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Global Occupational Health Services  
Human Resources

March 11, 1999

Document Processing Center (TS-790)  
Attn: Mr. Oscar Hernandez, Section 8(e) Coordinator  
Office of Pollution Prevention and Toxics  
U.S. Environmental Protection Agency  
401 "M" Street, S.W.  
Washington, D.C. 20460



Re: TSCA Section 8(e) Disclosure

Dear Mr. Hernandez:

Pursuant to section 8(e) of the Toxic Substances Control Act, 15 U.S.C. section 2607(e), International Business Machines Corporation (IBM) submits the following information on tetramethylammonium hydroxide, CAS number 75-59-2 (TMAH).

Within the United States, TMAH is used at IBM sites in East Fishkill, New York; Poughkeepsie, New York; Yorktown Heights, New York; Essex Junction, Vermont; Rochester, Minnesota; San Jose, California; and Tucson, Arizona. TMAH is primarily used in dilute aqueous solutions, in concentrations ranging from less than 1% to 25%, in semiconductor package manufacturing cleaning operations and in semiconductor photolithography processes.

In anticipation of further expanding our use of TMAH, IBM sponsored toxicity testing of TMAH on rats to provide additional information on potential dermal toxicity. Preliminary results from this study indicate that prolonged exposure of the rats' skin to concentrations of TMAH as low as 5% in distilled water may produce significant systemic toxicity, including death. A brief summary of the study design and the preliminary results follows.

Groups of 10 male and 10 female rats were dermally exposed to 0%, 0.25%, 0.55%, 1.0%, 5%, 12%, and 25% concentrations of TMAH in distilled water. The test material was administered at a constant volume of 1 ml/kg, placed in a small flat Hill Top chamber firmly affixed to a shaved area of the animal's back. The original study design required a staggered start to accommodate the number of animals under test. Males in each of the seven experimental groups were to be treated on the first day of the study; treatment of the females was to begin one day later. Exposures were to occur for 6 hours/day, 5 days/week, for 4 weeks.

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Approximately two hours after the first exposure of the males, rats in the 12% and 25% treatment groups were observed to convulse and die. All of the male rats in these two treatment groups died within the first three hours of exposure. During the first week of exposure, several males in the 5% treatment group died. Because of the significant toxicity observed in male rats at the two highest exposure concentrations, the maximum exposure concentration for the female rats was reduced to 5% TMAH in distilled water. Significant toxicity and mortality were observed in female rats in the 5% treatment group beginning in the first week of exposure. All animals in the 5% treatment group died by the end of the study. No mortality occurred in male or female rats in the 0%, 0.25%, 0.55%, or 1.0% treatment groups.

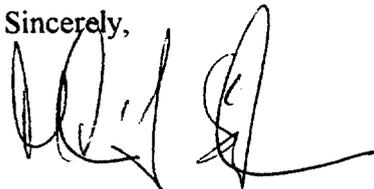
The previous information is based on a preliminary summary of the raw data and observations from IBM's contracted laboratory, IIT Research Institute, Chicago, Illinois. The draft report of the study is attached. IBM will submit a copy of the final report to the Office of Pollution, Prevention, and Toxics when it is available.

Consistent with IBM's proactive approach to health and safety, IBM has taken a number of actions as a result of these preliminary data. We have updated electronic material safety data sheets in use in IBM for TMAH and TMAH-containing substances irrespective of TMAH concentration to reflect the new information. IBM's medical and industrial hygiene professionals have initiated a notification program for employees and contractors who work in TMAH-using areas at IBM facilities. Concurrent with this TSCA 8(e) notification, we have provided our TMAH suppliers with a summary of IBM's toxicity testing results and informed the Chemical Manufacturers Association (CMA) and Semiconductor Industry Association (SIA) of these preliminary findings. Additionally, we have sponsored permeation testing of certain glove types using standard method ASTM F-739-96.

