configuration and dimensions and flow-through conditions will be selected to insure adequate O_2 and acceptable CO_2 levels for the animals. A Respitrace™ respiratory monitoring system will be used to monitor respiratory parameters of the animals (10). The system consists of two Respiband™ transducers placed around the thorax and abdomen of the animal and calibrated with spirometry bag baseline measurements. The transducer oscillator conditioner will be connected to a calibrator/demodulator unit and the system will provide measurements of changes in the respiratory rate and tidal volume. These measurements will be obtained prior to exposure to HCl, during exposure to HCl and during the recovery period [redacted] Changes in these parameters will be correlated with changes in arterial blood gases (pO_2 and pCO_2) which will be measured by conventional techniques just prior to exposure to determine a baseline, at 1-minute intervals during exposure, and during recovery. In addition, clinical signs indicative of alterations in the respiratory system, such as cyanosis and cough, will be recorded.

3.3.1.2.2 Pulmonary Function via the Invasive Method of Johanson et al (5, 6, 7)

Baseline pulmonary function measurements will be obtained for each animal three (3) days prior to exposure to HCl (or air for control animals) and at the fourth day and three months post exposure. Post-exposure measurements at subsequent time periods or for other exposure concentration animals (extra cost) may be added at the request of the Vinyl Institute Technical Monitor after consultation with SwRI Project Manager.

For these measurements, an endotracheal tube will be inserted into the anesthetized (Ketamine) animal and an esophageal balloon will be placed in the respiratory tract to measure the transpulmonary pressure. Lung volume and rebreathing maneuvers will be performed with a large syringe. Gas concentrations will be measured by mass spectrometry. Functional residual capability (FRC) will be determined by helium equilibration. Inspiratory capacity (IC), defined as the volume of air needed to inflate the lungs to a transpulmonary pressure of 40-cm H_2O, will be determined. Total lung capacity (TLC) will be obtained as the sum of FRC and IC. Residual volume (RV) will be determined as the difference between TLC and the volume of air in the lung after transpulmonary pressure of 40-cm H_2O.

Gas exchange will be determined by measurement of diffusing capacity of the lung for carbon monoxide (DL_{CO}) by the rebreathing technique and measurement of arterial blood gases. The presence of pulmonary edema will be determined by measurement of lung tissue volume (V_{tis}) using the soluble gas technique and by chest antero-postero radiography using standard conditions of lung inflation (40-cm H_2O airway pressure) and tube to film distance.

Airway resistance will be recorded by the technique of high frequency oscillation, and flow/volume curves will be obtained using

sudden application of 40-cm H_2O airway pressure.

The physiologic measurements to be performed are as follows:

a. Respiratory rate

b. Arterial blood gases - calculate alveolar/arterial oxygen pressure difference

c. Pulmonary volumes: Inspiratory capacity, expiratory residual volume, functional residual volume, total lung capacity, vital capacity, pulmonary pressure/volume curves

d. Diffusion studies - rebreathing technique to measure DL_{CO}, DL/VA, lung tissue volume (V_{tis})

e. Upper airway pressure

f. Flow/volume curves

g. Chest X-rays

3.3.1.2.3 Pulmonary Function via the CO_2 Challenge Response Adapted from the Method of Wong and Alarie (11)

The CO_2 challenge procedure has been proposed as a potential noninvasive tool for the evaluation of pulmonary function (i.e., lung disease) in guinea pigs. Since the ultimate goal of this work is prediction of what levels of a given toxicant will cause effects in man, the CO_2 challenge method will be conducted with the baboons. The results from the method will be compared with the well established but more invasive methods of Johanson et al. (5, 6, 7). Furthermore, these results will be used as a comparison with the response of rodents.

Each of the animals described in Section 3.3.1.1 will be anesthetized with Ketamine and challenged for 10 minutes with a gas mixture containing 10% CO_2, 20% O_2 and 70% N_2 four days prior to exposure and on the third day and at three months post exposure (one day before the use of the noninvasive method). Post-exposure measurements at subsequent time periods [redacted] may be added at the request of the Vinyl Institute Technical Monitor after consultation with the SwRI Project Monitor. The challenge will

be conducted in the same 200-L chamber used for the HCl and control exposures using a head-only exposure. Tidal volume (VT), respiratory frequency (f), and minute volume (VT-f) will be monitored using the Respitrace™ system. Since a plethysmograph will not be used to monitor pulmonary changes, ΔP, the change in pressure within the plethysmograph cannot be measured. However, the determination of ΔP is not necessary since studies by Wong, et al. (12) and Schaper, et al. (13) have indicated that the level of response of VT (tidal v lume or inspiratory volume) and ΔP are similar except that VT is a more sensitive indicator of severe bronchoconstriction. Therefore, VT is the parameter of choice.

3.3.1.2.4 Lung Pathology

Gross pathological and histopathological examination of the complete respiratory system will be performed on all animals that die or are moribund. Examinations will also be made on other animals when indicated by the severity and type of pulmonary function changes, as designated by the Vinyl Institute Technical Monitor.

In addition, two separate groups of baboons (three/group) will be established to study pathological changes in the lung and upper respiratory tract. One group will be exposed to a selected concentration of HCl based on the results of the pulmonary function studies, and the other group will be used as a control (air only exposure). A gross and histopathologic evaluation of the lungs and upper respiratory system will be conducted on all HCl-exposed animals and on one of the three animals in the control group. In an effort to conserve a valuable resource, the others will be sacrificed and subjected to a gross and microscopic examination only if it is necessary to corroborate any observations.

For these studies, the respiratory tract of the animal will be removed, inflated with 10% formalin and examined grossly. The tract will be embedded in 8 to 10 paraffin blocks. Approximately 12 sections of the tract will be taken, with multiple levels of the trachea, bronchi and lungs. In addition, the head of the animal will be decalcified prior to obtaining sections of the nasal cavity. Six micron sections will be stained with hematoxylin and eosin (H & E) stain for examination by light microscopy.

3.3.2 Rodent Studies

3.3.2.1 Animal Exposures

Male Sprague-Dawley rats (250-320 g) and Swiss-Webster mice (20-30 g) will be used in these studies. Groups of rats or mice (nine/group/species) will be exposed to 0, 500 or 5000 ppm for 15 minutes. Animals will be exposed head only in the same chamber as described for the primates. The control (0 ppm) will be exposed to air under the same conditions as the experimental groups. Animals will be randomly assigned to experimental and control groups according to a computer-generated randomization system.

3.3.2.2 Respiratory Parameters

The effects of HCl on the respiratory parameters (tidal volume, VT; respiratory frequency, f; minute volume, VT-f; and pressure change, ΔP) of the rat and mouse will be determined by the use of body plethysmographs during head-only exposures. Six of the nine animals per group will be placed in plethysmographs, while the remaining three will be cannulated for blood gas determinations. For respiratory measurement, each animal will be placed in a tubular aluminum restrainer modified to allow for the fitting of a latex dam around the chest. In this manner an airtight seal will be obtained between the animal and the restrainer without adversely restricting the

animal's neck. A second, larger tube with a closed end will be placed over each aluminum restrainer and sealed to the wall of the exposure chamber in order to create an airtight chamber. Two ports will be placed on the plethysmograph for measurement of pressure changes and volume calibration. Pressure changes caused by respiratory movements are sensed by Vacumed transducers and volume calibration is facilitated by to-and-fro movements of air with a 2.0-mL calibrated syringe. The signals from the six animals will be averaged and monitored by a laboratory computer. Blood samples will be obtained just prior to exposure and every three minutes during and after exposure and will be analyzed for blood gases (pO_2 and pCO_2) and blood pH. The effects on respiration and blood gases in rodents will be compared with those measured in nonhuman primates.

3.3.2.3 Pulmonary Function via the CO_2 Challenge Response as Adapted from the Method of Wong and Alarie (11)

The CO_2 challenge procedure has been proposed as a potential noninvasive tool for the evaluation of pulmonary performance (i.e., lung disease) in guinea pigs. Although the relevance of this method to pulmonary changes in man has not been validated, the use of this method in rodents in conjunction with the above mentioned studies in primates may provide valuable insight into both species differences and the validity of this method.

The effects of HCl at the concentrations and duration of exposure described above will be investigated using a modification of the method of Wong and Alarie (11). Each of the animals described in Section 3.3.2.1 will be challenged for 10 minutes with a gas mixture containing 10% CO_2, 20% O_2, and 70% N_2 four days prior to exposure and on the third day and at three months post exposure. Post-exposure measurements at subsequent time periods (extra cost) may be added at the request of the Vinyl Institute Technical Monitor after consultation with the SwRI Project Monitor. The challenge

will be conducted in the same 200-L chamber used for the HCl and control exposures using a head-only exposure. Tidal volume (VT), respiratory frequency (f), minute volume (VT-f), and pressure change (ΔP) will be monitored using the plethysmograph.

3.3.2.4 Lung Pathology

Gross pathology and histopathological examinations of the complete respiratory system will be performed on all animals that die or are moribund. Examinations will also be made on all other animals when indicated by the severity and type of pulmonary function changes, as designated by the Vinyl Institute Technical Monitor.

In addition, two groups per species (6 per group) will be established to study pathological changes in the lung and upper respiratory tract. One group will be exposed to a selected concentration of HCl based on the pulmonary function studies in primates and rodents, and the other group will be used as a control (air only exposure). A gross and histopathologic examination will be performed on the complete respiratory tracts of all animals from all groups. Microscopic slides of the tracts will be prepared by the same techniques as described for nonhuman primates.

3.4 Generation and Monitoring of Hydrogen Chloride

3.4.1 Generation of HCl for Animal Exposures

Mixtures of hydrogen chloride (HCl) in air for the animal exposures will be generated and monitored as described below. The concentration range of HCl will be from 50 ppm to 5000 ppm (v/v) and the flow rate will be a fixed value within the range of 20-40 L/min (0.1-0.2 volume changes per minute in the exposure chamber). The temperature of the atmosphere will be 22 ± 3°C and the relative humidity will be 40 ± 10 percent.

Various concentrations of HCl gas will be generated for the animal exposures by mixing compressed gases as shown schematically in Figure 1. The "test gas" cylinder will be either pure HCl or one of a series of specially-prepared, analyzed mixtures of HCl in pure air. These will be mixed (as shown in the figure) with breathing quality cylinder air to achieve the desired HCl concentration. Teflon and glass flowmeters will be used for flow measurement of HCl-containing mixtures. Regular metal and glass flowmeters will be used for air. The air will be humidified prior to mixing with the HCl by running it through a water vapor saturator maintained at a constant temperature T_1 (as shown in Figure 1). The air stream will then be heated to the desired test temperature (T_2) in order to create the desired relative humidity. Hydrogen chloride will then be mixed with this stream in order to create the proper HCl concentration and relative humidity.

Reasonably stable concentrations of HCl have been achieved in the laboratory when the humidity was less than about 50-percent R.H. At higher humidity, yellow droplets appeared on the walls and there was a greater rate of loss of HCl than under dry conditions. In general, even under low humidity conditions, only about 50 percent of the HCl introduced into a chamber could be found in the box atmosphere. For these reasons, the humidity will be maintained on the low side of 50% RH, rather than above that. Even so, a calculated volume flow rate of HCl will not necessarily produce the desired concentration. Therefore, the flow rates of HCl and air will have to be adjusted while HCl concentration is being monitored in order to insure that the system is ready for a test run.

3.4.2 Methods for Analysis of Hydrogen Chloride

Sampling and analysis of HCl will be performed by three different techniques. These may be summarized as follows:

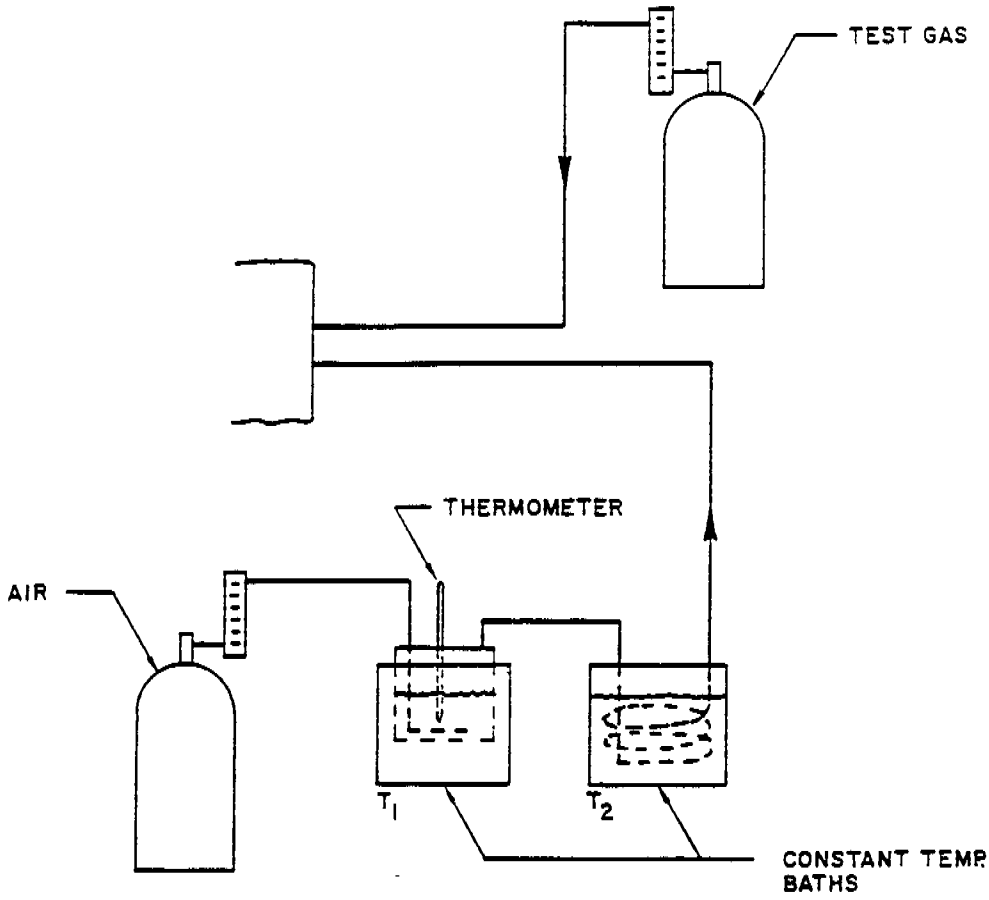

Figure 1. Gas mixing and humidification setup.

