

Table 3-1 Levels of Significant Exposure to Uranium - Inhalation

Key to Figure ^a	Species (Strain)	Exposure/Duration/Frequency (Route)	System	NOAEL (mg/m ³)	LOAEL		Reference Chemical Form	Comments
					Less Serious (mg/m ³)	Serious (mg/m ³)		
ACUTE EXPOSURE								
Death								
1	Rat (Long- Evans)	5 min					18210 M (40% mortality by day 14 postexposure)	Leach et al. 1984 Uranium Hexafluoride
2	Rat (NS)	1 d 10 min					1544 (75% mortality 30 days postexposure)	Spiegl 1949 Uranium Hexafluoride
3	Mouse (NS)	1 d 10 min					637 (20% mortality 30 days post-exposure)	Spiegl 1949 Uranium Hexafluoride
4	Gn Pig (Hartley)	2 min					23040 M (2/6 died 48 hrs postexposure)	Leach et al. 1984 Uranium Hexafluoride
5	Gn Pig (NS)	1 d 10 min					637 (13% mortality 30 days post-exposure)	Spiegl 1949 Uranium Hexafluoride
Systemic								
6	Rat (Long- Evans)	5 min	Resp		9131		54503 M (severe nasal congestion, hemorrhage)	Leach et al. 1984 Uranium Hexafluoride
			Renal		392 M (glucosuria)			
7	Rat (Long- Evans)	10 min	Renal		426 M (proteinuria, glucosuria, and polyuria)			Leach et al. 1984 Uranium Hexafluoride

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(continued)

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
8	Rat (Long- Evans)	2 min	Renal	920 M	1430 M (proteinuria)		Leach et al. 1984 Uranium Hexafluoride	
9	Rat (Fischer- 344)	once 100 min	Resp		5051 M (severe alveolar fibrosis)		Morris et al. 1990 Uranium Dioxide	
10	Rat (NS)	1 d 10 min	Resp		637 (gasping in 100% of rats; severe irritation of nasal passages)		Spiegl 1949 Uranium Hexafluoride	
			Renal		637 (severe degeneration of renal cortical tubules 5-8 days post-exposure)			
			Ocular		637 (conjunctivitis)			
11	Mouse (NS)	1 d 10 min	Resp		637 (gasping in 100% of mice; severe irritation of nasal passages)		Spiegl 1949 Uranium Hexafluoride	
			Ocular		637 (conjunctivitis)			
12	Gn Pig (Hartley)	2 min	Renal		23040 M (glucosuria and polyuria)		Leach et al. 1984 Uranium Hexafluoride	
13	Gn Pig (Hartley)	2 min	Renal		23040 M (glucosuria and polyuria)		Leach et al. 1984 Uranium Hexafluoride	

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
14	Dog [Beagle]	once 0.5-1 hr	Resp	270			Morrow et al. 1982a Uranyl Fluoride	
			Renal			250	(extensive degeneration in kidney cortex and tubules)	
Immuno/ Lymphoret								
15	Rat (Fischer- 344)	once			44 M (increased macrophage activity)		Morris et al. 1989 Uranium Dioxide	
16	Rat (Fischer- 344)	once			132 M (increased macrophage activity)		Morris et al. 1992 Uranium Dioxide	
INTERMEDIATE EXPOSURE								
Death								
17	Rat (NS)	30 d 6 hr/d				18	(32% mortality)	Dygert 1949a Uranium Tetrafluoride
18	Rat (NS)	30 d 6 hr/d				13.3	(75% mortality)	Spiegl 1949 Uranium Hexafluoride
19	Mouse (NS)	23 d 5 d/wk 5 hr/d				15.4	(63% mortality)	Dygert 1949d Uranium Peroxide
20	Mouse (NS)	30 d 6 hr/d				2	(92% mortality)	Spiegl 1949 Uranium Hexafluoride
21	Gn Pig (NS)	30 d 6 hr/d				18	(15% mortality)	Dygert 1949a Uranium Tetrafluoride