Existing IBM practices and procedures will continue to be strictly followed to provide for safe transportation, storage, use, handling, and disposal of TMAH. Adherence to these requirements is verified through routine reviews.

If you should have questions regarding IBM's toxicity testing of TMAH, please contact Dr. Bradford Brooks, IBM Center for Process and Product Toxicology, at (303)924-5621. Please direct all other questions regarding this submission to me.

Sincerely,



Martín-J. Sepúlveda, M.D.  
Vice President

Attachment



Life Sciences

March 11, 1999

Bradford Brooks, Ph.D.  
IBM Corporation  
P.O. Box 1900  
Boulder, CO 80301-9191

Dear Dr. Brooks:

This letter will serve as a preliminary report summarizing the data from a Four-Week Dermal Toxicity Study of Tetramethylammonium (TMAH) in Sprague-Dawley Rats (i.e.; IITRI Project No. 1052, Study No. 1).

**Study Design:**

The study was designed to determine the toxicity of graded concentrations of TMAH when applied repeatedly to the shaved dorsal skin. A vehicle control group of equal size was exposed dermally to the vehicle (distilled water) only. Initially, the study was composed of 5 groups consisting of 10 rats/sex/group. However, as described in detail below, the groups of male and female rats were dosed with different graded concentrations of the test substance ultimately resulting in a total of 7 treatment groups between both sexes. The dosing was staggered over two days, with each sex (males and females) being initiated over two consecutive days. The vehicle and test substance formulation was applied to the reservoir of a Hill Top Chamber® (Hill Top Biolabs, Inc., Cincinnati, Ohio) which was then placed on the shaved animal's back behind the shoulder blades. The chamber was held secure with an elastic cloth band fastened with Velcro®. The chamber and wrapping were removed 6 hours after dosing. To prevent potential ingestion of the test substance formulation, each animal was fitted with a plastic neck collar (Ejay International Inc., Glendora, CA) on days of treatment (i.e., collar removed on Saturday morning and replaced on Monday prior to dosing). The rats were weighed prior to treatment initiation (Day 0) of the study and weekly thereafter. Dosing volumes were based on the most current body weight. Food consumption was monitored to coincide with body weights. Rats were observed daily for overt signs of toxicity. At least once per week rats were given a thorough hand-held clinical examination which included evaluation of the application site skin.

The initial target dose levels were 0, 0.55, 5, 12 and 25% w/v. The dosages were administered 6 hours/day, 5 days/week, at a constant volume of 1 ml/kg. These dose levels were equivalent to 0, 5.5, 50, 120 and 250 mg/kg/day. On the first day of administration all male rats in the 120 and 250 mg/kg groups died within 3 hours of administration and one male in the 50 mg/kg group died at the end of the day. As a result of these deaths, the dose levels to be administered to the female rats were lowered. Therefore, a total of 7 treatment groups (a vehicle control and 6 TMAH dose levels) were evaluated between both sexes. The study dose levels were as follows:

<u>Males</u>		<u>Females</u>	
<u>Dose Level (%)</u>	<u>Dosage (mg/kg)</u>	<u>Dose Level (%)</u>	<u>Dosage (mg/kg)</u>
0	0	0	0
0.55	5.5	0.25	2.5
5	50	0.55	5.5
12	120	1	10
25	250	5	50

Because of the early deaths, other design changes were implemented. In an attempt to determine a possible cause of test substance induced toxicity/moribundity, blood samples were collected via the retroorbital plexus from five male and four female rats in the 5% dose level group for hematology and limited serum chemistry analysis on study days 4 and 3, respectively. In addition, rats dying spontaneously within the first week of the study were subjected to a gross necropsy and any tissues with grossly observable lesions (excluding application site skin) were collected. After one week of treatment the rats that died (five in the 50 mg/kg dose group) were subjected to a complete necropsy and their tissues were preserved, regardless of gross appearance. At study termination (day 29) all surviving rats were euthanized, a gross necropsy performed and all gross lesions were collected and preserved in 10% neutral buffered formalin for possible microscopic evaluation.

