UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

AUG 08 2000

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Mr. Stephen P. Risotto
Executive Director
Halogenated Solvents Industry Alliance, Inc.
2001 L Street, N.W., Suite 506A
Washington, D.C. 20036

Dear Mr. Risotto:

This is in response to your July 26, 2000 letter concerning our National Air Toxics Assessment (NATA) national-scale assessment effort.

You are correct in your assertion that we are proposing to utilize CalEPA cancer potency factors to help characterize the potential cancer risks associated with perchloroethylene and trichloroethylene, and that this proposal is based in part on the fact that there are currently no such factors in the EPA's Integrated Risk Information System (IRIS) database. Both of these chemicals are currently being reviewed for inclusion in the IRIS database, but it appears unlikely that these reviews will be completed in time for our national-scale assessment.

We are committed to using the best-available science in our assessments, and this one is no exception. As the CalEPA factors have undergone extensive peer review, we feel that they are appropriate surrogates for approved IRIS values for the purposes of this assessment. We will also characterize the uncertainties associated with their use in this assessment. Until EPA has approved IRIS assessments for these substances, we feel that this is the most responsible way to characterize these risks.

We intend to use the national-scale assessment for a variety of purposes, including (1) prioritizing substances and source categories for detailed risk assessments, (2) measuring progress of the air toxics program against goals, and (3) helping to set the research agenda. However, we do *not* intend to use this assessment as the basis for any regulatory actions. Thus, our use of CalEPA assessments should not have any direct impact on HSIA members. Furthermore, this national-scale assessment will undergo scientific peer review by the EPA's Science Advisory Board in the fall. We will specifically place the question of appropriate cancer potency factors for this assessment on their agenda. We will then follow their recommendation in finalizing the assessment and making the results publicly available.

Please feel free to contact Dave Guinnup, Leader of the Risk and Exposure Assessment Group at 919-541-5368 if you have additional questions concerning this issue.

Sincerely,

Sally L. Shaver

Sally L. Shaver
Director
Emission Standards Division

cc: Dave Guinnup

FACILITY	LOCATION	COMPOSITE[1] START TIME	COMPOSITE[1] END TIME	VALUE (ug/m3)	EQUIP GEN	HSIA Notes
DC-1	NYC PERC PROJECT 401949X	0111260940	0111271002	5	4th	DEC notes indicate that a 4th gen machine was
DC-1	NYC PERC PROJECT 401949X	0111260940	0111271002	5	4th	installed in 2000; all samples collected since then
DC-1	NYC PERC PROJECT 401949X	0112101700	0112112015	12	4th	
DC-1	NYC PERC PROJECT 401949X	0112101700	0112112015	11	4th	
DC-1	NYC PERC PROJECT 401949X	0112101703	0112112018	16	4th	
DC-2	2-PN LOCATION - LR	0301141707	0301151807	4,800	3rd/4th	4th gen machine was installed between May 2002
DC-2	2-PN LOCATION - LR	0301141807	0301151707	5,200	3rd/4th	and March 2003; DEC notes also indicate that the facility met NYSDOH guideline (100) on 3/20/03; eliminate all samples
DC-15	12208-PN LOCATION - LR	0206181849	0206191900	27	3rd	3rd gen machine operating when all of samples
DC-15	12208-PN LOCATION - LR	0206181851	0206191858	27	3rd	taken; eliminate all samples
DC-15	12208-PN LOCATION - KIT	0206181910	0206191903	23	3rd	
DC-16		9905110825	9905111025	6,400	3rd	Inspection reports indicate that a 4th gen machine
DC-16		9905110825	9905111025	6,200	3rd	was installed between Oct 2000 and Oct 2001;
DC-16		0001120905	0001121105	4,800	3rd	eliminate samples taken prior to Oct 2000
DC-16		0001120905	0001121105	4,800	3rd	
DC-16	APT 2D	0005190815	0005191015	300	3rd	
DC-16	APT 2D	0005190815	0005191015	300	3rd	
DC-16	GROUND FLR	0008110840	0008111040	1,400	3rd	
DC-16	GROUND FLR	0008110840	0008111040	1,400	3rd	
DC-16		0010270850	0010271050	170	4th	
DC-16		0010270850	0010271050	170	4th	
DC-16		0012051005	0012051205	180	4th	
DC-16	GROUND FLOOR	0012051006	0012051206	170	4th	
DC-16	APT 4D	0106260835	0106261035	15	4th	
DC-16	APT 4D	0106260835	0106261035	15	4th	
DC-16	APT 4D	0106260835	0106261035	20	4th	
DC-16	APT 4D	0106260835	0106261035	20	4th	
DC-16	APT 4D	0106260835	0106261035	15	4th	
DC-16	APT 4D	0106260835	0106261035	20	4th	
DC-16	13868 - PN LOCATION - LR	0207091637	0207101627	396	4th	
DC-16	13868 - PN LOCATION - LR	0207091639	0207101627	402	4th	
DC-16	13868 - PN LOCATION - CHILD BR	0207091644	0207101628	533	4th	
DC-16	13868 - PN LOCATION - LR	0209171703	0209181701	240	4th	
DC-16	13868 - PN LOCATION - LR	0209171703	0209181701	250	4th	
DC-16	13944 - PN LOCATION - LR	0209171912	0209181905	5	4th	
DC-16	13944 - PN LOCATION - LR	0209171912	0209181906	5	4th	
DC-16	13805 - PN LOCATION - LR	0209241835	0209251705	5	4th	
DC-16	13805 - PN LOCATION - LR	0209241835	0209251705	5	4th	
DC-16		0301310940	0301311140	40	4th	
DC-16		0301310940	0301311140	40	4th	