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
22	Gn Pig (NS)	30 d 6 hr/d				6.8 (20% mortality)	Dygert 1949b Ammonium Diuranate	
23	Gn Pig (NS)	23 d 5 d/wk 5 hr/d				15.4 (40% mortality)	Dygert 1949d Uranium Peroxide	
24	Gn Pig (NS)	5 wk 6 d/wk 6 hr/d				9.2 (55% mortality)	Rothstein 1949a Uranyl Fluoride	
25	Gn Pig (NS)	5 wk 5.5 d/wk 6 hr/d				15 (13% mortality)	Rothstein 1949d Sodium Uranate	
26	Gn Pig (NS)	30 d 6 hr/d				13.3 (45% mortality)	Spiegl 1949 Uranium Hexafluoride	
27	Dog (NS)	30 d 6 hr/d				18 (lethal dose)	Dygert 1949a Uranium Tetrafluoride	
28	Dog (NS)	30 d Cont.				9.5 (75% mortality)	Roberts 1949 Uranyl Nitrate	
29	Dog (NS)	4 wk 6 d/wk 6 hr/d				15.8 (17% mortality)	Rothstein 1949c Uranium Trioxide	
30	Dog (NS)	5 wk 6 d/wk 6 hr/d				9.2 (100% mortality)	Rothstein 1949a Uranyl Fluoride	

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
31	Dog (NS)	30 d 6 hr/d				13.3 (40% mortality)	Spiegl 1949 Uranium Hexafluoride	
32	Rabbit (NS)	30 d 6 hr/d				18 (33% mortality)	Dygert 1949a Uranium Tetrafluoride	
33	Rabbit (NS)	30 d 6 hr/d				6.8 (100% mortality)	Dygert 1949b Ammonium Diuranate	
34	Rabbit (NS)	23 d 5 hr/d 5 d/wk				15.4 (80% mortality)	Dygert 1949d Uranium Peroxide	
35	Rabbit (NS)	4 wk 6 d/wk 6 hr/d				15.8 (67% mortality)	Rothstein 1949c Uranium Trioxide	
36	Rabbit (NS)	5 wk 6 d/wk				19.4 (60% mortality)	Rothstein 1949b Uranium Dioxide	
37	Rabbit (NS)	5 wk 5.5 d/wk 6 hr/d				15 (28% mortality)	Rothstein 1949d Sodium Uranate	
38	Rabbit (NS)	30 d 6 hr/d				2 (80% mortality)	Spiegl 1949 Uranium Hexafluoride	
39	Cat (NS)	30 d 6 hr/d				18 (100% mortality)	Dygert 1949a Uranium Tetrafluoride	

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Key to Figure ^a	Species (Strain)	Exposure/Duration/Frequency (Route)	System	NOAEL (mg/m ³)	LOAEL		Reference Chemical Form	Comments	
					Less Serious (mg/m ³)	Serious (mg/m ³)			
40	Cat (NS)	23 d 5 d/wk 5 hr/d				15.4	(100% mortality)	Dygert 1949d Uranium Peroxide	
41	Cat (NS)	30 d Cont.				2	(100% mortality)	Roberts 1949 Uranyl Nitrate	
Systemic									
42	Rat (NS)	30 d 6 hr/d	Gastro		0.4		(ulceration of cecum)	Dygert 1949a Uranium Tetrafluoride	
			Hemato	18					
			Hepatic		0.4		(focal necrosis of liver)		
			Renal	4	18		(slight azotemia)		
			Bd Wt	4		18	(26% decrease body weight)		
43	Rat (NS)	30 d 6 hr/d	Resp		6.8		(interstitial bronchopneumonia in 25% of animals; nasal irritation)	Dygert 1949b Ammonium Diuranate	
			Hemato		6.8		(decreased RBC, hemoglobin)		
			Renal		6.8		(minimal necrosis of tubular epithelium followed by regeneration)		
			Bd Wt	6.8					

