

APPENDIX B: SYNONYMS AND TRADE NAMES OF ETU

Chemical Abstracts Service Registry Number 96-45-7  
NIOSH RTECS Number NI96250  
4,5-Dihydroimidazole-2(3H)-thione  
4,5-Dihydro-2-mercaptoimidazole  
N,N'-(1,2-Ethanediy1)thiourea  
Ethylene thiourea  
1, 3-ethylene-2-thiourea  
N,N'-Ethylenethiourea  
ETU  
Imidazolidinethione  
Imidazoline-2-thiol  
Imidazoline-2(3H)-thione  
2-imidazolidenethione  
2-imidazolidene-2-thiol  
Jor 4022  
Mercaptoimidazoline  
2-Mercaptoimidazoline  
2-Mercapto-2-imidazoline  
N, N'-ethylene-thiourea  
NA-22  
NA-22D  
NA-22F  
National Bureau of Standards Standard Reference Material 392  
Pennac CRA  
Robac 2.2  
Rhodanin S-62  
Sodium-22 neoprene accelerator  
Tetrahydro-2H-imidazole-2-thione  
Thiate-N  
2-thiol-dihydroglyoxaline  
Thiourea, N, N 1 (1, 2-ethandiy1)  
2H-Imidazole -2-thione, tetrahydro  
4,5-Dihydro-2-mercaptoimidazole  
Vulkacit NPV/C  
Warecure C

APPENDIX C  
 NIOSH ESTIMATE OF TYPES OF WORKERS EXPOSED TO ETU (Imidazolidinethione, 2-)  
 IN THE MANUFACTURE OF FABRICATED RUBBER PRODUCTS

National Occupational Hazard Survey (Projected) as of 3/7/78

Classification of Worker	No. of Exposures	% of Total
Industrial Engineers	30	0.2
Chemists	420	2.5
Personnel and Labor Relations Workers	60	0.4
Engineering and Science Technicians, N.E.C.	120	0.7
Research Workers, Not Specified	30	0.2
Managers and Administrators, N.E.C.	390	2.3
Shipping and Receiving Clerks	60	0.4
Weighers	246	1.4
Foremen, N.E.C.	600	3.6
Machinists	30	0.2
Heavy Equipment Mechanics, Incl. Diesel	246	1.4
Checkers, Examiners, and Inspectors; Manufacturing	930	5.6
Cutting Operatives, N.E.C.	330	2.0
Mixing Operatives	2,520	15.2
Packers and Wrappers, Except Meat and Produce	66	0.4
Painters, Manufactured Articles	66	0.4
Machine Operatives, Miscellaneous Specified	8,460	50.9
Miscellaneous Operatives	1,446	8.7
Not Specified Operatives	270	1.6
Freight and Material Handlers	150	0.9
Vehicle Washers and Equipment Cleaners	60	0.4
Miscellaneous Laborers	60	0.4
Not Specified Laborers	60	0.2
	16,620	100%

APPENDIX D - TABLES

Table 1  
 Mean Body Weights (g)  $\pm$  SE of Rats Fed ETU in the Diet  
 (Graham et al, 1975)

Dietary level, ppm	No. of rats	2 months of diet	No. of rats	6 months of diet	No. of rats	12 months of diet
Males						
0	68	419 $\pm$ 5	56	617 $\pm$ 10	45	703 $\pm$ 13
5	68	421 $\pm$ 4	58	613 $\pm$ 8	48	711 $\pm$ 11
25	68	411 $\pm$ 4	57	583 $\pm$ 8a	47	670 $\pm$ 12
125	68	421 $\pm$ 5	58	601 $\pm$ 9	46	692 $\pm$ 12
250	67	403 $\pm$ 4b	58	579 $\pm$ 8b	44	677 $\pm$ 12
500	68	327 $\pm$ 4a	58	509 $\pm$ 7a	47	604 $\pm$ 15a
Females						
0	68	270 $\pm$ 3	58	371 $\pm$ 6	47	466 $\pm$ 11
5	68	267 $\pm$ 3	58	363 $\pm$ 7	48	464 $\pm$ 11
25	68	259 $\pm$ 3b	58	357 $\pm$ 5	46	442 $\pm$ 10
125	68	254 $\pm$ 3a	58	342 $\pm$ 5a	48	429 $\pm$ 11c
250	68	245 $\pm$ 3a	57	331 $\pm$ 5a	46	408 $\pm$ 9a
500	68	231 $\pm$ 3a	58	326 $\pm$ 5a	46	406 $\pm$ 8a

a Significantly different from control value, p = 0.001.

b Significantly different from control value, p = 0.01.

c Significantly different from control value, p = 0.05.