1) Batch sampling is accomplished using dry soda-lime absorption tubes. Subsequent analysis of chloride ion in the aqueous extract from the soda lime is performed by titration (details of this procedure are given below).

2) Intermittent gas sampling may be done using a 60-mL syringe containing 5-mL of absorbing solution. Direct analysis of chloride ion in solution may be performed immediately by ion-selective electrode (ISE) or, using a different absorbing solution, subsequent analysis may be carried out by ion-chromatography (IC).

3) Continuous sampling and direct analysis of HCl may be performed using a recirculating pump and a Hall Conductivity Detector. This detector must be calibrated immediately prior to a run by technique No. 2 above.

Techniques No. 1 and 2 are relied upon for a quantitative assessment of HCl, while the continuous analysis method is used mostly to establish and maintain a constant level of HCl for the actual test runs.

The continuous monitoring system for HCl is shown schematically in Figure 2. A high volume recirculating pump draws a portion of the atmosphere from the chamber through heated sampling lines. Most of this is recirculated, while a very small volume of sample (usually 1-4 cc/min) is extracted for analysis. This sample is diluted with pure, dry air (flowing at approximately 40 cc/min) and the mixture flows through the conductance cell concurrent with a low volume (4 mL/min) of n-propyl alcohol as the solvent. The effluent solvent stream is not recirculated because of the high concentration of choride ion (however, the pure solvent is run through an ion-exchange bed anyway). The continuous monitor must be calibrated prior to each test run. The HCl is introduced step-wise into the volume being sampled (either the actual test chamber or another enclosed acrylic chamber) and a comparison is made between the mV output from the conductivity detector and the ppm analysis

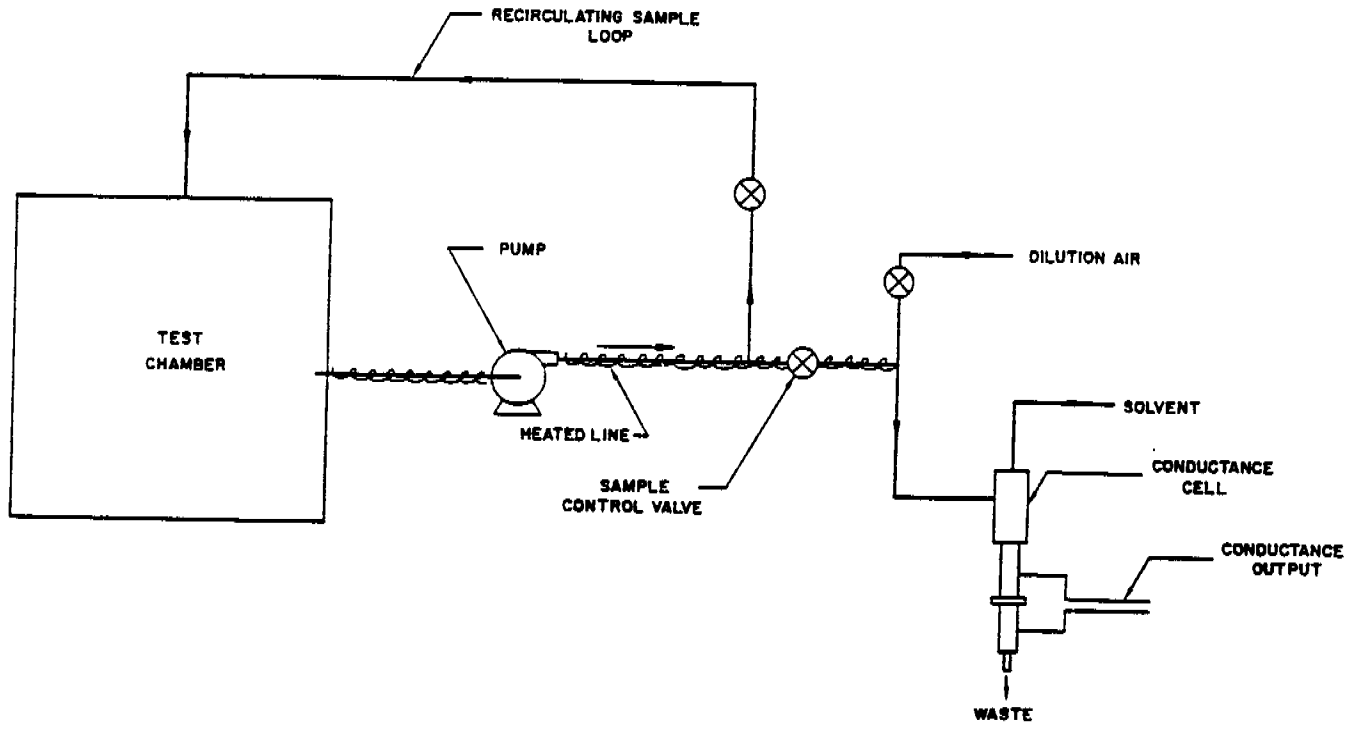

Figure 2. Schematic diagram of the continuous monitoring system for HCl.

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from the syringe/ISE method described above. The calibration curve is determined for the particular range of HCl concentration to be tested.

3.4.3 Sampling and Analysis of HCl using Soda Lime Tubes

A method of collection of gaseous HCl using tubes containing dry soda lime has proven to be reliable, easy to use, and with absorption efficiencies comparable to or better than solution impingers. This technique yields a time-integrated analysis (i.e., the average concentration is determined over some time period). If the time increments can be made small enough (e.g., 2 minutes) an intermittent plot of concentration vs. time can be developed. The time-integrated analyses by this method enable the development of a reliable concentration-time (Cxt) product.

A summary of the method, including preparation of the tubes, use conditions, desorption and analysis, is presented below. A major advantage in the use of these tubes is their ability to be located almost anywhere in a laboratory or full-scale fire test. The absorption tubes may be put at the very end of the gas sampling line, with connecting tubing, pumps and rotameters far removed from the sampling tubes.

Approximately 0.5 g of 20-30 mesh soda lime (a mixture of sodium hydroxide and calcium oxide) in a glass tube is used for collection of HCl. The tubes are 1/8-inch (3-mm) I.D. and 4 inches (10 cm) long. The ends of the tube are plugged with cotton. A suction pump, needle valve and rotameter are employed to pull a specific volume of the [redacted] atmosphere through the sorption tubes. Samples are taken over fixed time intervals. Due to difficulty in maintaining a specified flow rate, the calibrated rotameter is read frequently over the sampling time interval and the total volume of gas is then calculated. The rotameters are calibrated to 25°C. The equations below utilize this temperature for normalizing the concentrations of the

gases. Since concentrations are calculated on the basis of volume/volume, only the equivalent flow of sample gas at the location of the rotameter need be determined. No conversion factor is necessary to calculate concentration at the sampling point. The ideal molar volumes are used in these calculations.

The soda-lime absorbent, including the cotton wadding, is desorbed in 10-mL deionized water, and the solution is swirled briefly. After at least thirty minutes of standing, a three-mL aliquot is extracted for HCl determination. This sample is adjusted to pH 8-10 (phenolphthalein end point) with 0.1 N HNO_3. Titration of HCl is performed to a visual end point (s-diphenyl carbazone) with mercuric nitrate, in accordance with a standard procedure (14). The titrant is 0.014-0.0014 N, depending on the expected concentration of chloride.

Concentration of HCl in the gas phase is calculated as shown below:

HCl, ppm = S * N * R * 24.5 * (1/V) * 1000

where HCl, ppm = concentration of HCl in the gas phase, ppm;

S = mL titrant used for sample (corrected for that required for blank);

N = normality of titrant;

R = ratio of volume of desorbent solution (usually 10 mL) to that of aliquot (usually 3 mL), e.g. 10/3;

24.5 = molar volume of ideal gas, μL/μ mole, at 25°C and 1 atmosphere;

1/V = Reciprocal of total volume, in liters, of atmosphere sampled (volume rate of flow times time);

1000 = conversion factor.

3.5 Statistical Analysis

3.5.1 Randomization

The study design is based on usage of groups of three (3) baboons exposed to 0, 50, 500 or 5,000 ppm HCl; a similar design also will be used on the twelve selected rodents. Of concern is the random allocation of the animals to the four exposure groups, and the test sequence. Allocation to the exposure groups will be accomplished by assigning the twelve animals (either baboons or rodents) a number from 1 to 12, generating a random sequence of these 12 numbers (e.g., 1-7-4-3-10-9-2-12-6-8-5-11), and then using the first three numbers for the animals assigned to 0 ppm HCl exposure, the next three numbers for the animals assigned to 50 ppm HCl exposure, etc. The random sequence will be obtained by using a computer generated random number routine.

The test sequence, or run-order, will be based on the HCl concentrations. The 5,000 ppm will be evaluated first, followed by the 0, 500 and 50 levels. The three animals assigned to each level will be tested together before moving to the next level. A random run-order may be more desirable after the 5000 ppm test is completed. If so, this will be accomplished by randomly choosing the numbers 0, 50 and 500, and using the resultant sequence as the run-order following the 5000 ppm test.

3.5.2 Data Analysis

The purpose of the data analysis will be to lend support to the accomplishment of the study objectives. Objective 1 concerns evaluating the validity of the rodent as a model for determining the pulmonary toxicity of HCl in man. This will be done by utilizing graphs of the respiratory parameters (i.e., respiratory rate and tidal volume) versus the HCl concentration for both the rodent and the nonhuman primate samples.

Least-square curves fits will be made of the respiratory parameter of interest versus the HCl concentration for each animal group. The two curves then will be compared to determine if they have any statistical differences (i.e., are they coincident, parallel, or intersecting?). This will be accomplished by testing for equality the coefficients of the resultant curves. The statistical test will be a two-sample t-test for coefficient equality.

Several precautions will be taken in the above statistical procedures. These will include checking to determine if the data provide a good fit to the proposed curves (i.e., examining residual plots and other regression diagnosticis), checking if the data are normally distributed (i.e., using normal probability plots), and determining if the variability of the respiratory parameter is the same for the two curves (i.e., checking for equal variances). Depending on these results several alternative procedures may be needed. For example, and inerrant data point may need to be re-run or deleted, a transformation (such as to a log scale) may be helpful, or a non-normal statistical test may be desired. These alternatives will be pursued as they are needed or found to be appropriate.

The three repeat observations at each HCl level will be very helpful in assessing the adequacy of the curve fit and in obtaining a good measure of the variability of the curve. The results of this analysis may suggest that more data are needed to adequately describe the curves. If this occurs, a secondary test design will be developed and proposed for future work. If not, then the above test plan and analysis will be utilized.

Objectives 2 and 3 will be evaluated in a different manner. Objective 2 will be assessed utilizing the pathological and medical data obtained from analyzing the respiratory tracts of the animals. The

results will be observational and subjective so no statistical techniques are proposed here.

Objective 3 concerns evaluating the CO_2 challenge method. The results with the baboons will be compared to both the response of the rodents as well as to the results of Wong and Alarie, et al. (11). A similar analysis will run as that given under Objective 1. The respiratory variables of interest will be the tidal volume (VT) and respiratory frequency (f) of the animals and the predictor variable will be the HCl concentration.

4.0 PROGRAM ORGANIZATION AND MANAGEMENT

The program will be performed under the overall management of Dr. Gordon E. Hartzell, Director. Senior members of the project team are listed below. Data sheets for the principal project personnel are given in Section 7.3.

Program Manager: Dr. Harold L. Kaplan, Manager of Applied Environmental Toxicology.

Dr. Kaplan will have overall responsibility for the management and conduct of the project. Dr. Kaplan has had extensive experience as a researcher, laboratory supervisor and administrator in a wide range of toxicological and pharmacological disciplines. His work, focused primarily on risk assessment of the inhalation of potentially toxic atmospheres, has involved positions with the U.S. air Force and with the National Aeronautics and Space Administration, where he was Chief of the Toxicology Section at the Johnson Space Center. Dr. Kaplan's research has resulted in 32 presentations and publications.

Currently, Dr. Kaplan is Program Manager and Principal Investigator of a major project funded at SwRI by the Federal Aviation Administration on "A Research Study of the Assessment of Escape Impairment from Postcrash Aircraft Fires Due to Irritant Combustion Gases."

Principal Investigators: Toxicology and Respiratory Measurements: Harold L. Kaplan, Ph.D., Walter G. Switzer, M. S. and Howard W. Stacy.