### Results:

All of the male rats in the 120 and 250 mg/kg dose groups died within 3 hours of treatment initiation. Clinical signs noted in a few of the rats in these groups were lethargy followed by convulsions, tremors, and death beginning within 1-1/2 to 2 hours after administration of the first dose of TMAH. Conversely, no overt signs of systemic toxicity were observed in the 50 mg/kg males although one

male died on the first day of treatment following unwrapping. The remaining 50 mg/kg male and female rats died intermittently throughout the study with the longest survival being approximately 2 weeks. One female rat in the 50 mg/kg dose group exhibited hyperactivity and labored breathing. No deaths and no overt clinical signs of toxicity were observed at the lower doses (males; 5.5 mg/kg; female; 2.5, 5.5, or 10 mg/kg).

Application site skin irritation included erythema, edema and/or scabbing in all groups treated with the test substance. In addition, scabbing (i.e.; possible grooming irritation) was seen in all groups, including the controls, and was considered to be associated with the animal's instinctive grooming behavior occurring when the collars were removed on the weekends. Besides irritation at the application site skin, no gross lesions were noted in any of the 120 or 250 mg/kg dose group rats that died. Gross lesions were noted in five 50 mg/kg treatment group rats and included red lungs (2 rats), urinary bladder calculus (2 rats), red ovaries (2 rats), dark eye (1 rat) and small seminal vesicles (1 rat). Red ovaries were also observed in all surviving rats at the 10 mg/kg (10/10) and 4/10 at the 5.5 mg/kg dose levels.

No significant differences were seen in body weights (Table 2), body weight gains (Table 3) or food consumption (Table 4) at any time during the study. No overt changes in blood hematology or chemistry were seen, with the possible exception of a moderate increase in alkaline phosphatase was noted in the male rats in the 50 mg/kg group (Table 5).

The raw data for this study is undergoing review by IITRI's staff and audit by IITRI's Quality Assurance Unit.

John Findlay 3/11/99  
John Findlay, B.S. Date  
Study Director  
Life Sciences Operation

Bernadette Ryan 3/11/99  
Bernadette Ryan, Ph.D., D.A.B.T. Date  
Study Toxicologist  
Manager, Regulatory Toxicology Division  
Life Sciences Operation

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1052SN1

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 1

SUMMARY OF OBSERVATION FREQUENCY					
STUDY: 1052SN1	SEX: MALE				
DOSE:(mg/kg) GROUP:	0 1-M	5.5 2-M	50 3-M	120 4-M	250 5-M
Animal found dead	0	0	10	10	10
Normal	10	10	10	10	10
Lesion - scabbed	0	3	4	0	0
Application site-redness	0	0	5	0	0
Application site-edema	0	0	3	0	0
Poss. grooming irritation	0	8	0	0	0
Total Number of Animals	10	10	10	10	10

Poss. = Possible

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 1

-----  
SUMMARY OF OBSERVATION FREQUENCY  
-----

STUDY: 1052SN1

SEX: FEMALE

DOSE:(mg/kg) GROUP:	0	2.5	5.5	10	50
	1-F	2-F	3-F	4-F	5-F
Animal found dead	0	0	0	0	10
Normal	10	10	10	10	10
Hypoactive	0	0	0	0	1
Labored breathing	0	0	0	0	1
Lesion - scabbed	0	3	3	10	4
Application site-redness	0	0	2	4	8
Application site-edema	0	0	1	0	6
Poss. grooming irritation	1	5	6	0	0
Total Number of Animals	10	10	10	10	10

Poss. = Possible

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 2

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**SUMMARY OF BODY WEIGHTS (Grams)**  
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STUDY: 1052SN1