FACILITY	LOCATION	COMPOSITE[1] START TIME	COMPOSITE[1] END TIME	VALUE (ug/m3)	EQUIP GEN	HSIA Notes
DC-16		0301310942	0301311142	30	4th	
DC-16		0301310942	0301311142	20	4th	
DC-16		0301310944	0301311144	20	4th	
DC-16		0301310944	0301311144	20	4th	
DC-18	45554-PN LOCATION - LR	0212031640	0212041752	690	4th	
DC-18	45554-PN LOCATION - LR	0212031641	0212041753	700	4th	
DC-21		9711260845	9711261145	1,450	3rd	DEC notes indicate that a 3rd gen machine was
DC-21		9711260845	9711261045	1,400	3rd	installed in 1998 and that a 4th gen was in place as
DC-21		9803200820	9803201020	70	3rd	of Sept 2001; eliminate samples taken in 1998 or
DC-21		9803200820	9803201020	70	3rd	earlier
DC-21	11391 -PN LOCATION - LR	0206111610	0206121617	84	4th	
DC-21	11391 -PN LOCATION - LR	0206111611	0206121617	84	4th	
DC-40	15465-PN LOCATION - LR	0304031555	0304042000	44	4th	DEC notes indicate that a 4th gen machine was
DC-40	15465-PN LOCATION - LR	0304031557	0304042000	45	4th	installed in 1997; all samples collected since then
DC-40	15462-PN LOCATION - LR	0304031637	0304041919	77	4th	
DC-40	15462-PN LOCATION - LR	0304031637	0304041919	72	4th	
DC-40	15466-PN LOCATION - LR	0304031645	0304041828	76	4th	
DC-40	15466-PN LOCATION - LR	0304031645	0304041828	79	4th	
DC-40	15464-PN LOCATION - LR	0304031830	0304041704	217	4th	
DC-40	15464-PN LOCATION - LR	0304031830	0304041704	214	4th	
DC-40	15463-PN LOCATION - LR	0304301753	0305011734	120	4th	
DC-40	15463-PN LOCATION - LR	0304301753	0305011733	140	4th	
DC-40	15467-PN LOCATION - LR	0304301810	0305012037	11	4th	
DC-40	15467-PN LOCATION - LR	0304301810	0305012037	12	4th	
DC-41	NYC PERC PROJECT 401949X	0203051820	0203051913	2	4th	DEC notes indicate that a 4th gen machine was
DC-41	NYC PERC PROJECT 401949X	0203051852	0203061652	5	4th	installed in 1994; all samples collected since then
DC-41	NYC PERC PROJECT 401949X	0203051852	0203061652	5	4th	
DC-41	NYC PERC PROJECT 401949X	0203181935	0203182035	62	4th	
DC-41	NYC PERC PROJECT 401949X	0203181939	0203191938	81	4th	
DC-41	NYC PERC PROJECT 401949X	0203181940	0203191940	78	4th	
DC-41	NYC PERC PROJECT 401949X	0203181941	0203191941	97	4th	
DC-41	NYC PERC PROJECT 401949X	0203251700	0203251800	15	4th	
DC-41	NYC PERC PROJECT 401949X	0203251702	0203261730	12	4th	
DC-41	NYC PERC PROJECT 401949X	0203251702	0203261732	13	4th	
DC-41	8848-PN LOCATION - LR	0204082031	0204082122	2	4th	
DC-41	8848-PN LOCATION - LR	0204082035	0204091932	5	4th	
DC-41	8848-PN LOCATION - LR	0204082036	0204091932	5	4th	
DC-41	8868-PN LOCATION - LR	0204291804	0204291858	3	4th	
DC-41	8868-PN LOCATION - LR	0204291813	0204301859	5	4th	
DC-41	8868-PN LOCATION - LR	0204291813	0204301902	5	4th	

