

# **ROCKETDYNE WORKER HEALTH STUDY**

## **Appendix D**



### **Comparisons with Previous Investigation by UCLA**

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### Appendix D. Comparisons With Previous Investigation by UCLA

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**Table D1. Descriptions of the Radiation and Chemical Cohorts of Rocketdyne/AI Workers Comparing the Previous Investigation (UCLA) with the Current Investigation (IEI)**

	Externally Monitored		Internally Monitored		Chemical	
	UCLA	IEI	UCLA	IEI	UCLA	IEI
Number of subjects	4,563	5,743	2,297	2,232	6,107	8,372
Percent male	94.0	92.0	96.6	96.3	100	84.6
Mean follow-up time (yrs)	26.1	27.9	25.4	30.4	29.0	30.4
Number of total deaths	875	1,449	441	599	1,391	2,251
Total mortality rate (per 10 <sup>5</sup> /yr)	737	906	755	883	786	886
Number of cancer deaths	258	447	134	203	404	655
Cancer mortality rate (per 10 <sup>5</sup> /yr)	217	279	229	300	228	258
Pay type (% of total)						
Hourly/union	50.7	56.5	56.2	62.6	11.3	62.6

Table from Morgenstern and Ritz (Table 1, 2001) with follow-up through 1950-1993. The IEI numbers are from the current investigation (1948-1999).

**COMMENT.**

The current IEI investigation is larger and the follow-up longer than the previous UCLA study. Accordingly there were more deaths to evaluate. Another notable difference is the apparent low percentage of hourly workers in the UCLA Chemical Cohort (11.3%) compared to our 62.6 %.

**Table D2a. Distribution of Total Cumulative Doses (mSv) of External and Internal Radiation and Hydrazine Exposure in the Radiation and Chemical Cohorts of Rocketdyne/AI Workers, 1950-1993 (Morgenstern and Ritz, 2001, Table 2)**

External Radiation			Internal Radiation			Hydrazine Exposure		
mSv	No.	%	mSv	No.	%	Category	No.	%
<10	3,391	74.3	0	1,333	58.0	None	4,368	71.5
10 - < 20	589	12.9	> 0 - < 5	691	30.1	Low	32	0.5
10 - < 200	549	12.0	5 - < 30	256	11.2	Medium	654	10.7
≥ 200	34	0.7	≥ 30	17	0.7	High	1,053	17.2
Mean = 11.9 mSv			Mean = 2.1 mSv					

**Table D2b. Distribution of Total Cumulative Doses (mSv) of External and Internal Radiation and Hydrazine Exposure in the Radiation and Chemical Cohorts of Rocketdyne/AI Workers, 1948-1999 (Current IEI Study)**

External Radiation			Internal Radiation (Lung Dose) <sup>1</sup>			Hydrazine Exposure <sup>2</sup>		
mSv	No.	%	mSv	No.	%	Category	No.	%
<10	4,454	76.8	<10	150	6.7	Referent (SSFL)	1,598	52.6
10 - < 50	1,012	17.4	10 - < 50	1,726	77.3	None	920	30.3
50 - < 200	266	4.6	50 - < 200	253	11.3	Possible	205	6.7
≥ 200	69	1.2	≥ 200	103	4.6	> 0 – 1.4 yr	156	5.1
Mean = 13.6 mSv			Mean = 19.1 mSv			≥ 1.5 yr	159	5.2

<sup>1</sup> Includes external lung dose also.

<sup>2</sup> Male hourly workers other than test stand mechanics at SSFL used as referent. “Possible” hydrazine exposure reflects the uncertainty of actually working at a test stand where hydrazine was used. “Likely” years of potential exposure to hydrazines is presented. In total, there were 315 test stand mechanics with likely exposure to hydrazine and 205 with possible exposure.