Dr. Harold L. Kaplan, Mr. Walter G. Switzer and Mr. Howard Stacy will have overall responsibility for those phases of the the project that require the exposure of animals to HCl, air and CO_2. Mr. Switzer has had extensive experience in the design, data analysis and interpretation of physiological/behavioral experimentation in the field of combustion toxicology. Over the last seven years Mr. Switzer has conducted numerous large-scale and small-scale combustion toxicity experiments utilizing differing experimental designs, combustion techniques, behavioral paradigms and animal models. Mr. Switzer's research has resulted in 12 presentations and publications. Prior to joining SwRI, Mr. Stacy was responsible for the operation of Weyerhaeuser Company's combustion toxicology laboratory. He was directly responsible for the development of the radiant heat furnace modification to the NBS test method, and has had extensive experience in the use of this furnace in laboratory-scale toxicity testing. He participated in the NBS ad hoc committee during the development of the NBS test method, and conducted all laboratory work in the Weyerhaeuser Company's participation in the NBS interlaboratory evaluation. At SwRI, Mr. Stacy has conducted laboratory combustion toxicity testing of materials and recently has developed a body plethysmographic technique for the measurement of respiratory responses of rodents exposed to test gas atmospheres.

Principal Investigator: Exposure Atmosphere Generation and Analyses: Arthur F. Grand, Ph.D., Staff Scientist, Fire Research.

Dr. Grand will have responsibility for the generation and analyses of HCl exposure atmospheres. Dr. Grand is a physical chemist who is presently involved with programs on fire dynamics and fire modeling. Active in ASTM Committee E5 on Fire Standards since 1976, he is presently Secretary of Subcommittee E5.21 on Smoke and Combustion Products. His prior experience with Velsical Chemical Corporation involved studies on the flammability characteristics of plastics, including research on the mechanisms of combustion of flame retardant polymers.

At SwRI, Dr. Grand is responsible for specific projects involving heat and smoke release from materials under different combustion conditions. Using the SwRI room calorimeter, he conducted a study for NASA involving the measurement of heat and gas release from aircraft seat cushions and directed a similar study on room furnishings. Dr. Grand was responsible for generation and analysis of the gas atmospheres for major projects at SwRI funded by the FAA and NBS.

Principal Investigator: Pulmonary Function Tests and Respiratory Measurements in Baboons: Antonio Anzueto, M. D. and Waldemar G. Johanson, M. D.

Dr. Anzueto and Dr. Johanson will serve as consultants to this project. Dr. Anzueto will have responsibility for the conducting of pulmonary function tests, the measurement of respiratory parameters of baboons during exposure and the interpretation of data. Dr. Johanson is Director of the Pulmonary Department at the University of Texas Health Sciences Center, San Antonio and Director of the Pulmonary Laboratory at SFBR. Dr. Anzueto is Research Fellow at the University of Texas Health Science Center.

Principal Investigator: Animal Care: Gary T. Moore, D.V.M., Manager, Laboratory Animal Sciences.

Dr. Moore as Project Veterinarian will have overall responsibility for those aspects of the project involving animal care and sacrifice of baboons for histopathology and will assist in all baboon experiments involving exposure to HCl.

Other Project Personnel: Dr. Robert L. Mason, Manager, Statistical Design and Analysis Section, will be responsible for statistical analyses of experimental results. Dr. Chester A. Gleiser, D.V.M., board-certified veterinary pathologist at SFBR, will be responsible for gross pathology and histopathology.

5.0 WORK SCHEDULE AND REPORTING

The work described herein will commence within 30 days after notification of approval of the protocol by the Technical Monitor. Preparations for the work, such as construction of the nonhuman primate exposure chamber and development of the HCl delivery system, will begin immediately upon notification. The work plan will be scheduled to enable completion within six months after initiation. However, much of the proposed work is of a research nature so that modifications to the study design may be required. These modifications, which will be made upon approval by the Technical Monitor in consultation with the Program Manager, may result in deletion or reduction of some phases of the study design or an increase in the work. These modifications could either reduce or decrease the cost of the study.

The Technical Monitor will be kept well informed of the progress of the study by monthly progress reports as well as by telephone reports and visits to SwRI. The monthly progress reports will be brief reports, either in written or outline form, summarizing the work accomplished, results, problem areas and the expenditures for the month. A detailed final report of the study will be submitted to the Technical Monitor not later than 90 days after completion of the work.

6.0 COSTS

EXPERIMENTAL

Nonhuman Primates

Animal Procurement (12 @ $950.00)	$ 11,400	
Primate Maintenance & Care (SFBR)	4,095	
Veterinary Support (examinations, anesthesia, blood sampling & analyses, assistance during exposure)	8,000	
Pulmonary Function Testing (36 tests)	9,600	
Construction of Primate Exposure Chamber	1,700	
Primate Respiratory Measurements (HCl/Air Exposures)	4,380	
HCl Exposure Generation/Analyses	19,450	
Primate CO_2 Challenges (36 tests) (includes animal transport, supplies, respiratory measurements and data analysis)	14,540	
Histopathology	1,000	
		74,165

Rodents

Rat/Mice Respiratory Measurements (HCl/Air Exposure)	5,200	
HCl Exposure Generation/Analyses	12,550	
Rat/Mice CO_2 Challenges (24 tests)	12,000	
Equipment for Respiratory Measurements (3 additional systems-transducers, plethysmographs, etc.)	3,500	
Blood Gas Analyses (cannulations, analyses)	1,500	
Histopathology	2,360	
		37,110

GLP Supervision of Animals (Daily Observations, Record Keeping)	3,600
STATISTICAL ANALYSIS SUPPORT	2,500
MANAGEMENT (Scheduling, Coordination, Supervision)	6,500
REPORTS (Technical Monitor Discussions, Presentations, Reports)	7,500
TOTAL	131,375

7.0 QUALIFICATIONS OF OFFEROR

7.1 Southwest Research Institute

Southwest Research Institute is a nonprofit organization devoted to government and industrial research. It has a permanent staff of over 2000. Research revenue in 1983 exceeded 115 million dollars.

The Institute was organized in 1947 and has nine divisions covering a wide range of skills and disciplines.

The divisions are:

- Applied Physics
- Chemistry and Chemical Engineering
- Electromagnetics
- Electronic Systems
- Energy Systems
- Engineering and Materials Services
- Engines, Fuels and Lubricants
- Instrumentation Research
- Quality Assurance Systems and Engineering

Located in San Antonio, Texas, the Institute currently utilizes approximately 471 acres of a 3500-acre site owned by the Southwest Research Center.

7.2 Department of Fire Technology

The Department of Fire Technology of the Division of Chemistry and Chemical Engineering at Southwest Research Institute represents one of the largest and most experienced organizations of its kind in the world, having been engaged in various aspects of fire technology for over 30 years. The Department has a full-time staff of 32, including 12 professional personnel encompassing disciplines of organic, physical, analytical and polymer chemistry, chemical engineering, mechanical engineering, fire services technology, inhalation toxicology, pharmacology and experimental psychology (Figure 3). Through various other departments of Southwest Research Institute, the Southwest Foundation for Biomedical Research, and a consortium arrangement with the

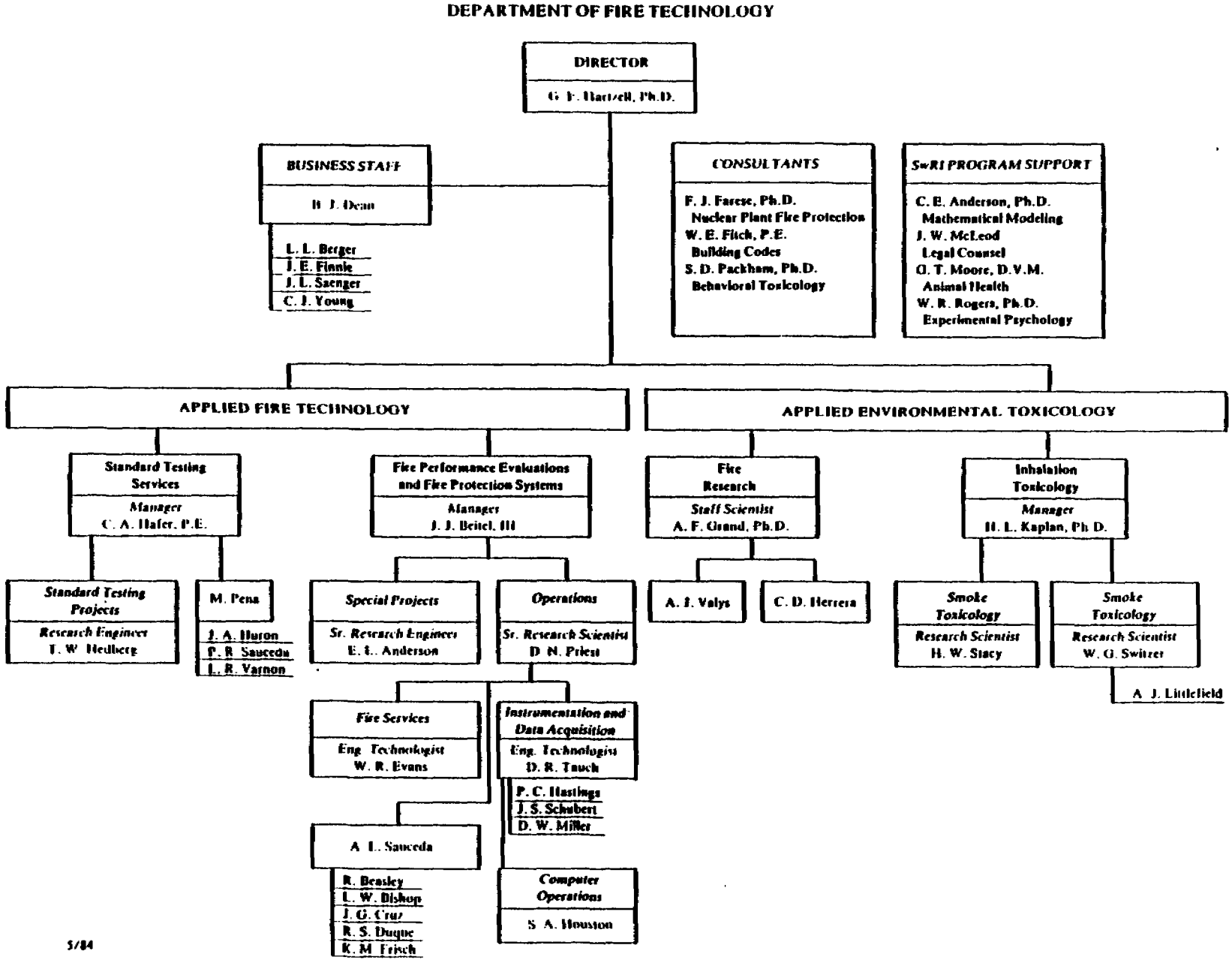

Figure 3. Organization Chart.

University of Texas Health Science Center, the Department of Fire Technology has available additional expertise in essentially all of the physical and biological sciences as may be desired.

The expertise of the SwRI staff is reflected in its participation with organizations and committees addressing numerous aspects of fire technology. Among these groups are the National Research Council of the National Academy of Sciences; American Society for Testing and Materials; International Standards Organization; International Conference of Building Officials; Southern Building Code Congress; Building Officials and Code Administrators, International; The Society of the Plastics Industry, Inc.; National Fire Protection Association; Foundation for Fire Safety; National Institute of Building Sciences; National Bureau of Standards; U. S. Fire Administration; National Aeronautics and Space Administration; Consumer Products Safety Commission; Department of Housing and Urban Development and Federal Aviation Administration. As a result of these activities, SwRI scientists are continually involved at the forefront of the scientific community addressing fire hazard issues.

The Department of Fire Technology also serves the fire science community in an educational role. In addition to performing the editorial function for the Journal of Fire Sciences (Technomic Publishing Company), the senior staff of the Department also periodically conducts workshops in fire technology. Three members of the staff have written a book entitled Combustion Toxicology: Principles and Test Methods, published in 1983.

The Department is housed in two recently constructed facilities located on the west campus of the Institute. The modern and well-equipped structures contain 10,400 square feet of floor space devoted to offices, research laboratories and small-animal housing facilities, with an additional 7,400 square feet of high-bay area for large-scale fire evaluation work. The

Department utilizes two Wang computer systems, a 2200T and an MVP, which are directly interfaced to instruments via analog/digital scanning data loggers. Both hard and floppy disk drives provide extensive versatility and high volume data storage capability. The computer system has two printers, one of which has plotting capabilities. The Department also has extensive capabilities for color video monitoring and recording via closed-circuit television.

The experience of the Fire Performance Evaluations and Fire Protection Systems Section of the Department has ranged through the entire spectrum of fire technology, from laboratory research and development to full-scale evaluations of the performance of materials and systems, to fire protection engineering and design. Extensive expertise exists in 1) design and conduct of fire evaluations of materials and end-use items, 2) determination of fire hazard specifications for materials and systems, 3) design and testing of fire barriers to limit extent of fires, 4) evaluations of fire protection systems and components, 5) selection of materials for use in hazardous areas based on current technology, 6) application of state-of-the-art techniques to equipment and procedures for extinguishment of fires, and 7) fire protection surveys.

The Standard Testing Services Section of the Department of Fire Technology has participated in the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National Bureau of Standards and is accredited for the performance of standard fire testing. Some 35 different test evaluations are performed from small-scale "Bunsen Burner" (FAA 25.853) to larger scale flame spread (ASTM E84) and roof tests (ASTM E108). Open lines of communication are maintained with various building officials, architects, government agencies and with sponsor organizations in the evaluation of newly developed processes or products. As a service to industry and with the cooperation of the Bureau of Mines, equipment and expertise is available to

determine explosive limits of dusts under a variety of operating conditions.