FACILITY	LOCATION	COMPOSITE[1] START TIME	COMPOSITE[1] END TIME	VALUE (ug/m3)	EQUIP GEN	HSIA Notes
DC-41	8845 - PN LOCATION - LR	0205211610	0205211710	6	4th	
DC-41	8846 - PN LOCATION - LR	0205211612	0205221857	5	4th	
DC-41	8847 - PN LOCATION - LR	0205211612	0205221858	5	4th	
DC-42	15433-PN LOCATION - LR	0212031845	0212041915	770	4th	DEC notes indicate that a 4th gen machine was
DC-42	15433-PN LOCATION - LR	0212031854	0212041916	750	4th	installed in 2001; all samples collected since then
DC-44		9701161151	9701161351	3,900	3rd	DEC notes indicate that a 4th gen machine was
DC-44		9701161151	9701161351	3,900	3rd	installed in April 1999; eliminate samples taken
DC-44		9703051230	9703051430	400	3rd	before then
DC-44	STREET LEVEL	9705211105	9705211305	200	3rd	
DC-44	STREET LEVEL	9705211105	9705211305	210	3rd	
DC-44	STREET LEVEL	9708191505	9708191705	1,800	3rd	
DC-44	STREET LEVEL	9708191505	9708191705	2,100	3rd	
DC-44	STREET LEVEL	9709300820	9709301020	500	3rd	
DC-44	STREET LEVEL	9709300820	9709301020	500	3rd	
DC-44		9712100845	9712101045	800	3rd	
DC-44		9712100845	9712101045	670	3rd	
DC-44	STREET LEVEL	9810010830	9810011030	150	3rd	
DC-44	STREET LEVEL	9810010830	9810011030	150	3rd	
DC-44	APT 2F	9901130745	9901130945	1,400	3rd	
DC-44	APT 2F	9901130750	9901130950	1,350	3rd	
DC-44	12583-PN LOCATION - LR	0207231659	0207241838	378	4th	
DC-44	12583-PN LOCATION - LR	0207231659	0207241838	366	4th	
DC-48	12643-PN LOCATION - LR	0207091837	0207101823	5	no data	No DEC data on compliance status; eliminate all
DC-48	12643-PN LOCATION - LR	0207091839	0207101822	5	no data	samples
DC-52		9801150830	9801151030	100	3rd	3rd gen machine operating when all of samples
DC-52		9801150830	9801151030	100	3rd	taken; eliminate all samples
DC-52	APT. 3L	0010121510	0010121710	5,000	3rd	
DC-52	APT. 3L	0010121510	0010121710	5,100	3rd	
DC-52		0102061340	0102061540	1,900	3rd	
DC-52		0102061340	0102061540	1,700	3rd	
DC-52	APT. 3L	0202050955	0202051155	2,600	3rd	
DC-52	APT. 3L	0202050955	0202051155	2,600	3rd	
DC-52	APT. 3L	0202050957	0202051157	4,300	3rd	
DC-52	APT. 3L	0202050957	0202051157	4,100	3rd	
DC-52	APT. 3L	0202051000	0202051200	1,300	3rd	
DC-52	APT. 3L	0202051000	0202051200	1,300	3rd	
DC-52	APT. 3L	0202051003	0202051203	3,200	3rd	
DC-52	APT. 3L	0202051003	0202051203	3,200	3rd	
DC-52	NYC PERC PROJECT 401949X	0202251630	0202251644	10	3rd	
DC-52	NYC PERC PROJECT 401949X	0202251830	0202261830	90	3rd	