SEX: MALE

PERIOD	DOSE: (mg/kg) GROUP:	0	5.5	50	120	250
		1-M	2-M	3-M	4-M	5-M
WEEK 0	MEAN	211	206	210	207	209
	S.D.	15.6	13.3	13.6	14.8	16.8
	N	10	10	10	10	10
WEEK 1	MEAN	248	246	246	--	--
	S.D.	21.1	20.3	20.4	--	--
	N	10	10	5	0	0
WEEK 2	MEAN	295	290	--	--	--
	S.D.	27.2	26.4	--	--	--
	N	10	10	0	0	0
WEEK 3	MEAN	336	328	--	--	--
	S.D.	30.2	29.3	--	--	--
	N	10	10	0	0	0
WEEK 4	MEAN	368	360	--	--	--
	S.D.	35.1	36.0	--	--	--
	N	10	10	0	0	0

\* P less than .05  
\*\* P less than .01  
-- = Data Unavailable

Analysis of Variance using DUNNETT'S Procedure

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 2

-----  
SUMMARY OF BODY WEIGHTS (Grams)  
-----

STUDY: 1052SN1

SEX: FEMALE

PERIOD	DOSE: (mg/kg) GROUP:	0	2.5	5.5	10	50
		1-F	2-F	3-F	4-F	5-F
WEEK 0	MEAN	169	169	164	169	167
	S.D.	8.6	12.6	10.5	10.4	12.0
	N	10	10	10	10	10
WEEK 1	MEAN	189	186	183	186	172
	S.D.	10.6	12.7	9.3	12.1	13.8
	N	10	10	10	10	4
WEEK 2	MEAN	206	203	203	206	--
	S.D.	12.1	17.2	11.6	17.1	--
	N	10	10	10	10	0
WEEK 3	MEAN	224	221	224	221	--
	S.D.	12.0	18.3	13.4	18.9	--
	N	10	10	10	10	0
WEEK 4	MEAN	237	236	236	237	--
	S.D.	13.6	17.7	16.7	18.0	--
	N	10	10	10	10	0

\* P less than .05  
\*\* P less than .01  
-- = Data Unavailable

Analysis of Variance using DUNNETT'S Procedure

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 3

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**SUMMARY OF WEIGHT GAINS (Grams)**  
 -----

STUDY: 1052SN1

SEX: MALE

PERIOD	DOSE: (mg/kg) GROUP:	0	5.5	50	120	250
		1-M	2-M	3-M	4-M	5-M
WEEK 1	MEAN	38	40	37	--	--
	S.D.	7.9	9.3	9.8	--	--
	N	10	10	5	0	0
WEEK 2	MEAN	47	44	--	--	--
	S.D.	6.4	7.8	--	--	--
	N	10	10	0	0	0
WEEK 3	MEAN	41	38	--	--	--
	S.D.	5.8	4.9	--	--	--
	N	10	10	0	0	0
WEEK 4	MEAN	33	32	--	--	--
	S.D.	7.9	7.3	--	--	--
	N	10	10	0	0	0
TOTAL GAIN	MEAN	158	154	--	--	--
	S.D.	21.6	24.2	--	--	--
	N	10	10	0	0	0

\* P less than .05

\*\* P less than .01

-- = Data Unavailable

Analysis of Variance using DUNNETT'S Procedure

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 3

-----  
SUMMARY OF WEIGHT GAINS (Grams)  
-----

STUDY: 1052SN1

SEX: FEMALE

PERIOD	DOSE: (mg/kg) GROUP:	0	2.5	5.5	10	50
		1-F	2-F	3-F	4-F	5-F
WEEK 1	MEAN	21	17	18	17	8**
	S.D.	4.5	5.6	5.4	4.5	5.4
	N	10	10	10	10	4
WEEK 2	MEAN	17	18	21	20	--
	S.D.	5.8	9.8	4.3	7.3	--
	N	10	10	10	10	0
WEEK 3	MEAN	18	18	20	16	--
	S.D.	4.0	5.9	4.3	5.9	--
	N	10	10	10	10	0
WEEK 4	MEAN	13	15	13	15	--
	S.D.	6.1	4.8	5.2	4.7	--
	N	10	10	10	10	0
TOTAL GAIN	MEAN	68	67	72	68	--
	S.D.	10.9	9.3	11.7	9.2	--
	N	10	10	10	10	0