The Applied Environmental Toxicology Section occupies over 1700 square feet of floor space in the new facility including two laboratories dedicated to combustion toxicology, a well-equipped necropsy/surgery laboratory and two rooms accredited for small-animal housing. The combustion toxicology laboratory utilizes a variety of methodologies for assessment of the toxicity of smoke produced from the burning of materials. Both conductive and radiant heat furnaces are used for smoke generation. In addition to conventional dose-response studies involving lethality of subject animals, instrumentation is available for behavioral response studies utilizing leg flexion, rotorod and tumble cage techniques. Laboratory instrumentation permits analysis of combustion atmospheres. Specialized analytical instrumentation is used for analysis of carboxyhemoglobin, blood gases and selected combustion products in blood specimens. Particular emphasis is placed on the research capability and experience of the smoke toxicology section.

The analytical capabilities of the Department are focused primarily on the monitoring and recording of both thermal and combustion product analytical data from fire studies on all scales. Capabilities include the use of continuous analyzers for carbon monoxide, carbon dioxide, oxygen, total hydrocarbons, and nitrogen oxides. Methods for continuous analysis of hydrogen chloride, hydrogen cyanide and acrolein are under development. Intermittent analyses of halogen acids (HF, HCl, and HBr) and hydrogen cyanide are currently provided by techniques involving absorption tubes and wet chemical analyses. Gas chromatographic methods for CO, CO_2, acrolein, benzene and acetaldehyde are also available. Readily accessible within the Division of Chemistry and Chemical Engineering are more sophisticated capabilities, including gas chromatography/mass spectrometry, ultraviolet and visible spectro-

scopy, and Fourier Transform infrared spectroscopy.

Members of the staff of the Department of Fire Technology have either in progress, recently conducted, or collaborated on a wide variety of projects. Project titles and brief descriptions of the projects are presented, except in cases where the proprietary nature of the work, as well as identification of the sponsor, must remain confidential.

- Acute Inhalation Toxicity Study of Combustion Products of Polymeric Materials. Project No. 01-7148, Current.

  The objective of this study is to assess the acute inhalation toxicity of smoke produced from the combustion of a variety of polymeric materials using the U.S. National Bureau of Standards test method supplemented with additional toxicological and analytical measurements. The test protocol provides for measurement of time-to-incapacitation, observations of clinical signs and determination of growth pattern effects in addition to lethality measurement in order to fully define the toxicity of the combustion atmospheres. Continuous and frequent analyses of appropriate combustion gases are made to enable correlation of the analytical data with the toxicity data and identification of the toxicant species.

- Investigation of the Hazards Posed by Chemical Vapors Released in Marine Operations - Phase II. Project No. 06-5686-006, Current.

  The objective of this study is to provide a comprehensive assessment of the toxicological hazards of exposure to chemical vapors released during marine operations. Analytical and biomonitoring data have been obtained relevant to concentrations of selected chemical vapors in the maritime environment during operations on tankers and barges. Exposure of personnel to these vapors may involve single event or repeated exposure to either single compounds or mixtures of these vapors. The analytical and biomonitoring data will be evaluated to determine the potential hazards of these different exposure environments.

- The Potential Contribution of Carpets and Rugs to Toxic Emission Hazards in Building Fires: A Research Study, Project No. 01-7369, Current.

  The primary objective of this program is the definition of the possible roles of carpets and rugs (including underlayment) in the toxicological hazards of real fire situations. Two separate, but coordinated, work phases are involved. One phase involves the evaluation of representative carpet and rug systems using two different laboratory smoke toxicity test methods (NBS and Radiant Panel). The other phase will define

the conditions under which carpeting would likely be exposed in real fire scenarios, and evaluate the potential contribution of various carpeting and rugs to overall hazard. The latter phase involves both experimental work and applied modeling.

- Comprehensive Large-Scale Fire Performance Evaluations of Materials. Project No. 01-7207, Current.

  This large-scale program involves characterization of the performance of materials in real-fire scenarios. Emphasis is on quantification of smoke and fire gases to provide for the assessment of the formation, transport and decay phenomena associated with time and distance from a fire zone.

- Combustion Gas Analysis - Ft. Lauderdale. Sponsor: NFPA Research Foundation, Project No. 01-7238, September 1982.

  This project provided for the monitoring of temperatures, smoke obscuration and fire gases (CO, HCl and HCN) in a series of fire tests conducted in five rooms of a building in Ft. Lauderdale. The work was in support of a joint effort by the NFPA Research Foundation, the U. S. Fire Administration and the Marriott Corporation to demonstrate the efficacy of polybutylene pipe sprinkler systems.

- A Research Study of the Assessment of Escape Impairment from Postcrash Aircraft Fires Due to Irritant Combustion Gases. Sponsor: Department of Transportation, Federal Aviation Administration Technical Center, Project No. 01-6745, Current.

  The objectives of this research program are to: 1) determine the potential of representative combustion atmosphere irritant gases to impair human escape from a fire environment, and 2) evaluate the validity and relevance of behavioral tasks that are presently used for materials evaluation in laboratory smoke toxicity tests with rodents. A nonhuman primate model and operant behavioral methodology are used to determine the threshold concentration for escape impairment when primates are exposed to systemic and irritant toxicants for the short periods of time relevant to escape from postcrash fire scenarios. A behavioral task of equivalent complexity is used with rodents under similar exposure conditions in order to compare the sensitivity and response of the two species and evaluate current methodology for measurement of escape impairment in laboratory smoke toxicity tests.

- Fire Modeling/Spread of Fire Effects From Room To Room. Sponsor: Southwest Research Institute. Project No. 01-9331, Current.

  The goal of this program is to develop an applied (zone-type) model of the burning process that will have direct applicability to full-scale fire simulations. The basis for this computer model is the Harvard Fire Code which will be modified to

accommodate multiple-room environments.

- A Critical Review of the State-of-the-Art of Combustion Toxicology. Project No. 01-6862, June 1982.

  The objective of this program was to conduct a critical review of the state-of-the-art of combustion toxicology and prepared a documented treatise suitable for educational use.

- Full-Scale Tests of the Flopetrol Offshore Burner. Project No. 01-7108, January 1983.

  Full-scale tests were conducted to establish the capability of an offshore burner of burning gas containing 80 to 85 percent noncombustible gases, the balance being essentially methane, when utilizing diesel fuel as a flame booster and operating at a flow rate of approximately 25 MMscf per day.

- Derating Effects of a Fire Proofing Material When Applied to Electrical Systems. Project No. 01-7253, Current.

  Current fire protecton requirements in nuclear power generating plants provide that backup safety shutdown circuits be fireproofed. In addition to the fire proofing tests, evaluations must be conducted on the fire proofing material to determine its ampacity derating characteristics. These tests were performed to determine the ampacity derating, if any, of copper conductor cable covered by a proprietary fire proofing material.

- Burning Characteristics of Foam Insulations. Project No. 01-7354, February 1983.

  The objective of this test program was to determine the burning characteristics of foam insulation materials when tested in accordance with test method PICC-401/March 1980, "An Enclosed Room Fire Test."

- Burning Disposal of Acrolein. Project No. 01-7339, March 1983.

  The purpose of this program was to determine whether or not acrolein could be effectively disposed of by burning in small, open pits and then to extrapolate the data to a simulated full-scale open pit burning.

- Evaluation of Burning Characteristics of Upholstered Chairs. Project No. 01-6911, March 1982.

  The objective of this program was to evaluate the relative ignition and flame spread properties of several chairs composed of fabric-covered urethane foam cushions on wood frames. The tests were full-scale simulations (i.e., entire items tested in a room-size environment) in order to make comparisons to smaller scale tests and other full-scale exper-

iments.

- Acute Inhalation Toxicity Study of Combustion Products in a Room-Sized Combustion/Exposure Chamber. Project No. 01-5921.

  The toxicity of smoke from smoldering flexible polyurethane foam was assessed in a series of room-sized burns and related to laboratory-scale tests on the same material. Toxicological potencies were comparable, but the nature of the insults differed somewhat. Deaths of rodents due to carbon monoxide and irritant-induced deaths from post-exposure bacterial infection were both observed. The project involved a significant histopathology study.

- Interlaboratory Evaluation of National Bureau of Standards Smoke Toxicity Test Protocol. Project No. 03-5708, December 1980.

  The SwRI Department of Fire Technology participated in the U.S. National Bureau of Standards Interlaboratory Evaluation of a developmental smoke toxicity test protocol. Experimental work involved the assessment of five materials for smoke toxicological potencies and incapacitation rate effects.

- Acute Inhalation Toxicity Study of Combustion Products from Halogenated Polymers. Project No. 01-6447, October 1981.

- Acute Inhalation Toxicity Study of Combustion Products. Project No. 01-6165, August 1981.

- Acute Inhalation Toxicity Study of Combustion Products. Project No. 01-6072, March 1981.

  In the three projects listed above, the acute inhalation toxicities of fire gases produced from the burning of selected materials were assessed using modifications of the U.S. National Bureau of Standards developmental protocol. Additionally, times-to-sublethal effect as functions of smoke concentrations were determined and related to potential relative tenability hazards.

  Analytical support for these programs included hydrogen halide gases. Preparation for the programs included experimentation to insure that the analytical techniques could differentiate among the various species present. A gas permeation device was utilized to generate atmospheres of hydrogen cyanide and hydrogen halide gases to test the efficiencies of the measurement systems.

- Investigation of the Interactive Effects Between Carbon Monoxide and Hydrogen Cyanide on Time-to-Incapacitation for Fire Hazard Modeling. Sponsor: Southwest Research Institute, Project No. 01-9316, Current.

The objective of this effort was to investigate the interactive effects between CO and HCN in mixtures on time-to-incapacitation in rodents. These gases were evolved by the thermal decomposition of many natural and synthetic materials. By determining whether the interactive effects are additive or synergistic, the study enabled establishment of appropriate tenability limits for mixtures of CO and HCN. These limits are essential for risk assessment of nitrogen-containing materials and fire hazard modeling.

- Evaluation of a Radiant Energy Combustion Device for Small-Scale Toxicity Testing and Research. Project No. 01-6655, Current.

  The objective of this project was to evaluate a prototype radiant energy device as a replacement for the presently used conductive furnace in laboratory toxicity tests. Thermal decomposition of materials by radiant heat is more relevant to real fires than by conductive heat. Also, the radiant energy device permitted testing of construction materials which could not be tested by the conductive furnace due to its inherent operational limitations. In this study, test parameters were established for use of this device and standard materials were tested to enable a comparison of results using the radiant and conductive heat furnaces.

- Fire Test Methodology for Aerospace Materials, Thermal and Smoke Toxicological Assessment of Graphite/Bismaleimide and Graphite/Epoxy Systems. Sponsor: National Aeronautics and Space Administration, Project No. 01-5565, NASA Contract No. NAS3-10140, October 1980.

  Assessment of the toxicological insults produced from the burning of two advanced materials was made using rodents for studying lethal and incapacitating effects. Thermal properties of the materials were also determined.

- Assessment of Burning Characteristics of Aircraft Interior Materials Task I, Analog Seats. Sponsor: National Aeronautics and Space Administration, Project No. 01-5584, NASA Contract No. NAS2-10148, March 1981.

  A study on the fire safety of advanced aircraft seat cushioning materials was performed for NASA. The program involved physical and chemical characterization of the combustion of the seats under simulated postcrash fire conditions. A toxicological assessment of the fire gases produced during each test was also performed.

- Investigation of Combustion Atmospheres in Real Building Fires. Sponsor: The Society of the Plastics Industry, Incorporated and U.S. Fire Administration, Project No. 01-6067, June 1981.

  This program involved the sampling of atmospheres in real building fires, using custom-made gas sampling boxes worn by

firemen. Analyses were performed for hydrogen chloride, acrolein, acetaldehyde, benzene, hydrogen cyanide, carbon monoxide, carbon dioxide, oxygen, and soot particle size.

- The Study of Changes in Blood Composition After In Vivo Exposure to Fire Off-Gases. Sponsor: Products Research Committee, Project No. 03-5288, PRC No. RP-78-U-1, November 1979.

  Toxicological insults produced from the burning of common cellular plastics were assessed. Changes in blood composition (hemoglobin, oxyhemoglobin, carboxyhemoglobin, methemoglobin, cyanomethemoglobin and blood gases) were studied in exposed rodents.

- Studies of Health Effects of Acute Exposure to Diesel Engine Emissions. May 1981.

  A research study of the toxicological effects of acute exposure to diesel engine emissions, with emphasis on carcinogenicity and effects on the pulmonary system. Inhalation exposure of more than two thousand rodents consisting of rats, hamsters and mice was required. Biomedical phases of the study included gross and histopathology, biochemical studies of alveolar macrophages, ultrastructural and morphometric studies of the lungs, pulmonary adenoma response and general toxicology.

- Studies of Potential Health Effects of Chronic Exposure to Diesel Engine Emissions. February 1982.

  A research study of the toxicological effects of chronic exposure to diesel engine emissions. This study was similar to the acute study, except it was much larger in scope. Approximately 5,000 rodents were exposed 20 hours per day, 7 days per week for 15 months to filtered air or to one of 3 concentrations of diluted diesel exhaust.

- Evaluate the Life and Property Hazards of Plastic and Traditional Furnishings of Completely Furnished Rooms: Volume I: Burning Characteristics and Off-Gas Analyses. Project No. 03-4328, Sponsor: Products Research Committee, November 1976.

  The objective of this program was to evaluate the burning characteristics and combustion products resulting from large-scale residential fire simulations involving household furnishings of traditional versus plastic materials. The program involved establishing methods for combustion gas sampling and analysis. The work also showed the effectiveness of an experimental facility designed for evaluating fires that originate in a given room with communication to other areas as in a residential dwelling.

- Large-Scale Burn Tests. Project No. 03-4639-003, November 1978.

This program examined the combustibility performance of polystyrene home furnishings in a full-scale living room fire simulation. This work required the coordination of a multidisciplinary team involved with the analysis of temperatures, combustion gases and burning characteristics and the exposure of laboratory animals for behavioral, pathological and hematological measurements. This program was performed in SwRI's burn facility which simulates a residential dwelling.