#### COMMENT.

Compared with the earlier UCLA investigation, the current IEI study included more workers exposed to external radiation, had about the same number of workers monitored for internal radiation, and had fewer workers exposed to hydrazines. The mean dose of workers monitored for external radiation was 14% greater in the IEI investigation. The dose distribution for the workers monitored for internal radiation includes much higher categories in the current investigation because, in part, the external lung doses were also added to the internal dose for each individual. In addition, different and more current biokinetic models of dose computation were used. The current study was also able to assign test stand mechanics to test areas where hydrazines were used and determine the number of years worked with the potential for exposure to hydrazines. The previous UCLA investigation apparently assumed that all test stand mechanics were potentially exposed to hydrazines whereas we estimate that less than 30% of test stand mechanics were potentially exposed to hydrazines.

**Table D3. External Comparisons of Rocketdyne/AI Workers in Radiation and Chemical Cohort with General Population: Estimated SMRs and 95% CIs for Selected Causes of Death, 1950-1994 (UCLA Morgenstern and Ritz, 2001, Table 3) and 1948-1999 (IEI)**

Cause of Death (IDCA-8)	Externally Monitored		Internally Monitored		Chemical Cohort	
	No. Deaths	SMR (95% CI)	No. Deaths	SMR (95% CI)	No. Deaths	SMR (95% CI)
All causes (001-998)						
UCLA (compared to U.S. population)	844	0.68 (0.64-0.73)	433	0.72 (0.66-0.80)	1,391	0.66 (0.62-0.69)
IEI (compared to California population)	1,449	0.78 (0.74-0.82)	599	0.81 (0.75-0.88)	2,251	0.83 (0.80-0.86)
All cancers (140-229)						
UCLA	248	0.79 (0.69-0.89)	133	0.87 (0.73-1.03)	404	0.79 (0.68-0.83)
IEI	447	0.89 (0.81-0.98)	203	1.04 (0.90-1.19)	655	0.89 (0.82-0.96)
Lung cancer (162)						
UCLA	87	0.75 (0.60-0.92)	46	0.81 (0.59-1.08)	146	0.74 (0.62-0.86)
IEI	148	0.88 (0.75-1.04)	69	1.05 (0.81-1.32)	215	0.89 (0.78-1.02)
Leukemia (204-207)						
UCLA	18	1.60 (0.95-2.52)	8	1.46 (0.63-2.88)	10	0.52 (0.25-0.96)
IEI	25	1.34 (0.87-1.98)	10	1.35 (0.65-2.49)	20	0.89 (0.54-1.37)
Lymphopoietic cancers (200-208)						
UCLA	30	1.01 (0.68-1.44)	12	0.83 (0.43-1.45)	41	0.81 (0.58-1.11)
IEI	51	1.03 (0.77-1.36)	21	1.07 (0.66-1.64)	29	1.02 (0.69-1.47)

**COMMENT.**

The current investigation has larger numbers and somewhat greater SMR values than the UCLA investigation. UCLA compared the study cohorts with the U.S. general population whereas we used the California general population for comparison. Also, the table for UCLA is restricted to white males whereas we included women and all races. Regardless, there were no statistically significant increases in either study.

**Table D4a Estimated RR for the Effect of Cumulative External Radiation Dose on Cancer Mortality Among Externally Monitored Workers, by Cancer Type and Dose Category (UCLA) (Table 4, Morgenstern and Ritz, 2001)**

Cancer Type (ICD-9)	Dose (mSv)	No. Deaths	RR	95% CI	Trend <i>P</i>
All sites (140-239)	<10	177	1	--	0.036
	10 - < 20	41	1.07	(0.75-1.52)	
	20 - < 200	36	1.13	(0.78-1.65)	
	≥ 200	4	3.10	(1.13-8.48)	
Lymphopoietic (200-208, excluding 204.1)	<10	15	1	--	0.003
	10 - < 20	7	1.74	(0.68-4.45)	
	20 - < 200	4	1.00	(0.31-3.21)	
	≥ 200	2	15.7	(3.33-73.5)	
Lung (162)	<10	65	1	--	0.045
	10 - < 20	8	0.63	(0.30-1.33)	
	20 - < 200	12	1.18	(0.61-2.28)	
	≥ 200	2	4.70	(1.05-21.0)	

**Table D4b Estimated RR for the Effect of Cumulative Radiation Dose on Cancer Mortality by Cancer Type and Dose Category (IEI)**