FACILITY	LOCATION	COMPOSITE[1] START TIME	COMPOSITE[1] END TIME	VALUE (ug/m3)	EQUIP GEN	HSIA Notes
DC-52	NYC PERC PROJECT 401949X	0202251830	0202261830	93	3rd	
DC-52	NYC PERC PROJECT 401949X	0202251832	0202251902	130	3rd	
DC-52	NYC PERC PROJECT 401949X	0203051754	0203061828	5	3rd	
DC-52	NYC PERC PROJECT 401949X	0203051754	0203061828	5	3rd	
DC-52	NYC PERC PROJECT 401949X	0203051756	0203061830	5	3rd	
DC-52	NYC PERC PROJECT 401949X	0203051756	0203061830	5	3rd	
DC-52	NYC PERC PROJECT 401949X	0203051801	0203051941	3	3rd	
DC-52	NYC PERC PROJECT 401949X	0203051952	0203052115	220	3rd	
DC-52	NYC PERC PROJECT 401949X	0203052000	0203061932	83	3rd	
DC-52	NYC PERC PROJECT 401949X	0203052000	0203061932	55	3rd	
DC-52	NYC PERC PROJECT 401949X	0203181801	0203181901	750	3rd	
DC-52	NYC PERC PROJECT 401949X	0203181805	0203191806	194	3rd	
DC-52	NYC PERC PROJECT 401949X	0203181807	0203191806	193	3rd	
DC-52	NYC PERC PROJECT 401949X	0203251533	0203251633	2	3rd	
DC-52	NYC PERC PROJECT 401949X	0203251535	0203261631	25	3rd	
DC-52	NYC PERC PROJECT 401949X	0203251535	0203261630	24	3rd	
DC-52	NYC PERC PROJECT 401949X	0203251539	0203261632	11	3rd	
DC-52	8577-PN LOCATION - LR	0204081655	0204081742	7	3rd	
DC-52	8577-PN LOCATION - LR	0204081702	0204091847	5	3rd	
DC-52	8577-PN LOCATION - LR	0204081704	0204091847	5	3rd	
DC-52		0204101155	0204101355	270	3rd	
DC-52		0204101156	0204101356	290	3rd	
DC-52		0204101158	0204101358	170	3rd	
DC-52		0204101200	0204101400	180	3rd	
DC-52		0204101201	0204101401	170	3rd	
DC-52		0204101202	0204101402	160	3rd	
DC-53	LOCATION - LR 15474-PN	0304161530	0304171600	10	4th	Inspection reports indicate that a 4th gen machine
DC-53	LOCATION - LR 15474-PN	0304161530	0304171600	9	4th	was installed between March 2000 and March 2001;
DC-53	LOCATION - LR 15474-PN	0304161630	0304171740	5	4th	all samples collected since then
DC-53	LOCATION - LR 15474-PN	0304161630	0304171740	5	4th	
DC-53	LOCATION - LR 15474-PN	0304161649	0304171800	5	4th	
DC-53	LOCATION - LR 15474-PN	0304161649	0304171804	5	4th	
DC-58	401810X STUDY	9705141030	9705141230	55	3rd	DEC notes indicate a 4th gen machine was
DC-58	401810X STUDY	9705141030	9705141230	55	3rd	installed between 1998 and March 2000; eliminate
DC-58	6203-PN LOCATION - LR	0205211743	0205211843	37	4th	samples collected in 1998 or earlier
DC-58	6203-PN LOCATION - LR	0205211746	0205221721	31	4th	
DC-58	6203-PN LOCATION - LR	0205211746	0205221723	25	4th	
DC-58	12049 - PN LOCATION - LR	0205211818	0205221805	8	4th	
DC-58	12049 - PN LOCATION - LR	0205211818	0205221805	8	4th	
DC-58	6236-PN LOCATION - LR	0205291600	0205301600	13	4th	
DC-58	6236-PN LOCATION - LR	0205291600	0205301600	13	4th	