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
44	Rat (NS)	30 d Cont.	Hemato	2.1	9.5	(decreased RBC, hemoglobin)	Roberts 1949 Uranyl Nitrate	
			Renal		0.13	(slight renal tubular degeneration in 33% after 28 days exposure)		
			Bd Wt	2.1	9.5	(5.6-12.6% decreased body weight)		
45	Rat (NS)	4 wk 6 d/wk 6 hr/d	Resp		16	(very slight degenerative changes in the lungs)	Rothstein 1949c Uranium Trioxide	
			Hemato		16	(increased percentage of myeloblasts and lymphoid cells of bone marrow)		
			Hepatic	16				
			Renal		16	(mild to severe tubular necrosis)		
			Bd Wt	16				

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(continued)

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
46	Rat (NS)	5 wk 6 d/wk 6 hr/d	Hemato	9.2			Rothstein 1949a Uranyl Fluoride	
			Renal	0.5	2.2	(minimal renal tubular degeneration)		
			Bd Wt	2.2	9.2	(unspecified moderate weight loss)		
47	Rat (NS)	5 wk 6 d/wk	Resp	19.4			Rothstein 1949b Uranium Dioxide	
			Hemato	19.4				
			Renal	19.4				
48	Rat (NS)	5 wk 5.5 d/wk 6 hr/d	Hemato	15			Rothstein 1949d Sodium Uranate	
			Renal		15	(moderate renal degeneration and necrosis)		

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
49	Rat (NS)	30 d 6 hr/d	Resp	2		13.3	(lung edema, hemorrhage, emphysema)	Spiegl 1949 Uranium Hexafluoride
			Hemato	13.3				
			Renal	0.05	0.2	(mild renal tubular damage)		
			Ocular	2	13.3	(eye irritation)		
			Bd Wt	2		13.3	(6% weight loss)	
50	Mouse (NS)	5 wk 6 d/wk	Resp	19.4				Rothstein 1949b Uranium Dioxide
			Hemato	19.4				
			Renal	19.4				
			Bd Wt	19.4				

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
51	Mouse (NS)	30 d 6 hr/d	Resp	2		13.3	(lung edema, hemorrhage, and emphysema; inflammation of bronchi, alveoli, and alveolar interstitices)	Spiegl 1949 Uranium Hexafluoride
			Renal	2		13.3	(severe renal-tubular degeneration followed by regeneration, and necrosis, and the presence of casts in the tubules)	
			Ocular	2	13.3	(eye irritation)		
			Bd Wt	2	13.3	(unspecified weight loss)		
52	Gn Pig (NS)	30 d 6 hr/d	Hemato	18				Dygert 1949a Uranium Tetrafluoride
			Renal	4		18	(moderate to severe necrosis of corticomedullary tubular epithelium)	
53	Gn Pig (NS)	30 d Cont.	Bd Wt	2.1		9.5	(2.9-27.9% decreased body weight)	Roberts 1949 Uranyl Nitrate

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
54	Gn Pig (NS)	5 wk 6 d/wk 6 hr/d	Renal	2.2		9.2	(severe degeneration of renal tubular epithelium)	Rothstein 1949a Uranyl Fluoride
			Bd Wt		2.2	(unspecified moderate weight loss)		
55	Gn Pig (NS)	5 wk 6 d/wk	Resp	19.4				Rothstein 1949b Uranium Dioxide
			Hemato	19.4				
			Renal	19.4				
			Bd Wt	19.4				
56	Gn Pig (NS)	30 d 6 hr/d	Resp	2		13.3	(lung edema, hemorrhage, and emphysema, acute inflammation was seen in the bronchi, alveoli, and alveolar interstitices)	Spiegel 1949 Uranium Hexafluoride
			Renal	2		13.3	(severe renal-tubular degeneration, necrosis, regeneration; casts in the tubules)	
			Bd Wt	2	13.3	(13% decreased body weight)		

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
57	Gn Pig	7.5 months 33 hr/wk	Renal	0.2			Stokinger et al. 1953 Uranium Tetrachloride	
			Bd Wt	0.2				
58	Gn Pig	9 mo 5.5 d/wk 6 hr/d	Renal	0.05			Stokinger et al. 1953 Uranium Hexafluoride	
			Bd Wt	0.05				
59	Gn Pig (NS)	7 mo 33 hrs/wk	Renal	10			Stokinger et al. 1953 Uranium Dioxide	
			Bd Wt	10				
60	Gn Pig (NS)	6.5 mo 33 hrs/wk	Hemato	2 M			Stokinger et al. 1953 Uranyl Nitrate	
			Renal	2 M				
61	Gn Pig	9 mo 5.5 d/wk 6 hr/d	Hemato	3			Stokinger et al. 1953 Uranium Tetrafluoride	
			Renal	3				
			Bd Wt	3				