- Furnished Living Room Burn Tests. Project No. 01-6358, January 1981.

  This program examined the burning behavior of various home furnishings in a full-scale living room fire simulation. The work analyzed the combustion gases generated, the temperatures obtained and smoke levels attained during fully vented fire combustion. This work was performed in Southwest Research Institute's burn facility, which represents a residential dwelling.

- Multi-Story Fire Performance Evaluations. Project No. 01-6112, November 1980.

  A series of six full-scale fire evaluations of various exterior wall systems was conducted. The objectives of this program was to evaluate the fire performance characteristics of foamed plastic, insulated nonbearing wall systems in a multistory, full-scale fire test configuration.

- Evaluation of the Burning Characteristics of Selected Mattress F am Materials. Project No. 03-5097, March 1979.

  This program evaluated the combustibility of various foam materials used in the manufacture of mattresses. This work involved an analysis of the combustion gases, mode levels, and temperatures attained during full-scale flammability tests in SwRI's burn room facility.

- Pool Fire Characteristics of Heat Transfer Fluids. Project No. 03-5966, August 1980.

  The release rates of heat, smoke and combustion products were studied for pool fires involving selected heat-transfer fluids. Experiments involved 2-ft and 4-ft square pans in a 9 x 9 x 9-ft "room" calorimeter and in an outdoor "free burning" environment.

- Full-Scale Fire Behavior of Mattress Foams. Project No. 03-5469, August 1980.

  Full-scale tests were conducted in a multi-room fire test facility to evaluate the performance of several candidate mattresses for institutional applications.

- The Effect of Major Fire Scenarios on Smoke Detector Response. Project No. 03-5430, May 1979.

  This program studied the relationship of smoke detector response to various parameters induced by smoldering combustion in a closed single room. The objective was to study the relationship of time to smoke density, particle size, major combustion gases (CO, CO_2, O_2, total hydrocarbons), temperature, behavioral incapacitation of rats and various parameters in the blood of those rats. These parameters included total hemoglobin, oxygen and carboxyhemoglobin, methemoglobin and the standard blood gas measurement. The scenarios were conducted in a full-scale multi-room, multi-level facility with combustion in both smoldering and flaming modes.

- Standard Testing Services. Sponsor: Multi-Client, 1957 and Continuing.

  Some 35 different test evaluations are performed covering small-scale "Bunsen Burner" (FAA 25.853) to larger scale Flame Spread (ASTM E84) and Roof tests (ASTM E108). Over 500 evaluations are performed each year for approximately 150 clients. Standard fire testing began in 1957 and such tests continue to provide accurate material on systems comparisons in their fire performance capability.

  Reports of the information and data obtained during each test conducted are used by the Client to obtain acceptance/approval from code officials, fire marshalls, architects, etc. The Southwest Research Institute Department of Fire Technology is accredited for certain test methods, (ASTM E84, ASTM E648, and UL992) by the National Voluntary Laboratory Accreditation Program (NVLAP) sponsored by the U.S. National Bureau of Standards.

- Liquid Spill Hazards. Project No. 03-4565, December 1979.

  The objective of the program was to identify and demonstrate methods of controlling liquid spill hazards in the event of a transportation accident. The materials considered were silicon tetrachloride and alkylchlorosilanes. Two types of hazards were considered: fire and toxic gas fuming.

- Dust Explosibility. Sponsor: Multi-Client, March 1965 and Continuing.

  The explosion hazard of finely divided solids presents a continuing problem for industry. Modern techniques of pneumatic transport of dusts, frequently at elevated temperatures, intensifies the problem. As a service to industry and with the cooperation of the Bureau of Mines, equipment is available in the Department of Fire Technology to determine explosive limits of dusts under a variety of operating conditions. This work has been followed frequently by on-site investigations to

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- Evaluation of Smoke Detector/Alarm Systems According to AT & T Specifications. Sponsor: Multi-Clients, Industrial, Project Nos. 01-5925, 01-6265, 01-6483, 01-6614, 01-6845, 01-6848.

  A series of tests were performed utilizing the detector heads and control panels. Each series included variations in air flow, fuel source, ignition source and location of smoke generating equipment.

- Aerosol Can Fire Hazards. Project Nos. 03-5003 and 01-5630, September 1980; and 01-6870, 01-6871 and 01-7384, Current.

  Threshold flammability limits on aerosol cans and multi-pallet aerosol can storage for fire hazard potential in a simulated warehouse (sprinkler system protected) configuration were evaluated.

- Fire Tests on Navy Bulkhead Systems. Project No. 03-5347, 1979.

  The objective of this program was to evaluate various bulkhead materials for: 1) fire endurance, 2) flame spread, 3) smoke generation, 4) combustion gases, and 5) rate of heat release.

- Measurement of Concentrations of Halon 1301 Required to Extinguish Flames in Elastomers Containing Increasing Amounts of Nitrates. Project No. 01-6265.

  A simulated glove box was constructed wherein accurate control of halon concentrations and air flow was made. Extinguishment at halon concentrations/flow rate was noted.

Qualifications

GORDON E. HARTZELL
Director
Department of Fire Technology
Division of Chemistry and Chemical Engineering

B.S. in Chemistry, Ohio University, 1955
Ph.D. in Organic Chemistry, University of Illinois, 1958

Dr. Hartzell's industrial background of nearly 20 years includes a wide range of research activities in organic and polymer chemistry. Of particular relevance was his work in flammability of materials, fire retardant systems, smoke evolution studies and large-scale fire testing.

Dr. Hartzell was an Industrial Research Associate at the Flammability Research Center of the University of Utah during 1975-77, after which he was appointed a Research Associate Professor of Materials Science. At the University of Utah, Dr. Hartzell was involved in the development of methodology for the toxicological assessment of smoke, including use of an animal model for assessing incapacitating and lethal effects. He was responsible for the development and implementation of smoke toxicity protocols for a variety of industrial and government sponsors.

In 1978, Dr. Hartzell was appointed Director of the Department of Fire Technology at Southwest Research Institute, with overall responsibility for programs in real-fire performance evaluation of materials and systems, standard fire testing services, analysis of combustion products and toxicological assessment of smoke. In this role, he continues to work closely with industry, standards organizations and regulatory agencies as new methodology is developed and toxicological evaluations are employed in hazard assessment. Dr. Hartzell holds six U.S. patents and has authored 28 papers, largely in the field of fire technology and combustion toxicology.

Dr. Hartzell was a member of the National Bureau of Standards Ad Hoc Smoke Toxicity Advisory Committee. He is a member of the American Society for Testing and Materials Committee E.5 on Fire Standards and is currently serving on two ASTM E5.21 Task Groups on Smoke Toxicity. A member of the U.S. Technical Advisory Group for International Standards Organization TC92/SC3 on Toxic Hazards in Fire, Dr. Hartzell also serves on that subcommittee's working groups. He also worked on the Special Aviation Fire and Explosion Reduction (SAFER) Committee of the Federal Aviation Administration. Dr. Hartzell is an author of "Combustion Products and Their Effects on the Life Safety" in the NFPA Fire Protection Handbook - Fifteenth Edition and is a co-author of Combustion Toxicology: Principles and Test Methods, published by Technomic Publishing Company. He also serves as Editor-in-Chief of the Journal of Fire Sciences.

PROFESSIONAL CHRONOLOGY: The Dow Chemical Company, 1958-77; (Research Chemist, 1958-63; Project Leader, 1963-6; Research Placement Manager, 1966-8; Industrial Relations Manager-Research, 1968-72; Research Specialist, 1973-5; The Flammability Research Center, University of Utah, Research Associate, 1975-7); University of Utah Flammability Research Center, 1977-8 Research Associate Professor of Materials Science; Southwest Research Institute, Director, Department of Fire Technology, 1978-.

MEMBERSHIP: American Chemical Society, Sigma Xi, American Society for Testing and Materials, National Fire Protection Association.

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Gordon E. Hartzell

PUBLICATIONS/PRESENTATIONS

1. C. S. Marvel and G. E. Hartzell, "Preparation and Aromatization of Poly-1, 3-Cyclohexadiene," J. Am. Chem. Soc., 81, 448 (1959).

2. G. E. Hartzell and E. S. Huyser, "Generation of Methyl Radicals by Decomposition of Bibenzyl Compounds Containing ∝-Methoxy Substituents," J. Org. Chem., 29, 3341 (1964).

3. G. E. Hartzell, C. J. Bredeweg and B. Loy, "Physical and Chemical Properties of the ∝-Methoxydiphenylmethyl Radical," J. Org. Chem., 30, 3119 (1965).

4. E. C. Steiner and G. E. Hartzell, "Device for Measuring Instantaneous Rates of Gas-Evolving Reactions," J. Chem. Ed., 42, 559 (1965).

5. G. E. Hartzell and Janet N. Paige, "Ethylene Episulfoxide," J. Am. Chem. Soc., 88, 2616 (1966).

6. G. E. Hartzell and J. N. Paige, "Stereochemistry of the Decomposition of 2-Butene Episulfoxides," J. Org. Chem. 32,459 (1967).

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8. G. E. Hartzell, "Fire Research and Public Safety," 64th National Safety Congress and Exposition, Chicago, Illinois, October 21, 1976.

9. G. E. Hartzell, S. C. Packham, F. D. Hileman, S. C. Israel, M. L. Dickman, R. C. Baldwin, and R. W. Mickelson, "Physiological and Behavioral Responses to Fire Combustion Products," Fourth International Cellular Plastics Conference, Society of the Plastics Industry, Montreal, Canada, November 18, 1976.

10. G. E. Hartzell and W. A. Galster, "The Role of Asphyxia in the Investigation of Animal Responses to Fire Combustion Products," Eighth Conference on Environmental Toxicology, Dayton, Ohio, October 4, 1977.

11. G. E. Hartzell, "Protocol Development for Assessment of Smoke Toxicity," Fire Retardant Chemicals Association Semi-Annual Meeting, Chicago, Illinois, October 31, 1977.

PUBLICATIONS/PRESENTATIONS (Continued)

12. G. E. Hartzell, "Laboratory Assessment of Incapacitating and Lethal Effects of Burning Materials," Third International Conference on Fire Safety, University of San Francisco, San Francisco, California, January 16 - 20, 1978.

13. G. E. Hartzell, "Advances in Fire Combustion Product Toxicology," Conference on Flame Retardants and Plastics, Society of Plastics Engineers, Inc. -- Fire Retardant Chemicals Association Joint Conference, Houston, Texas, March 13 - 15, 1978.

14. G. E. Hartzell, "Assessment of Smoke Toxicity - A Progress Report," Society of the Plastics Industry, Incorporated Eighth Annual Symposium on Consumer Safety, Houston, Texas, March 28-29, 1979.

15. D. G. Farrar, G. E. Hartzell, T. L. Blank, and W. A. Galster, "Development of a Protocol for the Assessment of the Toxicity of Combustion Products Resulting from the Burning of Cellular Plastics," Final Report to the Products Research Committee, UTEC 79/ 130, Flammability Research Center, University of Utah, Salt Lake City, Utah, September, 1979.

16. S. C. Packham and G. E. Hartzell, "Fundamentals of Combustion Toxicology in Fire Hazard Assessment," J. of Testing and Evaluation, Vol. 9, No. 6 (November 1981), p. 341.

17. G. E. Hartzell and W. G. Switzer, "Combustion Products and Their Effects on Life Safety," Fire Protection Handbook, Fifteenth Edition, Section 3, Chapter 3, National Fire Protection Association, Quincy, Massachusetts, 1981.

18. G. E. Hartzell, "Toxic Products From Fires," American Academy of Industrial Hygiene and American Academy of Occupational Medicine Joint Conference on Occupational Health, Nashville, Tennessee, October 14, 1981.

19. G. E. Hartzell, "Generation of Combustion Atmospheres in the Laboratory for Purposes of Toxicological Assessment," Presentation to Society of Toxicology Meeting, Boston, Massachusetts, February 25, 1982.

20. G. E. Hartzell, S. C. Packham and W. G. Switzer, "Assessment of Toxic Hazards of Smoke Toxicological Potency and Intoxication Rate Thresholds," INTERFLAM '82 International Conference on Flammability, University of Surrey, Guilford, England, March 31, 1982.

PUBLICATIONS/PRESENTATIONS (Continued)

21. H. L. Kaplan, A. F. Grand and G. E. Hartzell, Combustion Toxicology: Principles and Test Methods, Technomic Publishing Company, Incorporated, Lancaster, Pennsylvania, 1983.

22. G. E. Hartzell, "Fundamentals of Combustion Toxicology in Fire Hazard Assessment," 7th Annual Inland Spills Conference, Columbus, Ohio, September 27, 1982.

23. G. E. Hartzell, "The Role of Smoke Toxicity Testing," Society of the Plastics Industry, Inc., Polyurethane Division 27th Annual Technical/Marketing Conference, Bal Harbour, Florida, October 20, 1982.

24. G. E. Hartzell, "Toxicity and the Smoke Problem," Society of Fire Protection Engineers Symposium, University of Maryland, College Park, Maryland, February 16, 1983.

25. G. E. Hartzell, "Smoke Toxicity Testing," Fire Retardant Chemicals Association Conference, Baltimore, Maryland, March 22, 1983.

26. G. E. Hartzell, "Development of a Standard Test Protocol and its Recommended Uses," Society of the Plastics Industry, Incorporated, 11th Combustibility Symposium, Washington, D.C., April 13, 1983.