FACILITY	LOCATION	COMPOSITE[1] START TIME	COMPOSITE[1] END TIME	VALUE (ug/m3)	EQUIP GEN	HSIA Notes
DC-58	12050-PN LOCATION - LR	0205291700	0205301731	39	4th	
DC-58	12050-PN LOCATION - LR	0205291700	0205301730	39	4th	
DC-60	NYC PERC PROJECT 401949X	0202251715	0202261939	12	3rd	3rd gen machine operating when all of samples
DC-60	NYC PERC PROJECT 401949X	0202251715	0202251745	12	3rd	taken; eliminate all samples
DC-60	NYC PERC PROJECT 401949X	0202251716	0202261939	13	3rd	
DC-62	8479-PN LOCATION - LR	0204291948	0204292032	29	4th	Inspection reports indicate that a 4th gen machine
DC-62	8479-PN LOCATION - LR	0204291950	0204301943	392	4th	was installed prior to Feb 2002; all samples
DC-62	8479-PN LOCATION - LR	0204291951	0204301943	408	4th	collected since then
DC-62	8479-PN LOCATION - OTHER APT (LR)	0204292008	0204301948	293	4th	
DC-62	8479-PN LOCATION - OTHER APT (LR)	0204292030	0204301948	314	4th	
DC-62	8457-PN LOCATION - LR	0206181748	0206191822	16	4th	
DC-62	8457-PN LOCATION - LR	0206181750	0206191824	17	4th	
DC-62	8457-PN LOCATION - MUSIC RM	0206181753	0206191826	16	4th	
DC-62	8484-PN LOCATION - LR	0206181935	0206191944	15	4th	
DC-62	8484-PN LOCATION - LR	0206181938	0206191944	15	4th	
DC-62	8450-PN LOCATION - LR	0210081958	0210091837	5	4th	
DC-62	8450-PN LOCATION - LR	0210082000	0210091836	5	4th	
DC-66	APT 7E	9906161345	9906161545	60	3rd	3rd gen machine operating when all of samples
DC-66	APT 7E	9906161345	9906161545	50	3rd	taken; eliminate all samples
DC-66	10458-PN LOCATION - BR	0207231531	0207241533	55	3rd	
DC-66	10458-PN LOCATION - BR	0207231531	0207241534	56	3rd	
DC-66	10458-PN LOCATION - LR	0207231535	0207241536	49	3rd	
DC-66	10458-PN LOCATION - LR	0207231537	0207241537	48	3rd	
DC-66	10535-PN LOCATION - BD	0207231554	0207241553	26	3rd	
DC-66	10535-PN LOCATION - BD	0207231555	0207241554	25	3rd	
DC-66	10535-PN LOCATION - LR	0207231601	0207241551	36	3rd	
DC-66	10535-PN LOCATION - LR	0207231602	0207241550	36	3rd	
DC-68	30126-PN LOCATION - LR	0212031601	0212041602	340	3rd	3rd gen machine operating when all of samples
DC-68	30126-PN LOCATION - LR	0212031602	0212041645	330	3rd	taken; eliminate all samples
DC-68	30118 -PN LOCATION - LR	0301141531	0301151615	4,400	3rd	
DC-68	30118 -PN LOCATION - LR	0301141531	0301151615	4,800	3rd	
DC-68	30121 -PN LOCATION - LR	0301141616	0301151631	220	3rd	
DC-68	30121-PN LOCATION - LR	0301141616	0301151631	230	3rd	
DC-68	15475-PN LOCATION - LR	0301142000	0301151900	730	3rd	
DC-68	15475-PN LOCATION - LR	0301142000	0301151900	690	3rd	
DC-71	NYC PERC PROJECT 401949X	0112101840	0112111905	10	4th	DEC notes indicate that a 4th gen machine was
DC-71	NYC PERC PROJECT 401949X	0112101840	0112111905	10	4th	installed in 1996; all samples collected since then
DC-71	NYC PERC PROJECT 401949X	0202111540	0202121541	42	4th	
DC-71	NYC PERC PROJECT 401949X	0202111541	0202121539	42	4th	
DC-71	1338-PN LOCATION - LR	0204151952	0204161932	9	4th	