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
62	Dog (NS)	30 d 6 hr/d	Gastro	4		18	(vomited blood)	Dygert 1949a Uranium Tetrafluoride
			Hemato	18				
			Renal	0.5	3	(very slight degenerative changes in tubular epithelium)		
			Ocular	4	18	(conjunctivitis)		
			Bd Wt	4		18	(26% decreased body weight)	
63	Dog (NS)	23 d 5 d/wk 5 hr/d	Hemato	15.4			Dygert 1949d Uranium Peroxide	
			Bd Wt	15.4				

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
64	Dog (NS)	30 d Cont.	Resp	2.1	9.5	(rales; slight degeneration in lung epithelium)	Roberts 1949 Uranyl Nitrate	
			Gastro	2.1	9.5	(vomiting, anorexia)		
			Hemato		0.13	(slightly decreased fibrinogen)		
			Renal		0.13	(proteinuria, transient increase in bromosulfalein retention)		
			Bd Wt	2.1	9.5	(approximately 25% decreased body weight in 3/4 that died)		
		Other	2.1					
65	Dog (NS)	4 wk 6 d/wk 6 hr/d	Resp		16	(very slight pulmonary degenerative changes)	Rothstein 1949c Uranium Trioxide	
			Hemato	16				
			Hepatic	16				
			Renal		16	(mild to severe tubular necrosis)		
		Bd Wt	16					

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
66	Dog (NS)	5 wk 6 d/wk 6 hr/d	Gastro	2.2		9.2	(vomited blood)	Rothstein 1949a Uranyl Fluoride
			Hemato	9.2				
			Renal		0.15 ^b	(very slight renal degeneration in approximately 50% of dogs)		
			Bd Wt	2.2		9.2	(unspecified severe weight loss)	
67	Dog (NS)	5 wk 6 d/wk	Resp	9.2				Rothstein 1949b Uranium Dioxide
			Hemato	9.2				
			Renal	1.1 ^c	8.2	(slight renal tubular degeneration in 2/6)		
			Bd Wt	9.2				
68	Dog (NS)	30 d 6 hr/d	Resp	0.2	2	(slight pneumonia)		Spiegl 1949 Uranium Hexafluoride
			Hemato	2				
			Renal	0.05	0.2	(slight pneumonia)		
			Ocular	2	13.3	(conjunctivitis)		

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
69	Rabbit (NS)	30 d 6 hr/d	Hemato	18			Dygert 1949a Uranium Tetrafluoride	
			Renal		0.4	(increased urinary catalase and phosphatase)		
			Bd Wt	3		18		(24% decreased body weight)
70	Rabbit (NS)	30 d 6 hr/d	Resp				Dygert 1949b Ammonium Diuranate	
			Hemato		6.8	(increased neutrophils, decreased lymphocytes)		
			Renal			6.8		(severe necrosis of the tubular epithelium)

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					Less Serious (mg/m ³)	Serious (mg/m ³)			
71	Rabbit (NS)	23 d 5 d/wk 5 hr/d	Resp				15.4	(edematous alveoli, alveolar hemorrhage, hyperemia, and atelectasis)	Dygert 1949d Uranium Peroxide
			Hemato	15.4					
			Hepatic	15.4					
			Renal		15.4	(moderate corticomedullary tubule necrosis with regeneration of tubular cells; azotemia)			
			Bd Wt	15.4					
72	Rabbit (NS)	30 d Cont.	Resp	0.2					Roberts 1949 Uranyl Nitrate
			Hemato		0.13	(increased plasma prothrombin and fibrinogen)			
			Renal		0.13	(increased urinary catalase)			
			Bd Wt	0.13	0.2	(unspecified decrease in body weight)			