27. G. E. Hartzell, S. C. Packham and W. G. Switzer, "Toxic Products From Fires," Am. Ind. Hyg. Assoc. J., 44 (4): 248-255 (1983)

28. G. E. Hartzell, S. C. Packham and W. G. Switzer, "Assessment of Toxic Hazards of Smoke: Toxicological Potency and Intoxication Rate Thresholds," Fire and Materials, Vol. 7, No. 3, pp. 128-131 (1983).

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30. H. L. Kaplan and G. E. Hartzell, "Modeling of Toxicological Effects of Fire Gases: I. Incapacitating Effects of Narcotic Fire Gases," J. Fire Sciences (In Press).

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B.A., Psychology, Harvard University, 1946
M.A., Biology, Boston University, 1948
B.S., Pharmacy, Massachusetts College of Pharmacy, 1951
Ph.D., Toxicology/Pharmacology,
Indiana University Medical School, 1967

Dr. Kaplan has had extensive experience as a researcher, laboratory supervisor and administrator in a wide range of toxicology disciplines including environmental, combustion and forensic toxicology. Prior to joining the Southwest Foundation for Research and Education and the Southwest Research Institute, he was chief of the Toxicology Section at the National Aeronautics and Space Administration's Johnson Space Center. In this position, he was responsible for evaluating the potential toxicity of spacecraft atmospheres and for determining the requirements for environmental control systems. He also directed the combustion toxicity testing and evaluations of candidate aircraft and spacecraft materials for NASA's materials selection program. A review of the toxicology and risk assessment of spacecraft contaminants was authored by him in the NASA publication, The Physiological Basis of Spacecraft Design Requirements.

During the past six years at Southwest Research Institute, Dr. Kaplan has conducted research in the areas of combustion toxicology, inhalation toxicology and risk assessment, with studies of the acute inhalation toxicity of industrial chemicals and combustion products of plastics and studies of chronic exposure to diesel exhaust emissions. He is currently program manager and/or principal investigator in several projects investigating the toxicity of combustion gases in rodents and primates. Dr. Kaplan is a co-author of two reference books entitled Combustion Toxicology: Principles and Test Methods and Alcohols Toxicology. He also serves as an Associate Editor of the Journal of Fire Sciences.

PROFESSIONAL CHRONOLOGY: Graduate student in toxicology and teaching assistant, Indiana University Medical School, 1963-1967; Research Toxicologist, Aerospace Medical Research Laboratory, 1967-1970; Director, Air Force Drug Abuse Testing Laboratory, 1971-1973; Consultant Toxicologist to Air Force Strategic Air Command, 1973-1974; Chief, NASA/Johnson Space Center Toxicology Section, 1974-1978; Foundation Scientist, Southwest Foundation for Research and Education and Institute Toxicologist, Southwest Research Institute, 1978-1980; Southwest Research Institute, Manager, Applied Environmental Toxicology, Department of Fire Technology, 1980-.

MEMBERSHIPS: American Academy of Forensic Sciences (Fellow), Society of Toxicology, International Association of Forensic Toxicologists, Southwest Association of Toxicologists.

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PUBLICATIONS/PRESENTATIONS

1. Postman, L. and H. L. Kaplan. Reaction time as a measure of retroactive inhibition. J. Exp. Psych. 37:136-145, 1947.

2. Kaplan, H. L., R. B. Forney, F. W. Hughes, and A. Richards. Comparative effects of hypnotics on mental and physical performance. Proc. XXIII Int. Cong. Physiol. Sci. 1071, 1965.

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8. Kaplan, H. L., R. B. Forney, F. W. Hughes, A. Richards, and N. C. Jain. Chloral hydrate-alcohol interactions in the mouse and dog. Toxicol. Appl. Pharmacol. 14:127-137, 1969.

9. Lathrop, G. D., H. L. Kaplan, and J. E. Wallace. Drug abuse detection efforts. AGARD Conf. Proc. (AGARD-CP-108), A14, 1-4, 1973.

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11. Geller, I., J. R. Rowlands, and H. L. Kaplan. Effects of ketones on lever-pressing behavior of rats. Proc. 1st Int. Symp. Voluntary Inhal. Indus. Solvents, June 21-24, 1976, Mexico City, D.F.

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12. Kaplan, H. L. and I. Geller. Effects of methyl ethyl ketone and methyl isobutyl ketone on the behavior of the juvenile baboon. Proc. 1st Int. Symp. Voluntary Inhal. Indus. Solvents, June 21-24, 1976, Mexico City, D.F.

13. Russo, D. M., H. L. Kaplan, and L. Young. The effects of scopolamine and d-amphetamine on two different schedules of reinforcement. Presented at Southwestern Psychol. Assn. Mtg., 1977, Ft. Worth, TX.

14. Kaplan, H. L., Contaminants. In: Physiological Basis of Spacecraft Environmental Design, D. Grounds, ed. General Electric Co., Space Division, Contract NAS 9-15094, Dec. 1977.

15. Russo, D. M. and H. L. Kaplan. Effects of carbon monoxide on two behavioral measures in the rat. Proc. West. Pharmacol. Soc., 21:419-425, 1978.

16. Garcia, C. R., I. Geller, and H. L. Kaplan. Effects of ketones on lever-pressing behavior of rats. Proc. West. Pharmacol. Soc., 21:433-438, 1978.

17. Geller, I., R. L. Martinez, R. J. Hartmann and H. L. Kaplan. Effects of ketones on a match-to-sample task in the baboon. Proc. West. Pharmacol. Soc., 21:439-442, 1978.

18. Geller, I., Rowlands, J. R. and Kaplan, H. L., "Effects of Ketones on Operant Behavior of Laboratory Animals," DHWE Publ. Adm- 79-779, Voluntary Inhalation of Industrial Solvents, 1978, pp. 363-376.

19. Geller, I., E. Gause, H. L. Kaplan and R. J. Hartmann. Effects of acetone, methyl ethyl ketone and methyl isobutyl ketone on a match-to-sample task in the baboon. Pharmacol. Biochem. Behav. 11:401-406, 1979.

20. Kaplan, H. L., MacKenzie, W. F., Springer, K. J., Schreck, R. M., and Vostal, J. J., "A Subchronic Study of the Effects of Exposure of Three Species of Rodents to Diesel Exhaust," Proceedings of EPA 1981 Diesel Emissions Symposium, Raleigh, North Carolina, October 5-7, 1981.

21. Kaplan, H. L., "Perspectives in Smoke Toxicity - Hazards to Humans," Presentation to ASTM E05 Research Review Session, Houston, Texas, December 8, 1981.

22. Kaplan, H. L., "An Overview of Combustion Toxicology," presentation to the Joint Meeting of The Society of the Plastics Industry, Incorporated (CCCS) and The Fire Retardant Chemicals Association, San Antonio, Texas, March 18, 1982.

PUBLICATIONS/PRESENTATIONS (Continued)

23. Kaplan, H. L., Grand, A. F. and Hartzell, G. E. Toxicity and the Smoke Problem. J. of Combustion Toxicology, Vol. 9, p. 121-138, August 1982.

24. Kaplan, H. L., Grand, A. F. and Hartzell, G. E., Combustion Toxicology: Principles and Test Methods, Technomic Publishing Company, Incorporated, Lancaster, Pennsylvania, 1983.

25. Wimer, W. W., Russell, J. A. and Kaplan, H. L. Alcohols Toxicology. Noyes Publishing Company, Park Ridge, New Jersey (1983).

26. Kaplan, H. L., MacKenzie, W. F., Schreck, R. M., Vostal, J. J. A Chronic Inhalation Exposure Study of Diesel Exhaust in Rodents. The Toxicologist, Volume 3, No. 1, March 1983.

27. Kaplan, H. L., Grand, A. F., Switzer, W. G. and Gad, S. C. Acute Inhalation Toxicity of the Smoke Produced by Five Halogenated Polymers. The Toxicologist, Volume 3, No. 1, March 1983.

28. Kaplan, H. L., "State-of-the-Art of Toxicity Tests," Presented at the Fire and Plastics Seminar of the California Fire Chiefs Association, June 29, 1983, Oakland, California.

29. Kaplan, H. L., Grand, A. F., Mitchell, D. S., Switzer, W. G. and Hartzell, G. E. "A Research Study of the Assessment of Escape Impairment from Postcrash Aircraft Fires Due to Irritant Combustion Gases," Presented at the Gordon Research Conference on Physiological and Toxicological Aspects of Combustion Products, August 14-19, 1983, New London, New Hampshire.

30. White, H., Kaplan, H. L. and MacKenzie, W. F. Is There a Neoplastic Potential Resulting From Long-Term Inhalation of Diesel Emissions? Science, 1983 (In Press).

31. H. L. Kaplan, A. F. Grand and G. E. Hartzell, "Toxicity and the Smoke Problem," Fire Safety J., 7, pp. 11-23 (1984).

32. H. L. Kaplan and G. E. Hartzell, "Modeling of Toxicological Effects of Fire Gases: I. Incapacitating Effects of Narcotic Fire Gases," J. Fire Sciences (In Press).

WALTER G. SWITZER
Research Scientist
Department of Fire Technology
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B.A. Trinity University, 1973
M.S. Trinity University, 1982

Mr. Switzer has had extensive experience as a researcher in the design, data analysis and interpretation involved in physiological/behavioral experimentation. Previous work has included an interdisciplinary approach to the study of microwave health effects involving cortical ultrastructure, hematologic profiles and behavioral studies.

At Southwest Research Institute, the majority of his work has been involved with the field of combustion toxicology. Over the last six years, Mr. Switzer has conducted numerous large-scale and hundreds of small-scale combustion experiments to elucidate the toxic nature of combustion atmospheres. This experimentation has utilized numerous designs, combustion techniques, behavioral paradigms and animal models; and covered an extensive range of materials, as well as pure gases. Currently, this experience is being combined with ongoing experimentation in the development of the theoretical and practical aspects of combustion toxicity testing and its relation to hazard analysis. In addition, he has introduced sophisticated blood collection and analytical techniques involving rodents, primates and other species for research involving correlation of hematologic parameters to behavioral and physiological effects. These studies have included toxicity of combustion atmospheres and pure gases, drug-gas interactions, crash impact survivability, and methemoglobin kinetics.

PROFESSIONAL CHRONOLOGY: Southwest Research Institute: Research Assistant, 1975-76; Research Scientist, 1977-.

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Walter G. Switzer

PUBLICATIONS/PRESENTATIONS

1. Mitchell, D. S., Switzer, W. G., and Bronaugh, E. L. Effects of chronic athermal microwave radiation on innate and learned behaviors in rats. International IEEE/AP-S Symposium and USNC/URSI Meetings, University of Massachusetts, Amherst, October 1976.

2. Switzer, W. G. and Mitchell, D. S. An electron microscopic and hematologic investigation of rats chronically exposed to low-intensity 2.45 GHz microwave radiation. International IEEE/AP-S Symposium and USNC/URSI Meetings, University of Massachusetts, Amherst, October 1976.

3. Mitchell, D. S., Switzer, W. G., and Bronaugh, E. L. Hyperactivity and disruption of operant behavior in rats after multiple exposures to microwave radiation. Radio Science, Supplement No. 6(S). 12: 263-271, 1977.

4. Switzer, W. G. and Mitchell, D. S. Long-term effects of 2.45 GHz radiation on the ultrastructure of the cerebral cortex and hematologic profiles in rats. Radio Science, Supplemental No. 6(S). 12:287-293, 1977.

5. Mitchell, D. S., Rogers, W. R., Herrera, W. R., and Switzer, W. G. Behavioral incapacitation of rats during full-scale combustion of natural fiber and synthetic polymeric furnishings. Fire Research, 1:187-197 (1977/78).

6. Rogers, W. R., Mitchell, D. S., Herrera, W. R., and Switzer, W. G. Hematologic correlates of behavioral incapacitation during full-scale combustion of natural fiber and synthetic polymeric furnishings. Journal of Combustion Toxicology, 5:290-304, 1978.

7. Hartzell, G. E. and Switzer, W. G., "Combustion Products and Their Effects on Life Safety," Fire Protection Handbook, Fifteenth Edition, Section 3, Chapter 3, National Fire Protection Association, Quincy, Massachusetts, 1981.

8. Hartzell, G. E., Packham, S. C. and Switzer, W. G., "Assessment of Toxic Hazards of Smoke Toxicological Potency and Intoxication Rate Thresholds," Interflam '82 International Conference on Flammability, University of Surrey, Guilford, England, March 31, 1982.

9. G. E. Hartzell, S. C. Packham and W. G. Switzer, "Toxic Products From Fires," Am. Ind. Hyg. Assoc. J., 44 (4): 248-255 (1983).

PUBLICATIONS/PRESENTATIONS

10. G. E. Hartzell, S. C. Packham and W. G. Switzer, "Assessment of Toxic Hazards of Smoke: Toxicological Potency and Intoxication Rate Thresholds," Fire and Materials, Vol. 7, No. 3, pp. 128-131 (1983).

11. H. L. Kaplan, A. F. Grand and W. G. Switzer, "Acute Inhalation Toxicity Study of the Smoke Produced by Five Halogenated Polymers," Society of Toxicology 22nd Annual Meeting, Las Vegas, Nevada, March 7-11, 1983.

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B.S., Zoology, Washington State University, 1975

As a researcher and laboratory manager in the field of combustion toxicology, Mr. Stacy has been involved in the design, development and application of a variety of laboratory-scale combustion toxicity testing strategies and devices. His experience has been primarily in the area of applying innovative research and testing techniques to fit specific fire exposure situations. He was primarily responsible for the design and development of a radiant heat furnace for the generation of combustion products for toxicological evaluation. This device is under consideration for use as an alternative sample heating method for laminated or composite materials in the National Bureau of Standard's toxicity test method. Mr. Stacy is also familiar with standard and non-standard large- and small-scale flammability evaluations and the analysis of combustion gases from these tests.