FACILITY	LOCATION	COMPOSITE[1] START TIME	COMPOSITE[1] END TIME	VALUE (ug/m3)	EQUIP GEN	HSIA Notes
DC-71	1338-PN LOCATION - LR	0204151952	0204161932	9	4th	
DC-75	NYC PERC PROJECT 401949X	0201141620	0201151540	60	4th	Inspection reports indicate that a 4th gen machine
DC-75	NYC PERC PROJECT 401949X	0201141620	0201151540	62	4th	was installed prior to Feb 2000; all samples
DC-75	NYC PERC PROJECT 401949X	0201141632	0201151544	73	4th	collected since then
DC-75	NYC PERC PROJECT 401949X	0201141707	0201151610	8	4th	
DC-75	NYC PERC PROJECT 401949X	0201141707	0201151610	8	4th	
DC-76		0103010920	0103011120	280	4th	DEC notes indicate that a 4th gen machine was
DC-76		0103010921	0103011121	270	4th	installed in 1996; all samples collected since then
DC-76		0105090901	0105101101	117	4th	
DC-76		0105100855	0105101055	72	4th	
DC-76		0105100856	0105101057	72	4th	
DC-76		0105100900	0105101100	109	4th	
DC-76		0105100900	0105101100	68	4th	
DC-76		0105100900	0105101100	54	4th	
DC-76		0105100902	0105101102	65	4th	
DC-76		0105100902	0105101102	69	4th	
DC-76		0105100902	0105101102	103	4th	
DC-76		0105100904	0105101104	58	4th	
DC-76		0105100904	0105101104	64	4th	
DC-76		0105100905	0105101105	123	4th	
DC-76	STREET LEVEL	0107050850	0107051050	200	4th	
DC-76	STREET LEVEL	0107050850	0107051050	200	4th	
DC-76	STREET LEVEL	0107050855	0107051055	150	4th	
DC-76	STREET LEVEL	0107050855	0107051055	150	4th	
DC-76	STREET LEVEL	0107050900	0107051100	330	4th	
DC-76	STREET LEVEL	0107050900	0107051150	340	4th	
DC-76	STREET LEVEL	0107050905	0107051105	170	4th	
DC-76	STREET LEVEL	0107050905	0107051105	170	4th	
DC-76		0111290942	0111291142	250	4th	
DC-76		0111290942	0111291142	250	4th	
DC-76		0111290944	0111291144	230	4th	
DC-76		0111290944	0111291144	290	4th	
DC-76		0111290946	0111291146	400	4th	
DC-76		0111290946	0111291146	400	4th	
DC-76	13661 - PN LOCATION - KIT	0206251946	0206261735	329	4th	
DC-76	13661 - PN LOCATION - KIT	0206251946	0206261735	375	4th	
DC-76		0303240847	0303241047	70	4th	
DC-76		0303240847	0303241047	60	4th	
DC-76		0303240852	0303241052	60	4th	
DC-76		0303240852	0303241052	60	4th	
DC-76		0303240910	0303241110	280	4th	