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					Less Serious (mg/m ³)	Serious (mg/m ³)			
73	Rabbit (NS)	4 wk 6 d/wk 6 hr/d	Resp				16	(hemorrhage and consolidation in lungs of animals that died)	Rothstein 1949c Uranium Trioxide
			Hemato	16					
			Hepatic		16	(moderate fatty livers in 5/8 animals that died)			
			Renal		16	(mild to severe necrosis of the tubular epithelium with degeneration and regeneration; increased NPN)			
			Bd Wt	16					
74	Rabbit (NS)	5 wk 6 d/wk	Resp	19.4					Rothstein 1949b Uranium Dioxide
			Hemato	19.4					
			Renal	9.2		19.4	(severe tubular necrosis in dying animals)		
			Bd Wt	8.2	9.2	(unspecified decreased body weight)			

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
75	Rabbit (NS)	5 wk 5.5 d/wk 6 hr/d	Hepatic		15	(slight decrease in lactate)		Rothstein 1949d Sodium Uranate
			Renal		15	(progressive degeneration and necrosis followed by regeneration of tubular epithelium; increased NPN)		
			Bd Wt	15				
76	Rabbit (NS)	30 d 6 hr/d	Resp	0.2	2	(severe pulmonary edema)		Spiegl 1949 Uranium Hexafluoride
			Hemato	13				
			Renal		0.2	(mild tubular degeneration)		
			Bd Wt	0.2	2	(12% decreased body weight)		
77	Rabbit (NS)	6.5 mo 5.5 d/wk 6 hr/d	Hemato	2				Stokinger et al. 1953 Uranyl Nitrate
			Renal		0.25	mild tubular atrophy)		
			Bd Wt			2	(weight loss)	

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
78	Rabbit	9 mo 5.5 d/wk 6 hr/d	Renal		0.2	(very mild tubular injury)	Stokinger et al. 1953 Uranium Hexafluoride	
			Bd Wt	0.2				
79	Rabbit	9 mo 5.5 d/wk 6 hr/d	Hemato	3			Stokinger et al. 1953 Uranium Tetrafluoride	
			Renal	3				
			Bd Wt	3				
80	Rabbit (NS)	7 mo 33 hrs/wk	Hemato	10			Stokinger et al. 1953 Uranium Dioxide	
			Renal	10				
			Bd Wt	10				
81	Rabbit	7.5 mo 33 hr/wk	Renal	0.2			Stokinger et al. 1953 Uranium Tetrachloride	
			Bd Wt	0.2				

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
82	Cat (NS)	30 d 6 hr/d	Resp		18	(rhinitis)		Dygert 1949a Uranium Tetrafluoride
			Gastro			18	(vomited blood)	
			Hemato	18				
			Renal			18	(moderate to severe typical renal injury in 2/3 dying cats; azotemia)	
			Ocular		18	(conjunctivitis)		
			Bd Wt		18	(18% decreased body weight)		
83	Cat (NS)	23 d 5 d/wk 5 hr/d	Hemato	15.4				Dygert 1949d Uranium Peroxide
			Renal			15.4	(azotemia)	
			Bd Wt	15.4				
84	Cat (NS)	5 wk 6 d/wk 6 hr/d	Resp	2.2	9.2	(rhinitis)		Rothstein 1949a Uranyl Fluoride
			Gastro	2.2		9.2	(vomited blood prior to death)	
			Renal	2.2		9.2	(severe degeneration of renal tubular epithelium)	

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
Immuno/ Lymphoret								
85	Rat (NS)	30 d 6 hr/d			0.4	(edematous cecal lymph nodes; focal necrosis of spleen)	Dygert 1949a Uranium Tetrafluoride	
86	Rat (NS)	30 d 6 hr/d			6.8	(rise in neutrophils, decreased lymphocytes, moderate fall in the white blood count, rise in the eosinophils)	Dygert 1949b Ammonium Diuranate	
87	Rat (NS)	30 d Cont.		2.1	9.5	(decreased absolute number of lymphocytes and neutrophils)	Roberts 1949 Uranyl Nitrate	
Neurological								
88	Rat (Sprague-Dawley)	3 wk 4 d/wk 0.5 hr (NS)			190 M	(increased spontaneous activity; decreased spatial working memory)	Monleau et al. 2005 Uranium Dioxide	
89	Dog (NS)	30 d 6 hr/d		4	18	(weakness and unsteady gait)	Dygert 1949a Uranium Tetrafluoride	
90	Cat (NS)	30 d 6 hr/d			18	(weakness and unsteady gait)	Dygert 1949a Uranium Tetrafluoride	