Table 2  
 Mean Organ-to-Body Weight (g/kg) Ratios  $\pm$  SE of Charles River Rats Fed  
 ETU for 2 Months, 6 months, and 12 months. (Ten Rats per Group)  
 (Graham et al, 1975)

Dietary level, ppm	2 Months Thyroid(a)	6 Months Thyroid(a)	12 Months Thyroid(a)
Males			
0	44.7 $\pm$ 2.3	51.5 $\pm$ 3.3	44.3 $\pm$ 2.0
5	45.4 $\pm$ 3.5	45.1 $\pm$ 2.4	43.9 $\pm$ 3.3
25	40.1 $\pm$ 1.9	44.3 $\pm$ 2.3	48.8 $\pm$ 2.9
125	55.9 $\pm$ 4.9	61.9 $\pm$ 4.1	52.9 $\pm$ 3.5b
250	93.6 $\pm$ 5.9d	79.9 $\pm$ 6.1c	87.7 $\pm$ 13.2c
500	102.9 $\pm$ 8.3d	139.5 $\pm$ 14.9b	779.0 $\pm$ 231.4b
Females			
0	60.0 $\pm$ 2.9	59.1 $\pm$ 3.1	57.3 $\pm$ 3.5
5	66.8 $\pm$ 3.5	65.9 $\pm$ 4.4	56.4 $\pm$ 3.3
25	66.2 $\pm$ 3.3	59.8 $\pm$ 3.8	56.8 $\pm$ 3.3
125	78.4 $\pm$ 3.3d	72.0 $\pm$ 4.6d	68.6 $\pm$ 4.1b
250	105.5 $\pm$ 5.3d	93.5 $\pm$ 4.1b	97.7 $\pm$ 8.0e
500	171.3 $\pm$ 15.5d	174.6 $\pm$ 21.5b	271.5 $\pm$ 85.7b

a Thyroid ratios are expressed as mg/kg.

b Significantly different from control, p = 0.05.

c Significantly different from control, p = 0.01.

d Significantly different from control, p = 0.001.

Table 3  
 THYROID HORMONE LEVELS - AFTER 30 DAYS ON STUDY (Freudenthal et al, 1977)

ETU (ppm)	Sex	125-I (percent uptake)	TBG (percent T-3 bound)	T-3 (ng percent)	T-4 (ug percent)	TSH (uIU per ml)
625	M	1.2 ± 0.4*	60.3 ± 2.6*	57.3 ± 3.7*	0.9 ± 0.6*	14.3 ± 0.9*
625	F	2.1 ± 1.4*	60.6 ± 1.8	58.4 ± 9.9*	1.1 ± 1.0*	14.6 ± 1.9*
125	M	3.6 ± 0.8	60.7 ± 1.3*	71.1 ± 11.8	2.6 ± 0.4*	23.3 ± 5.9
125	F	4.0 ± 1.7	61.5 ± 1.3*	104.4 ± 16.3*	2.1 ± 0.5*	18.3 ± 4.0*
25	M	2.9 ± 0.6	65.7 ± 2.3	67.1 ± 15.9	5.6 ± 1.1	7.3 ± 1.5
25	F	3.2 ± 1.3	63.5 ± 2.0	86.3 ± 14.8	3.8 ± 0.8	5.1 ± 1.3
5	M	3.6 ± 0.6	69.3 ± 6.3	79.0 ± 8.1	4.7 ± 0.4	6.7 ± 1.4
5	F	3.8 ± 1.0	68.9 ± 1.3	88.1 ± 12.8	2.9 ± 0.9	4.9 ± 1.4
1	M	3.7 ± 0.7	64.5 ± 1.2	82.1 ± 13.0	5.1 ± 1.0	6.4 ± 0.8
1	F	3.0 ± 0.5	63.4 ± 1.3	90.9 ± 11.3	3.5 ± 1.0	4.5 ± 0.9
0	M	3.6 ± 0.9	68.0 ± 5.6	76.0 ± 11.8	5.0 ± 1.7	6.7 ± 2.5
0	F	3.5 ± 0.9	66.0 ± 5.2	83.2 ± 16.2	3.8 ± 1.4	6.0 ± 4.1
PTU (propyl thiourea)						
(ppm)						
125	M	2.9 ± 1.1	67.8 ± 2.0	58.9 ± 6.1*	0.9 ± 0.2*	--
125	F	3.3 ± 0.7	69.5 ± 1.6	52.0 ± 8.0*	0.7 ± 0.1*	

\*Significantly different (p = 0.05) from corresponding control. Student's t test was used to make comparison between the control and treated animals. All data reported as the mean, ± S.D.

Table 4  
 THYROID HORMONE LEVELS - AFTER 60 DAYS ON STUDY (Freudenthal et al, 1977)