\* P less than .05  
\*\* P less than .01  
-- = Data Unavailable

Analysis of Variance using DUNNETT'S Procedure

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 4

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**SUMMARY OF FOOD CONSUMPTION (Grams)**  
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STUDY: 1052SN1

SEX: MALE

PERIOD	DOSE: (mg/kg) GROUP:	0	5.5	50	120	250
		1-M	2-M	3-M	4-M	5-M
WEEK 1	MEAN	188	185	182	-	-
	S.D.	21.6	13.6	20.2	-	-
	N	10	10	4	0	0
WEEK 2	MEAN	213	205	-	-	-
	S.D.	21.1	20.2	-	-	-
	N	10	10	0	0	0
WEEK 3	MEAN	227	216	-	-	-
	S.D.	22.1	19.8	-	-	-
	N	10	10	0	0	0

\* P less than .05  
 \*\* P less than .01  
 -- = Data Unavailable

Analysis of Variance using DUNNETT'S Procedure

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 4

SUMMARY OF FOOD CONSUMPTION (Grams)

STUDY: 1052SN1

SEX: FEMALE

PERIOD	DOSE: (mg/kg) GROUP:	0	2.5	5.5	10	50
		1-F	2-F	3-F	4-F	5-F
WEEK 1	MEAN	155	155	152	155	143
	S.D.	10.8	14.3	9.6	6.8	16.9
	N	10	10	10	10	4
WEEK 2	MEAN	165	164	163	171	-
	S.D.	12.6	13.3	10.1	11.4	-
	N	10	10	10	10	0
WEEK 3	MEAN	171	171	172	176	-
	S.D.	12.2	14.5	11.2	11.3	-
	N	10	10	10	10	0

\* P less than .05

\*\* P less than .01

-- = Data Unavailable

Analysis of Variance using DUNNETT'S Procedure

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 5

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**SUMMARY OF HEMATOLOGY DATA**  
**PERIOD: 02-05-99**  
-----

STUDY ID: 1052-1

SEX: MALE

GROUP(s): 50 mg/kg

Test: LEUKOCYTES (thsn/cmm)

MEAN	16.5
SD	3.61
N	5

Test: ERYTHROCYTES (mill/cmm)

MEAN	6.31
SD	0.348
N	5

Test: HEMOGLOBIN (g/dL)

MEAN	14.5
SD	0.76
N	5

Test: HEMATOCRIT (%)

MEAN	41.9
SD	1.92
N	5

Test: MEAN CORPUSCULAR VOLUME (fl)

MEAN	66.5
SD	1.36
N	5

Test: MEAN CORPUSCULAR HEMOGLOBIN (pg)

MEAN	23.0
SD	0.54
N	5

Test: MEAN CORP. HEMOGLOBIN CONC. (%)

MEAN	34.6
SD	0.37
N	5

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WBC corrected for NRBC > 0

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 5

-----  
**SUMMARY OF HEMATOLOGY DATA**  
-----  
**PERIOD: 02-05-99**  
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STUDY ID: 1052-1

SEX: MALE

GROUP(s): 50 mg/kg

Test: PLATELETS (thsn/cmm)  
MEAN 1247  
SD 67.6  
N 5

Test: RETICULOCYTES(%) (%)  
MEAN 4.2  
SD 1.17  
N 5

Test: RETICULOCYTES (Absolute#) (thsn/cmm)  
MEAN 265.3  
SD 65.14  
N 5

Test: Nucleated Red Cells (#/100 WBC)  
MEAN 0.0  
SD 0.00  
N 5

Test: MAT NEU (thsn/cmm)  
MEAN 2.4  
SD 0.72  
N 5

Test: LYMPH (thsn/cmm)  
MEAN 13.5  
SD 3.23  
N 5

Test: MONO (thsn/cmm)  
MEAN 0.4  
SD 0.12  
N 5

-----  
WBC corrected for NRBC > 0

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 5

**SUMMARY OF HEMATOLOGY DATA  
PERIOD: 02-05-99**

STUDY ID: 1052-1

SEX: MALE

GROUP(s): 50 mg/kg

Test: EOSIN (thsn/cmm)