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					Less Serious (mg/m ³)	Serious (mg/m ³)		
CHRONIC EXPOSURE								
Death								
91	Dog (Beagle)	5 yr 5 d/wk 5.4 hr/d					5 (4.5% mortality)	Leach et al. 1970, 1973 Uranium Dioxide
Systemic								
92	Monkey	5 yr 5 d/wk 5.4 hr/d	Resp		5.1 ^d	(minimal pulmonary hyaline fibrosis)		Leach et al. 1970, 1973 Uranium Dioxide
			Hepatic	5.1				
			Renal	5.1				
			Bd Wt	5.1				
93	Rat (NS)	1 yr 33 hrs/wk	Resp	0.2				Stokinger et al. 1953 Uranium Tetrachloride
			Gastro	0.2				
			Hepatic	0.2				
			Renal	0.05	0.2	(slight to mild tubular injury)		
			Endocr	0.2				
			Bd Wt	0.2				
94	Rat (NS)	1 yr 33 hrs/wk	Resp	2				Stokinger et al. 1953 Uranyl Nitrate
			Renal	0.25	2	(mild to marked renal tubular atrophy)		
			Bd Wt	2				

Table 3-1 Levels of Significant Exposure to Uranium - Inhalation

(continued)

Key to Figure ^a	Species (Strain)	Exposure/Duration/Frequency (Route)	System	NOAEL (mg/m ³)	LOAEL		Reference Chemical Form	Comments
					Less Serious (mg/m ³)	Serious (mg/m ³)		
95	Rat (NS)	1 yr 5.5 d/wk 6 hr/d	Resp	0.2			Stokinger et al. 1953 Uranium Hexafluoride	
			Cardio	0.2				
			Gastro	0.2				
			Hemato	0.2				
			Hepatic	0.2				
			Renal	0.05	0.2	(very mild renal tubular lesions)		
			Endocr	0.2				
			Dermal	0.2				
			Bd Wt	0.2				
96	Rat (NS)	2 yr 5.5 d/wk 6 hr/d	Hemato	2			Stokinger et al. 1953 Uranyl Nitrate	
			Renal		2	(mild tubular atrophy)		
			Bd Wt	2				
97	Rat (NS)	1 yr 5.5 d/wk 6 hr/d	Hemato	3			Stokinger et al. 1953 Uranium Tetrafluoride	
			Renal	3				
			Bd Wt	3				

Table 3-1 Levels of Significant Exposure to Uranium - Inhalation

(continued)

Key to Figure	Species (Strain)	Exposure/Duration/Frequency (Route)	System	NOAEL (mg/m ³)	LOAEL		Reference Chemical Form	Comments
					Less Serious (mg/m ³)	Serious (mg/m ³)		
98	Rat	1 yr 33 hrs/wk	Hemato	10			Stokinger et al. 1953 Uranium Dioxide	
			Renal	10				
			Bd Wt	10				
99	Dog (Beagle)	1-5 yr 5 d/wk 5.4 hr/d	Resp		5.1	(lung fibrosis)	Leach et al. 1970, 1973 Uranium Dioxide	
			Hemato	5.1				
			Renal	5.1				
			Bd Wt	5.1				
100	Dog (NS)	1 yr 33 hrs/wk	Hemato	0.2			Stokinger et al. 1953 Uranium Tetrachloride	
			Hepatic	0.2				
			Renal	0.05 ^e	0.2	(slight tubular atrophy)		
			Bd Wt	0.2				
101	Dog (NS)	1 yr 5.5 d/wk 6 hr/d	Hemato	2			Stokinger et al. 1953 Uranyl Nitrate	
			Hepatic	2				
			Renal	0.15	0.25	(mild to moderate tubular atrophy)		
			Bd Wt	2				