Mr. Stacy has interacted extensively with the fire science community in the development of the area of combustion toxicology. He was a representative on the National Bureau of Standards Ad Hoc Smoke Toxicity Advisory Committee and has served on the U.S. Technical Advisory Group for International Standards Organization TC92/SC3 on Toxic Hazards in Fire. He was responsible for the development and reporting of all the laboratory work in the Weyerhaeuser/National Forest Products Association particiation in the NBS interlaboratory evaluation.

PROFESSIONAL CHRONOLOGY: Weyerhaeuser Company, Research Assistant, 1976-1978, Research Scientist (Project Leader, Combustion Toxicology), 1978-1983; Southwest Research Institute, Research Scientist, 1983-.

ARTHUR F. GRAND
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B.S. in Chemistry, Union College (New York), 1963
Ph.D. in Physical Chemistry, The University of Michigan, 1968

Dr. Grand's industrial experience of 13 years encompassed applied and basic chemical research, product development and plant technical service. For 8 years, he was responsible for programs dealing with flammability, smoke evolution, analysis and toxicity of combustion products, and mechanisms of combustion of flame-retardant polymers. He has been active in ASTM Committee E-5 on Fire Standards and is currently Secretary of Subcommittee E5.21 on Smoke and Combustion Products. Dr. Grand is a co-author of Combustion Toxicology: Principles and Test Methods, publised by Technomic Publishing Company. He is also an Assoicate Editor of the Journal of Fire Sciences.

At Southwest Research Institute, Dr. Grand has been involved in programs dealing with the elucidation of the chemistry and dynamics of fires. These studies have included analysis of fire gases, measurement of rate of burning and rate of heat release, and computer modeling of fire growth. He is familiar with numerous analytical techniques, having been chairman of the task group that developed ASTM E800, and has applied this knowledge to the generation and monitoring of pure gases for toxicological studies. He is currently developing increased capability at Southwest Research Institute for measurement of the rate of heat release of combustible materials, both in full room-size and laboratory-scale calorimeters.

PROFESSIONAL CHRONOLOGY: Research Chemist, FMC Corporation, 1967-1972; Research Scientist (Senior Research Chemist, Group Leader of Combustion Research), Velsicol Chemical Corporation, 1972-1980; Staff Scientist, Department of Fire Technology, Southwest Research Institute, 1980-.

MEMBERSHIPS: American Society for Testing and Materials, Sigma Xi.

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Arthur F. Grand

PUBLICATIONS/PRESENTATIONS

1. A. F. Grand, "The Maximum Smoke Density Hazard of Flame Retardant Polymers," presentation at the 1976 International Symposium on Flammability and Fire Retardants, Toronto, Canada, May 6 and 7, 1976.

2. A. F. Grand, "Defining the Smoke Density Hazard of Plastics," J. Fire and Flamm., 7 (April 1976), pp. 217-233.

3. C. A. Megal, A. F. Grand, and J. F. Sabala, "A Comparative Study of Smoke Ratings from Two Laboratory Scale Smoke Test Methods," J. Cellular Plastics, 14 (6), 1978, pp. 325-331, 340. (Presented at the 23rd SPI Annual Technical Conference, San Francisco, California, Oct. 25-27, 1977).

4. A. F. Grand, "Toxicity of Polymer Combustion Products--Impact on the Construction Industry," presentation to the Fire Retardant Chemicals Association (FRCA), San Francisco, California, Oct. 29 - Nov. 1, 1978.

5. A. F. Grand, "Heat Release of Aircraft Seats," presentation to National Aeronautics and Space Administration, Johnson Space Center, meeting on "Aircraft Seat Fireworthiness Research," February 10-11, 1981.

6. A. F. Grand, "A Systematic Approach to Evaluating Fire Safety in Transportation," presentation to the Fire Retardant Chemicals Association, St. Louis, Missouri, March 23-25, 1981.

7. A. F. Grand, "Toxic Atmospheres in Real Building Fires," presentation to the International Association of Fire Fighters (IAFF), Hollywood, Florida, November 8-11, 1981.

8. A. F. Grand, "Fire Dynamics and Chemistry," presentation to the Joint Meeting of The Society of the Plastics Industry, Incorporated (CCCS) and The Fire Retardant Chemicals Association, San Antonio, Texas, March 18, 1982.

9. A. F. Grand, "Fire Chemistry," presentation at the 7th Annual Inland Spills Conference, Columbus, Ohio, September 27-29, 1982.

10. H. L. Kaplan, A. F. Grand and G. E. Hartzell, Combustion Toxicology: Principles and Test Methods, Technomic Publishing Company, Incorporated, Lancaster, Pennsylvania, 1983.

11. H. L. Kaplan, A. F. Grand and G. E. Hartzell, "Toxicity and the Smoke Problem," Fire Safety J., 7, pp. 11-23 (1984).

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CURRICULUM VITAE

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Education: Colegio Liceo Javier, Guatemala, Guatemala
B.S. - 1972

Medical School, Universidad de San Carlos de Guatemala, Guatemala
M.D. - 1979

10/79 - 1/75	Student Fellow in Neurology, St. Paul-Ramsey Hospital, St. Paul, Minnesota
11/77 - 2/78	Student Fellow in Pulmonary, St. Paul-Ramsey Hospital, St. Paul, Minnesota
2/79 - 2/82	Resident in Medicine, Hospital General San Juan de Dios, Universidad de San Carlos de Guatemala, Guatemala City, Guatemala
2/82 - 6/83	Fellow in Pulmonary Disease, Hospital General San Juan de Dios, Guatemala City, Guatemala
7/81 - 6/83	Instructor of Medicine, School of Medicine, Universidad Francisco Marroquin, Guatemala, Guatemala.
9/83 - Present	Research Fellow in Pulmonary Diseases, The University of Texas Health Science Center at San Antonio, San Antonio, Texas

CURRICULUM VITAE

W. G. Johanson, Jr., M.D.

Date of Birth: September 9, 1937

Place of Birth: St. Paul, Minnesota

College: Gustavus Adolphus College, St. Peter, Minnesota, B.S., 1959

Medical School: University of Minnesota Medical School, M.D., 1962

Internship: University of California at Los Angeles Medical Center, Los Angeles, California, 1962-1963

Military Service: Captain, United States Army Medical Corps, 82nd Airborne Division, Fort Bragg, North Carolina, 1963-1965

Residency: St. Paul-Ramsey Hospital, St. Paul, Minnesota, 1965-1966
Minneapolis VA Hospital, St. Paul, Minnesota, 1966-1967
Parkland Memorial Hospital, Dallas, Texas, 1967-1969
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Additional Training:

1967-1968	Fellow in Infectious and Pulmonary Diseases, Department of Internal Medicine, The University of Texas Southwestern Medical School at Dallas, Dallas, Texas
1968-1971	USPHS Special Research Fellow, National Institute of Allergy and Infectious Diseases, The University of Texas Southwestern Medical School at Dallas, Dallas, Texas
1973-1974	Research Career Development Award, National Heart, Lung, and Blood Institute

Professional Appointments:

1978-Pres	Professor of Medicine and Chief, Division of Pulmonary Diseases, Department of Medicine, The University of Texas Health Science Center at San Antonio, San Antonio, Texas
1974-Pres	Foundation Scientist, Southwest Foundation for Research and Education, San Antonio, Texas
1974-1983	Chief, Pulmonary Diseases Section, Audie L. Murphy Memorial Veterans Hospital, San Antonio, Texas
1974-1978	Associate Professor of Medicine and Chief, Division of Pulmonary Diseases, Department of Medicine, The University of Texas Health Science Center at San Antonio, San Antonio, Texas
1972-1974	Medical Director, Chest Division, Woodlawn Hospital, Dallas, Texas
1972-1974	Associate Professor of Medicine, The University of Texas Southwestern Medical School at Dallas, Dallas, Texas
1970-1972	Assistant Professor of Medicine, The University of Texas Southwestern Medical School at Dallas, Dallas, Texas
1969-1974	Director, Chest Medicine Clinic, Parkland Memorial Hospital, Dallas, Texas
1969-1970	Instructor in Medicine, The University of Texas Southwestern Medical School at Dallas, Dallas, Texas

Hospital Affiliations:

Attending Staff, Medical Center Hospital, Robert B. Green Hospital, Audie L. Murphy Memorial Veterans Hospital, and St. Luke's Lutheran Hospital, San Antonio, Texas

Board Certification:

American Board of Internal Medicine, 1969
American Board of Pulmonary Disease, 1974

Professional Societies And Organizations:

American Society for Clinical Investigation
Fellow, American College of Chest Physicians
Fellow, American College of Physicians
American Federation for Clinical Research
Southern Society for Clinical Investigation
American Thoracic Society, Vice-President, 1979-1980
Texas Thoracic Society, President, 1974-1975
American Lung Association
American Lung Association, Alamo Area, Board of Directors
Texas Medical Association
VA Pulmonary Physicians Association
Bexar County Medical Society
Alpha Omega Alpha Honorary Medical Fraternity
San Antonio Club of Internal Medicine

Other:

Alpha Omega Alpha Honorary Medical Fraternity
American Board of Internal Medicine, Associate Member, 1979-80;
Board of Governors, 1980-1982;
Subspecialty Board on Pulmonary Disease, Member, 1979-1980; Chairman, 1980-
Joint Committee on Critical Care Medicine, 1981-
Editorial Board, Annals of Internal Medicine - 1982-1985
Editorial Board, Chest - 1978-1983
Editorial Board, Infection and Immunity - 1979-1981
Editorial Board, Clinical Research - 1970-1973
Consultant, Brooke Army Medical Center
Councillor, Midwestern Section, AFCR - 1970-1973
Research Manpower Review Committee, NIH
Chairman, Pulmonary Section, MKSAP VII

Special Honors

Outstanding Clinical Teacher in Medicine
1973-1974 - The University of Texas Southwestern Medical School, Dallas, Texas
1975-1976 - The University of Texas Health Science Center at San Antonio, San Antonio, Texas
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Abstracts

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108. De los Santos, R., Coalson, J.J., Holcomb, J.R., and Johanson, W.G., Jr.: Oxygen toxicity in mechanically ventilated primates with and without previous lung injury. Am. Rev. Respir. Dis. 127:97, 1983. Presented to American Thoracic Society, May, 1983.
109. Collins, J.F., and Johanson, W.G., Jr.: Acute effects of oleic acid-induced lung injury in baboons. Am. Rev. Respir. Dis 127:129, 1983.
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111. Campbell, D., Johanson, W.G., Jr., and Coalson, J.J.: The effect of bacterial superinfections on lung function following diffuse alveolar damage. Crit Care Med 11:252, 1983. Presented to Fifth World Congress on Intensive and Critical Care Medicine, May, 1983.

GARY T. MOORE
Manager
Laboratory Animal Sciences
Department of Bioengineering
Electronic Systems Division

B.S. Texas A&M University, 1965
D.V.M. Texas A&M University, 1966

Dr. Moore was commissioned in the United States Army Veterinary Medical Corps in September, 1966, and served as a Veterinary Research Officer until August, 1968. Dr. Moore has authored or coauthored papers pertaining to breeding and utilization of baboons and chimpanzees for biomedical research, nursery rearing of infant baboons, management of a chimpanzee after cross circulation with a hepatitis patient, immunogenicity of staphylococcal enterotoxin B for *Macaca mulatta*, parasites and their control in nonhuman primates, chloramphenicol-pentobarbitol interaction in baboons, rearing of conventional and gnotobiotic nonhuman Primates (baboons, chimpanzees and marmosets), economics of nonhuman primate conservation, age estimation by dental characteristics in baboons, production of a rhesus (*Macaca mulatta*) X baboon (*Papio cynocephalus*) hybrid (first time ever accomplished), ovarian function in hysterectomized cynomologous monkeys (*Macaca fascicularis*) and multiple tuberculosis outbreak in baboons. Dr. Moore has a broad base of experience in experimental surgery in nonhuman primates. This experience includes the contribution of a chapter on experimental surgery in the book, Comparative Reproduction in Nonhuman Primates by E.S.E. Hafex; development of a model for perfusion of the isolated brain in baboons; production of the first baboon infant by surgical embryo transfer methods; delivery of germ-free nonhuman primate infants; and multiple experimental procedures on the reproductive tract of both male and female baboons, i.e., cannulation of oviducts for chronic fluid production endometrial tissue collection for cell physiology studies, implantation of intrauterine devices, testicular biopsies, and cannulation of vas deferens with devices to block sperm transport. His experience also includes transplantation of kidneys, *in vivo* perfusion of kidneys and livers, cannulation of the bile duct for chronic collections, lung lobectomies, insertion of a Dacron® graft as a total arterial replacement for the thoracic portion of the descending aorta, and applying inflating cuffs on the coronary arteries to establish myocardial infarcts. He has experience in orthopedic procedures that include insertion of intramedullary leg prosthesis and evaluation of total knee joint prosthesis.

During the period 1972-9, Dr. Moore managed one of the largest multispecied nonhuman primate research programs in the world. Baboons and chimpanzees were the chief research animals. He designed and developed new animal facilities including an animal research hospital, outdoor group cages and indoor individual caging systems. He also planned and developed the first semi-free ranging baboon breeding corral at the Southwest Foundation for Research and Education. This facility is a six acre circular compound, housing 450-500 animals, and producing 150-200 infant baboons for research use annually.