MEAN 0.2

SD 0.20

N 5

Test: BASO (thsn/cmm)

MEAN 0.0

SD 0.00

N 5

Test: IMM NEU (thsn/cmm)

MEAN 0.0

SD 0.00

N 5

WBC corrected for NRBC &gt; 0

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**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 5

-----  
**SUMMARY OF HEMATOLOGY DATA**  
-----  
**PERIOD: 02-05-99**  
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STUDY ID: 1052-1

SEX: FEMALE

GROUP(s): 50 mg/kg

Test: LEUKOCYTES (thsn/cmm)  
MEAN 12.7  
SD 1.94  
N 4

Test: ERYTHROCYTES (mill/cmm)  
MEAN 6.82  
SD 0.188  
N 4

Test: HEMOGLOBIN (g/dL)  
MEAN 15.3  
SD 1.12  
N 4

Test: HEMATOCRIT (%)  
MEAN 43.1  
SD 1.66  
N 4

Test: MEAN CORPUSCULAR VOLUME (fl)  
MEAN 63.1  
SD 1.48  
N 4

Test: MEAN CORPUSCULAR HEMOGLOBIN (pg)  
MEAN 22.5  
SD 1.16  
N 4

Test: MEAN CORP. HEMOGLOBIN CONC. (%)  
MEAN 35.6  
SD 1.27  
N 4

-----  
WBC corrected for NRBC > 0

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 5

-----  
**SUMMARY OF HEMATOLOGY DATA**  
-----  
**PERIOD: 02-05-99**  
-----

STUDY ID: 1052-1

SEX: FEMALE

GROUP(s): 50 mg/kg

Test: PLATELETS (thsn/cmm)

MEAN	1296
SD	206.1
N	4

Test: RETICULOCYTES(%) (%)

MEAN	3.6
SD	0.60
N	4

Test: RETICULOCYTES (Absolute#) (thsn/cmm)

MEAN	241.4
SD	35.83
N	4

Test: Nucleated Red Cells (#/100 WBC)

MEAN	0.0
SD	0.00
N	4

Test: MAT NEU (thsn/cmm)

MEAN	1.9
SD	0.48
N	4

Test: LYMPH (thsn/cmm)

MEAN	10.5
SD	2.17
N	4

Test: MONO (thsn/cmm)

MEAN	0.3
SD	0.12
N	4

-----  
WBC corrected for NRBC > 0

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 5

**SUMMARY OF HEMATOLOGY DATA  
PERIOD: 02-05-99**

STUOY ID: 1052-1

SEX: FEMALE

GROUP(s): 50 mg/kg

Test: EOSIN (thsn/cmm)

MEAN	0.0
SD	0.05
N	4

Test: BASO (thsn/cmm)

MEAN	0.0
SD	0.00
N	4

Test: IMM NEU (thsn/cmm)

MEAN	0.0
SD	0.00
N	4

WBC corrected for NRBC &gt; 0

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**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 6

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**SUMMARY OF CLINICAL CHEMISTRY DATA**  
PERIOD: 02-05-99  
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STUDY ID: 1052-1

SEX: MALE

GROUP(s): 50 mg/kg

Test: Sodium (mmol/L)

MEAN	143
SD	0.8
N	5

Test: Potassium (mmol/L)

MEAN	6.3
SD	0.37
N	5

Test: Chloride (mmol/L)

MEAN	101
SD	2.5
N	5

Test: Calcium (mg/dL)

MEAN	10.6
SD	0.17
N	5

Test: Phosphate (Inorganic) (mg/dL)

MEAN	10.8
SD	0.54
N	5

Test: Creatine Kinase (IU/L)