Table 3-1 Levels of Significant Exposure to Uranium - Inhalation

(continued)

Key to Figure ^a	Species (Strain)	Exposure/Duration/Frequency (Route)	System	NOAEL (mg/m ³)	LOAEL		Reference Chemical Form	Comments
					Less Serious (mg/m ³)	Serious (mg/m ³)		
102	Dog	1 yr 33 hrs/wk	Hemato	10			Stokinger et al. 1953 Uranium Dioxide	
			Renal	1	10	(slight to mild tubular degeneration)		
			Bd Wt	10				
103	Dog	1 yr 5.5 d/wk 6 hr/d	Hemato	3			Stokinger et al. 1953 Uranium Tetrafluoride	
			Renal	0.5	3	(tubular damage)		
			Bd Wt	3				
104	Dog (NS)	1 yr 5.5 d/wk 6 hr/d	Resp	0.2			Stokinger et al. 1953 Uranium Hexafluoride	
			Hemato	0.2				
			Renal	0.05	0.2	(mild tubular injury)		
			Bd Wt	0.2				
105	Dog (NS)	2 yr 5.5 d/wk 6 hr/d	Hemato	2			Stokinger et al. 1953 Uranyl Nitrate	
			Renal		2	(moderate tubular atrophy)		

Table 3-1 Levels of Significant Exposure to Uranium - Inhalation

(continued)

Key to Figure ^a	Species (Strain)	Exposure/Duration/Frequency (Route)	System	NOAEL (mg/m ³)	LOAEL		Reference Chemical Form	Comments
					Less Serious (mg/m ³)	Serious (mg/m ³)		
Immuno/ Lymphoret								
106	Dog (Beagle)	5 yr 5 d/wk 5.4 hr/d			5.1 (minimal lymph node fibrosis)		Leach et al. 1970, 1973 Uranium Dioxide	
Cancer								
107	Rat (Sprague-Dawley)	65 wk 5 d/wk 4.2 hr/d				8.4 M (CEL: malignant lung tumors)	Mitchel et al. 1999 Uranium dust	
108	Dog (NS)	1-5 yr 5 d/wk 5.4 hr/d				5.1 (CEL: lung cancer)	Leach et al. 1973 Uranium Dioxide	

a The number corresponds to entries in Figure 3-1.

b Used to derive an intermediate-duration inhalation minimal risk level (MRL) of 0.0001 mg U/m³ for soluble uranium compounds based on a LOAELADJ of 0.032 mg/m³ and an uncertainty factor of 300 (3 for used of a minimal LOAEL, 10 for extrapolation from animals to humans, and 10 for human variability).

c Used to derive an intermediate-duration inhalation minimal risk level (MRL) of 0.002 mg U/m³ for insoluble uranium compounds based on a NOAELADJ of 0.24 mg/m³ and an uncertainty factor of 100 (10 for extrapolation from animals to humans and 10 for human variability).

d Used to derive a chronic-duration inhalation minimal risk level (MRL) of 0.0008 mg U/m³ for insoluble uranium compounds based on a LOAELADJ of 0.82 mg/m³ and an uncertainty factor of 1000 (10 for use of LOAEL, 10 for extrapolation from animals to humans and 10 for human variability).

e Used to derive a chronic-duration inhalation minimal risk level (MRL) of 0.00004 mg U/m³ for soluble uranium compounds based on a BMCLADJ of 0.0037 mg/m³ and an uncertainty factor of 100 (10 for extrapolation from animals to humans and 10 for human variability).

Bd Wt = body weight; Cardio = cardiovascular; CEL = cancer effect level; d = day(s); Endocr = endocrine; Gastro = gastrointestinal; Gn Pig = guinea pig; Hemato = hematological; hr = hour(s); LOAEL = lowest-observed-adverse-effect level; M = male; min = minute(s); NOAEL = no-observed-adverse-effect level; NS = not specified; occup = occupational; Resp = respiratory; wk = week(s); yr = year(s)