PROFESSIONAL CHRONOLOGY: Research veterinarian, U.S. Army Veterinary Corps, Division of Microbiology, Fort Detrick, Maryland, 1966-8; research veterinarian, Yerkes Regional Primate Center, Emory University, Atlanta, Georgia, 1968-9; Southwest Foundation for Research and Education, 1969-80 (chief, research support branch, department of animal resources and facilities, 1969-72; director, department of laboratory animal medicine, 1972-9; foundation veterinarian, 1979-80); Southwest Research Institute, 1980-(manager, laboratory animal sciences, department of bioengineering, electronic systems division).

Memberships: American Association of Laboratory Animal Science, Texas Association of Laboratory Animal Science, Bexar County Veterinary Medical Association, Association of Primate Veterinary Clinicians.

Sept/81

ROBERT L. MASON
Manager
Statistical Design and Analysis Section
Department of Energy Conversion and Combustion Technology

B.S. in Mathematics, St. Mary's University, 1968
Ph.D. in Statistics, Southern Methodist University, 1971

Dr. Mason has been actively engaged in the field of statistics for over 13 years and has broad and diversified experience both in statistical consulting at the industrial level and in statistical methodology teaching at the university level. He has presented numerous papers, contributed as well as invited, at both regional and national statistical meetings and has authored or co-authored over 25 papers in statistical-related journals. In 1974, he was the recipient of the W.J. Youden Award for the best expository paper in *Technometrics*, a statistical journal serving the physical, chemical, and engineering sciences. In 1982, he received the Don Owen Award for excellence in research, activity in statistical consulting, and service to the statistical community. Dr. Mason currently serves as a referee for several statistical journals and is the co-author of *Regression Analysis And Its Application: A Data-Oriented Approach* (1980).

At SwRI Dr. Mason has provided statistical support to a variety of research projects. These include studies in fuel and lubricant characteristics and properties, engine test designs and reliability, vehicle emission controls and fuel economy, wastewater irrigation, hazards posed by chemical vapors, ship tank testing, geopressure energy conversion, fire technology and toxicity, the health effects of environmental pollutants, highway safety research, vehicle accident characteristics, and impact sled testing. He also has assumed leadership in designing and optimizing experiments, establishing sampling procedures, and analyzing and interpreting data for many related programs.

Dr. Mason currently is the manager of the statistical design and analysis section at SwRI. This group consists of statisticians, computer scientists, and data processors dedicated to improving data collection and analysis techniques in all areas of research.

PROFESSIONAL CHRONOLOGY: NDEA Fellow, department of statistics, Southern Methodist University, 1968-71; visiting assistant professor, department of statistics, Florida State University, 1971-2; assistant professor, department of biometry, Medical University of South Carolina, 1972-5; lecturer, division of mathematics, University of Texas at San Antonio, 1975-; Southwest Research Institute, 1975-(senior research statistician, Automotive Research Division, 1975-9; visiting associate professor, division of statistics, University of California at Davis, 1980; manager, Statistical Analysis Section, Automotive Research Division, 1979-81; manager, Statistical Analysis Section, Department of Energy Conversion and Combustion Technology, Fuels and Lubricants Research Division, 1981-)

Memberships: American Statistical Association; Biometric Society; Sigma Xi.

Rev Apr/84

CURRICULUM VITAE

Chester A. Gleiser, V.M.D.

Date of Birth: February 27, 1919 Place: Camden, New Jersey

Education:	Degree	Date	Major Field
University of Pennsylvania	V.M.D.	1940	Veterinary Medicine
Ohio State University	M.Sc.	1941	Pathology
Johns Hopkins University	M.P.H.	1948	

Present Position:

1980-present Scientist, Department of Laboratory Animal Medicine, Southwest Foundation for Research and Education, and Professor (Veterinary Pathologist), The University of Texas Health Science Center at San Antonio, San Antonio, Texas.

Previous Positions:

1975-1980 Professor of Veterinary Medicine, Veterinary Pathologist (Comparative Pathology), The University of Texas System Cancer Center, M.D. Anderson Hospital and Tumor Institute, Houston, Texas.

1968-1975 Professor, Veterinary Public Health, College of Veterinary Medicine, Texas A&M University, College Station, Texas and Visiting Professor, Department of Experimental Biology, Baylor College of Medicine, Texas Medican Center, Houston, Texas.

1965-1975 Professor, Veterinary Pathology, College of Veterinary Medicine, Texas A&M University, College Station, Texas.

1962-1965 Veterinary Advisor, Minister of Agriculture, U.S. Army Mission to Panama, U. S. Embassy, Rep. of Panama.

1956-1961 Pathologist and Assistant Chief, Animal Assessment Branch, U.S. Army Medical R&D Command, Medical Unit, Fort Detrick, Frederick, Maryland.

1953-1956 Department Director and Director of Veterinary Medicine, Walter Reed Army Institute of Research, Walter Reed Army Medical Center, Washington, D.C.

1950-1953 Chief, Veterinary Pathology, Armed Forces Institute of Pathology, Washington, D.C.

Consultant Positions:

Consultant in Veterinary Pathology, The University of Texas System Cancer Center, M.D. Anderson Hospital and Tumor Institute, Houston, Texas, 1968-1975.
Consultant to Accreditation Committee, American Association for Accreditation of Animal Care.

Licenses:

Pennsylvania, 1940
Ohio, 1941
Florida, 1941 (inactive)

Professional Memberships:

International Academy of Pathology
American Association for the Advancement of Science
American College of Veterinary Pathologists--Diplomate, 1952
American Society for Experimental Pathology
American Veterinary Medical Association
National Research Council - Institute of Laboratory Animal Resources
  (a) Advisory Council
  (b) Committee on Diseases of Laboratory Animals
Texas Veterinary Medical Association
  (a) Committee on Laboratory Animals
  (b) Program Committee

Honor Societies:

Who's Who in the Southwest, 1969
11th Edition American Men of Science, 1974

Institutional Committee Appointments:

M.D. Anderson

1976-79	Animal Resources and Facilities Advisory Committee, ex officio
1976-78	Environmental Carcinogenesis Study Section
1977-78	Education Committee, Member-at-large
1976-79	Institutional Biohazards Committee Member
1978-79	Microbial Review Subcommittee Member, Chairman, 1979
1977-79	Chairman, Chemical Carcinogenesis Review Subcommittee, Member, 1979-
1977-78	Education Committee, Curriculum Subcommittee for Summer Veterinary Student Program
1978-79	Research Committee
1978-79	Virology Study Section
1977-79	Chairman, Search Committee for Biosafety Officer
1978-80	Basic Science Board Member
1976-77	Sarcoma Study Section

Texas A&M University

1973	Chairman, Search Committee for Dean, College of Veterinary Medicine
1969-70	Curriculum Committee, College of Veterinary Medicine
1972-75	Graduate Committee, College of Science
1966-75	Chairman and member, Graduate Student Committees (M.S. and Ph.D. candidates)

Publications:

1. Yager, R. H. and Gleiser, C. A.: Trichomonas and hemoproteus infections and the experimental use of DDT in the control of ectoparasites in a flock of signal corps pigeons in the territory of Hawaii. J. Am. Vet. Med. Assoc. 109:204-207, 1946.

2. Jones, T. C., Gleiser, C. A., Maurer, F. D., Hale, M. W., and Roby, T. O.: Transmission and immunization studies on equine influenza. Am. J. Vet. Res. 9:243-253, 1948.

3. Gleiser, C. A.: The sequence of pathological events in dogs exposed to a lethal dose 100/30 of total body x-radiation. Am. J. Vet. Res. 14:287-297, 1953.

4. Gleiser, C. A.: The determination of the lethal dose 50/30 of total body x-radiation for dogs. Am. J. Vet. Res. 14:284-286, 1953.

5. Gleiser, C. A.: The Armed Forces Institute of Pathology and its relation to veterinary medicine. J. Am. Vet. Med. Assoc. 122:269-271, 1953.

6. Gleiser, C. A. and Alexander, A.: Leptospirosis today. Presented at the National Research Council, September, 1953. Reproduced by the National Research Council.

7. Gleiser, C. A.: Mucormycosis in animals. A report of three cases. J. Am. Vet. Med. Assoc. 123:441-445, 1953.

8. Gleiser, C. A.: A review of some basic concepts of the biology and pathogenesis of acute ionizing total body radiation. J. Am. Vet. Med. Assoc. 124:220-224, 1954.

9. Gleiser, C. A.: The pathology of total body radiation in dogs which died following exposure to a lethal dose. Am. J. Vet. Res. 15:329-335, 1954.

10. Jones, T. C. and Gleiser, C. A., editors. Veterinary Necropsy Procedures. Philadelphia, Pennsylvania, J. B. Lippincott Company, 1954. 136 pp.

11. Alexander, A., Evans, L. B., Jeffries, H., Gleiser, C. A., and Yager, R. H.: Serologic characterization of the Fort Bragg leptospire. Proc. Soc. Exp. Biol. Med. 86:405-408, 1954.

12. Alexander, A. D., Wetmore, P. W., Evans, L. B., Jeffries, H., and Gleiser, C. A.: Classification of leptospiral isolates from Malaya, Thailand and North Borneo. Am. J. Trop. Med. Hyg. 4:492-506, 1955.

13. Byrne, R. J., Jahnes, W., and Gleiser, C. A.: Studies on experimental avian leptospirosis. Cornell Vet. 45:290-296, 1955.

14. Gleiser, C. A., Jahnes, W., and Byrne, R. J.: Avian leptospirosis: Studies on chick-embryo culture. Cornell Vet. 45:296-304, 1955.

15. Murphy, L. C., Blackford, V. L., and Gleiser, C. A.: Study of the properties of the virus of Venezuelan equine encephalomyelitis modified by in vitro cultivation in HeLa cells. Am. J. Vet. Res. 16:521-524, 1955.

16. Low, D. G., Hiatt, C. W., Gleiser, C. A., and Bergman, E. N.: Experimental canine leptospirosis. I. Leptospira Icterohemorrhagiae infections in immature dogs. J. Infect. Dis. 98:249-259, 1956.

17. Low, D. G., Bergman, E. N., Hiatt, C. W., and Gleiser, C. A.: Experimental canine leptospirosis. II. Renal function studies. J. Infect. Dis. 98:260-265, 1956.

18. Gleiser, C. A. and Alexander, A. D.: Evaluation of methods for the serodiagnosis of leptospirosis. Research Report, Walter Reed Army Institute of Research, 171-156, October 1956.

19. Alexander, A. D., Smith, O. H., Hiatt, C. W., and Gleiser, C. A.: Presence of hemolysin in cultures of pathogenic leptospires. Proc. Soc. Exp. Biol. Med. 91:205-211, 1956.

20. Alexander, A. D., Gleiser, C. A., Malnati, P., and Yoder, H.: Observations on the prevalence of leptospirosis in canine populations of the United States. Am. J. Hyg. 65:43-56, 1957.

21. Gleiser, C. A., Thiel, J., and Cashell, I. G.: Visceral leishmaniasis in a dog imported into the United States. Am. J. Trop. Med. Hyg. 6:227-231, 1957.

22. Gleiser, C. A.: Experimental canine leptospirosis. III. Histopathologic changes. J. Infect. Dis. 100:249-256, 1957.

23. Yoder, H. W., Bergman, E. N., and Gleiser, C. A.: Experimental canine leptospirosis. IV. Evaluation of selected antibiotics in the therapy of acute experimental Leptospira icterohemorrhagiae infections in immature dogs. J. Infect. Dis. 100:257-267, 1957.

24. Gochenour, W. S., Jr., Gleiser, C. A., and Ward, M. K.: Laboratory diagnosis of leptospirosis. Ann. N. Y. Acad. Sci. 70:421-426, 1958.

25. Tigertt, W. D., Berge, T. O., Gochenour, W. S., Jr., Gleiser, C. A., Eveland, W. C., Vorder Bruegge, C., and Smetana, H. F.: Experimental yellow fever. Trans. N. Y. Acad. Sci. 22:323-333, 1960.

26. Berdjis, C. C., Gleiser, C. A., Gochenour, W. S., and Berge, T. O.: Virus infection and X radiation: A comparative study of infection with an attenuated Venezuelan equine encephalomyelitis virus and of X radiation. J. Infect. Dis. 109:62-70, 1961.

27. Berge, T. O., Gleiser, C. A., Gochenour, W. S., Jr., Miesse, M. L., and Tigertt, W. D.: Studies on the virus of Venezuelan equine encephalomyelitis. II. Modification by specific immune serum of response of central nervous system of mice. J. Immunol. 87:509-517, 1961.

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29. Gleiser, C. A., Gochenour, W. S., Jr., Berge, T. O., and Tigertt, W. D.: The comparative pathology of experimental Venezuelan equine encephalomyelitis infection in different animal hosts. J. Infect. Dis. 110:80-97, 1962.

30. Gochenour, W. S., Jr., Gleiser, C. A., and Tigertt, W. D.: Observations on penicillin prophylaxis of experimental inhalation anthrax in the monkey. J. Hyg. 60:29-33, 1962.

31. Gleiser, C. A.: Gross anatomy of the brain of Macaca mulatta. Armed Forces Institute of Pathology, 1962 (Brochure).

32. Gochenour, W. S., Jr., Berge, T. O., Gleiser, C. A., and Tigertt, W. D.: Immunization of burros with living Venezuelan equine encephalomyelitis virus. Am. J. Hyg. 75:351-362, 1962.

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34. Berdjis, C. C., Gleiser, C. A., and Hartman, H. A.: Experimental parenteral anthrax in Macaca mulatta. Br. J. Exp. Pathol. 44:101-115, 1963.

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37. Medina, Gerardino, Gleiser, C. A., and Mackenzie, R. B.: Brote de encefalomielitis equina en la Republica de Panama. Bol. Of. Sanit. Panam. 58:390-394, 1965.

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