MEAN	441
SD	171.9
N	5

Test: Alkaline Phosphatase (IU/L)

MEAN	367
SD	76.3
N	5

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**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 6

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**SUMMARY OF CLINICAL CHEMISTRY DATA**  
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**PERIOD: 02-05-99**  
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STUDY ID: 1052-1

SEX: MALE

GROUP(s): 50 mg/kg

Test: Alanine Aminotransferase (IU/L)

MEAN	43
SD	2.1
N	5

Test: Aspartate Aminotransferase (IU/L)

MEAN	93
SD	19.1
N	5

Test: Total Bilirubin (mg/dL)

MEAN	0.36
SD	0.036
N	5

Test: Blood Urea Nitrogen (mg/dL)

MEAN	13
SD	2.8
N	5

Test: Creatinine (mg/dL)

MEAN	0.4
SD	0.08
N	5

Test: Glucose (mg/dL)

MEAN	123
SD	8.1
N	5

Test: Total Protein (g/dL)

MEAN	5.3
SD	0.25
N	5

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**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

**TABLE 6**

**SUMMARY OF CLINICAL CHEMISTRY DATA  
PERIOD: 02-05-99**

STUDY ID: 1052-1

SEX: MALE

GROUP(s): 50 mg/kg

Test: Albumin (g/dL)

MEAN 4.0  
SD 0.11  
N 5

Test: Globulin (g/dL)

MEAN 1.3  
SD 0.16  
N 5

Test: A/G Ratio (-)

MEAN 3.1  
SD 0.32  
N 5

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 6

**SUMMARY OF CLINICAL CHEMISTRY DATA  
PERIOD: 02-05-99**

STUDY ID: 1052-1

SEX: FEMALE

GROUP(s): 50 mg/kg

Test: Sodium (mmol/L)

MEAN	143
SD	1.9
N	5

Test: Potassium (mmol/L)

MEAN	6.0
SD	0.59
N	5

Test: Chloride (mmol/L)

MEAN	103
SD	2.7
N	5

Test: Calcium (mg/dL)

MEAN	11.1
SD	0.36
N	5

Test: Phosphate (Inorganic) (mg/dL)

MEAN	10.7
SD	1.92
N	4

Test: Creatine Kinase (IU/L)

MEAN	327
SD	130.7
N	4

Test: Alkaline Phosphatase (IU/L)

MEAN	213
SD	30.7
N	5

**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 6

-----  
**SUMMARY OF CLINICAL CHEMISTRY DATA**  
**PERIOD: 02-05-99**  
-----

STUDY ID: 1052-1

SEX: FEMALE

GROUP(s): 50 mg/kg

Test: Alanine Aminotransferase (IU/L)

MEAN	41
SD	13.3
N	5

Test: Aspartate Aminotransferase (IU/L)

MEAN	98
SD	21.6
N	5

Test: Total Bilirubin (mg/dL)

MEAN	0.43
SD	0.053
N	4

Test: Blood Urea Nitrogen (mg/dL)

MEAN	15
SD	1.7
N	5

Test: Creatinine (mg/dL)

MEAN	0.4
SD	0.13
N	4

Test: Glucose (mg/dL)

MEAN	132
SD	31.0
N	4

Test: Total Protein (g/dL)

MEAN	6.0
SD	0.35
N	5

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**FOUR - WEEK DERMAL TOXICITY STUDY OF  
TETRAMETHYLAMMONIUM HYDROXIDE (TMAH) IN RATS**

TABLE 6

**SUMMARY OF CLINICAL CHEMISTRY DATA  
PERIOD: 02-05-99**

STUDY ID: 1052-1

SEX: FEMALE

GROUP(s): 50 mg/kg

Test: Albumin (g/dL)

MEAN	4.6
SD	0.36
N	4

Test: Globulin (g/dL)

MEAN	1.4
SD	0.05
N	4

Test: A/G Ratio (-)

MEAN	3.4
SD	0.13
N	4