Cancer Type (ICD-9)	Dose (mSv)	No. Deaths	RR	95% CI	Trend <i>P</i>
All sites (140-239)	Not monitored	2,733	1.00	Ref	0.25
	0	44	1.22	(0.90-1.66)	
	> 0-	214	0.89	(0.76-1.02)	
	5-	60	0.93	(0.70-1.24)	
	10-	105	0.99	(0.77-1.27)	
	50-	12	0.69	(0.39-1.25)	
	100-	14	1.53	(0.87-2.67)	
	≥ 200	7	1.25	(0.58-2.71)	
Lymphopoietic (200-208, excluding 204.1)	Not monitored	245	1.00	Ref	0.18
	0	3	1.03	(0.33-3.26)	
	> 0-	19	0.88	(0.54-1.44)	
	5-	11	2.10	(1.04-4.22)	
	10-	8	0.93	(0.41-2.14)	
	≥ 50-	3	1.14	(0.32-3.97)	
Lung (162)	Not monitored	917	1.00	Ref	0.49
	0	17	1.37	(0.84-2.26)	
	> 0-	74	0.93	(0.72-1.21)	
	5-	21	1.03	(0.63-1.67)	
	10-	27	0.75	(0.47-1.19)	
	50-	7	0.63	(0.28-1.40)	
	≥ 200	5	1.39	(0.54-3.60)	

**COMMENT.**

The current study has more cancer deaths to evaluate and more workers who received relatively high doses. This is in part because we had included all occupational exposures received both at Rocketdyne and elsewhere. The UCLA study reported statistically significant radiation risks among workers who received greater than 200 mSv and statistically significant dose-response trends. The current investigation revealed no statistically significant findings at any dose level and none of the dose-response trends approached statistical significance. P-values for the current study are 1-sided.

**Table D5a Estimated RR for the Effect of Hydrazine Exposure on Lung Cancer Mortality Among Workers in the Chemical Cohort by Exposure Category (UCLA) (Table 8, Morgenstern and Ritz , 2001)**

<b>Exposure Category</b>	<b>No. Deaths Lung Cancer</b>	<b>RR</b>	<b>95% CI</b>
None	97	1	--
Medium	5	0.41	(0.17-1.02)
High	44	1.68	(1.12-2.52)

**Table D5b Estimated RR for the Effect of Years Worked as a Test Stand Mechanic on Lung Cancer Among Male Test Stand Mechanics with Hourly SSFL Workers as Referent (IEI)**

<b>Exposure Category</b>	<b>No. Deaths Lung Cancer</b>	<b>RR</b>	<b>95% CI</b>
Referent (SSFL workers)	59	1.00	--
< 1 year	10	0.80	(0.41-1.56)
1 – 4 years	31	1.02	(0.66-1.59)
≥ 5 years	22	0.96	(0.58-1.59)

**Table D5c Estimated RR for the Effect of Cumulative Potential Exposure to Hydrazines (Likely and Possible) on Lung Cancer Among Test Stand Mechanics with Hourly SSFL Workers as Referent (IEI)**

<b>Exposure Category</b>	<b>No. Deaths Lung Cancer</b>	<b>RR</b>	<b>95% CI</b>
Referent (SSFL workers)	59	1.00	--
No Hydrazine exposure	30	0.52	(0.23-1.14)
Possible (not likely) Hydrazine exposure	13	0.96	(0.34-2.69)
Likely Hydrazine exposure >0 – 1.4 years	7	0.79	(0.26-2.46)
Likely Hydrazine exposure ≥ 1.5 years	8	0.76	(0.25-2.30)

**COMMENT.**

The previous study by UCLA assumed all test stand mechanics were exposed to hydrazines. These workers represent the “High” exposure category in their table D5a. For comparison, we present our analyses of lung cancer among test stand mechanics over categories of years worked as a test stand mechanic (D5b) and our analyses with respect to years worked with “likely” or “possible” exposure to hydrazines (D5c). We observed no association between hydrazines potential exposure and risk of lung cancer.