ETU (ppm)	Sex	125-I (percent uptake)	TBG (percent T-3 bound)	T-3 (ng Percent)	T-4 (ug percent)	TSH (uIU per ml)
625	M	1.9 ± 1.0*	79.0 ± 0.9	56.9 ± 10.3*	0.2 ± 0.1*	-
625	F	2.4 ± 1.8*	71.8 ± 1.4	56.8 ± 6.9*	0.2 ± 0.1*	-
125	M	3.6 ± 1.4	66.3 ± 1.3	79.8 ± 28.1	2.8 ± 0.5*	-
125	F	3.3 ± 1.0	66.3 ± 2.1	78.5 ± 28.6*	2.0 ± 0.5*	-
25	M	3.2 ± 0.7	76.9 ± 1.6	86.4 ± 7.6	2.8 ± 0.5*	-
25	F	3.7 ± 1.3	74.7 ± 1.7	126.2 ± 15.1	2.6 ± 0.5*	-
5	M	3.5 ± 0.8	66.4 ± 1.2	85.4 ± 12.7	4.9 ± 0.5	-
5	F	4.0 ± 0.8	64.0 ± 1.8	118.5 ± 14.3	2.9 ± 0.9	-
1	M	2.7 ± 0.6	70.4 ± 1.2	80.3 ± 12.0	4.9 ± 0.7	-
1	F	3.2 ± 0.7	67.1 ± 1.3	93.3 ± 13.5	2.8 ± 0.8	-
0	M	4.3 ± 0.9	73.6 ± 4.9	77.3 ± 8.5	4.8 ± 0.7	5.8 ± 0.4**
0	F	3.5 ± 0.8	69.4 ± 4.3	103.8 ± 19.1	3.3 ± 0.5	6.4 ± 0.9**
PTU						
(ppm)						
125	M	3.9 ± 1.6	61.7 ± 2.6*	46.1 ± 3.9*	1.2 ± 0.2*	9.8 ± 1.0*
125	F	5.4 ± 1.7	62.2 ± 2.1*	50.9 ± 9.7*	0.8 ± 6.1*	10.8 ± 1.9*

\* Significantly different (p 0.05) from corresponding control.

\*\* TSH values to be used as control for PTU group.

Table 5  
 THYROID HORMONE LEVELS - AFTER 90 DAYS ON STUDY (Freudenthal et al, 1977)

ETU (ppm)	Sex	125-I (percent uptake)	TBG (percent T-3 bound)	T-3 (ng percent)	T-4 (ug percent)	TSH (uIU per ml)
625	M	2.5 ± 0.8*	62.7 ± 2.0*	27.9 ± 13.3*	1.1 ± 0.6*	-
625	F	3.7 ± 1.8	62.7 ± 0.9*	35.2 ± 4.3*	1.1 ± 0.6*	-
125	M	2.8 ± 0.7	65.3 ± 1.1	86.1 ± 15.0	2.3 ± 0.6*	-
125	F	3.9 ± 1.1	64.3 ± 1.6	105.5 ± 16.0	1.6 ± 0.3*	-
25	M	3.3 ± 0.7	68.9 ± 1.5	79.4 ± 12.6	3.8 ± 1.0	-
25	F	3.4 ± 0.9	65.6 ± 2.3	108.7 ± 11.6	2.9 ± 0.7	-
5	M	3.7 ± 0.6	71.4 ± 0.8	76.1 ± 13.1	5.0 ± 1.0	-
5	F	4.2 ± 1.1	70.1 ± 2.2	105.2 ± 16.6	3.0 ± 0.7	-
1	M	3.5 ± 0.6	65.8 ± 1.1	68.7 ± 9.9	4.0 ± 1.0	-
1	F	3.2 ± 0.9	63.1 ± 1.4	116.7 ± 17.6	2.5 ± 0.7	-
0	M	3.8 ± 0.5	69.3 ± 2.7	72.0 ± 21.5	4.5 ± 0.8	5.8 ± 0.4**
0	F	4.1 ± 1.0	65.2 ± 2.9	106.8 ± 25.0	3.3 ± 0.8	6.4 ± 0.9**
PTU (ppm)						
125	M	4.7 ± 1.7	59.1 ± 1.3*	73.2 ± 9.9	0.6 ± 0.2*	9.4 ± 1.3*
125	F	5.6 ± 2.5	60.4 ± 1.7*	69.6 ± 9.4*	0.4 ± 0.2*	10.7 ± 2.1*

\* Significantly different (p = 0.05) from corresponding control.

\*\*TSH values to be used as control for PTU group.

Table 6  
 Relative risk for development of tumors among mice treated with ETU when compared with negative controls  
 (Innes et al, 1969)

Compound	Strain*	Mice with hepatomas			Mice with pulmonary tumors			Mice with lymphomas			Total mice with tumors		
		M	F	Sum	M	F	Sum	M	F	Sum	M	F	Sum
ETU	X	48.79*	Inf.+>	91.53+	1.31	5.45	3.03	0	1.59	1.06	14.82+	Inf.+>	27.44+
	Y	Inf.+>	68.82+	127.36+	1.16	0	1.05	13.47	6.28&	8.16+	Inf.+>	27.96+	38.18+
	Sum	82.08+	158.90+	106.06+	1.22	3.49	1.87	4.52	3.83&	4.04&	24.04+	42.93+	32.75+

\*Strain X-(C57BL/6 x C3H/Anf) F1; strain Y-(C57BL/6 x AKR)F1.

+Increased tumor yield significant at 0.01 level.

>Inf.- relative risk calculated as infinite. This figure may result from the absence of tumors in the control group and is not necessarily significant.

&Increased tumor yield significant at 0.05 level.