FACILITY	LOCATION	COMPOSITE[1] START TIME	COMPOSITE[1] END TIME	VALUE (ug/m3)	EQUIP GEN	HSIA Notes
DC-76		0303240910	0303241110	300	4th	
DC-76		0303240912	0303241112	260	4th	
DC-76		0303240912	0303241112	290	4th	
DC-76		0303240914	0303241114	370	4th	
DC-76		0303240914	0303241114	330	4th	
DC-76		0303240918	0303241118	280	4th	
DC-76		0303240918	0303241118	280	4th	
DC-76		0303240940	0303241140	60	4th	
DC-76		0303240940	0303241140	50	4th	
DC-76		0303240943	0303241143	60	4th	
DC-76		0303240943	0303241143	50	4th	
DC-76	LOCATION AT STREET LEVEL	9704230910	9704231110	600	4th	
DC-76	LOCATION AT STREET LEVEL	9704230910	9704231110	600	4th	
DC-76		9705210845	9705211045	260	4th	
DC-76		9705210845	9705211045	240	4th	
DC-76	401810X DRY CLEANER	9708060835	9708061035	30	4th	
DC-76	401810X DRY CLEANER	9708060835	9708061035	40	4th	
DC-84		0112270915	0112271115	5,300	no data	No DEC data on compliance status; eliminate all
DC-84		0112270915	0112271115	5,200	no data	samples
DC-84		0112270917	0112271117	5,400	no data	
DC-84		0112270917	0112271117	5,100	no data	
DC-84		0112270919	0112271119	6,300	no data	
DC-84		0112270919	0112271119	7,000	no data	
DC-84		0204101455	0204101655	1,400	no data	
DC-84		0204101456	0204101656	1,400	no data	
DC-84		0204101458	0204101658	1,800	no data	
DC-84		0204101459	0204101659	1,700	no data	
DC-84		0204101501	0204101701	1,500	no data	
DC-84		0204101501	0204101701	1,400	no data	
DC-84		0206270950	0206271150	390	no data	
DC-84		0206270950	0206271150	350	no data	
DC-84		0206270952	0206271152	420	no data	
DC-84		0206270955	0206271155	380	no data	
DC-84		0206270955	0206271155	400	no data	
DC-84		0210031455	0210031655	1,600	no data	
DC-84		0210031455	0210031655	1,700	no data	
DC-84		0210031457	0210031657	2,000	no data	
DC-84		0210031457	0210031657	2,400	no data	
DC-84		0210031500	0210031700	2,200	no data	
DC-84		0210031500	0210031700	2,700	no data	
DC-84	669-PN LOCATION - LR	0210291700	0210301658	2,100	no data	

FACILITY	LOCATION	COMPOSITE[1] START TIME	COMPOSITE[1] END TIME	VALUE (ug/m3)	EQUIP GEN	HSIA Notes
DC-84	669-PN LOCATION - LR	0210291701	0210301655	2,100	no data	
DC-84	671-PN LOCATION - LR	0301141915	0301151930	220	no data	
DC-84	671-PN LOCATION - LR	0301141915	0301151930	210	no data	
DC-84		0303251320	0303251520	300	no data	
DC-84		0303251320	0303251520	300	no data	
DC-84		0303251322	0303251522	330	no data	
DC-84		0303251322	0303251522	320	no data	
DC-84		0303251324	0303251524	400	no data	
DC-84		0303251324	0303251524	430	no data	
DC-84		0307020848	0307021048	1,300	no data	
DC-84		0307020848	0307021048	1,300	no data	
DC-84		0307020850	0307021050	1,000	no data	
DC-84		0307020850	0307021050	1,000	no data	
DC-84		0307020852	0307021052	1,300	no data	
DC-84		0307020852	0307021052	1,300	no data	
DC-89	15468-PN LOCATION - LR	0304301700	0305011815	2,130	3rd	3rd gen machine operating when all of samples
DC-89	15468-PN LOCATION - LR	0304301700	0305011815	2,140	3rd	taken; eliminate all samples
DC-91	NYC PERC PROJECT 401949X	0203181628	0203181711	51	3rd	3rd gen machine operating when all of samples
DC-91	NYC PERC PROJECT 401949X	0203181640	0203191608	101	3rd	taken; eliminate all samples
DC-91	NYC PERC PROJECT 401949X	0203181642	0203191603	97	3rd	
DC-91	9139-PN LOCATION - LR	0204081804	0204081900	64	3rd	
DC-91	9139-PN LOCATION - LR	0204081805	0204092005	22	3rd	
DC-91	9139-PN LOCATION - LR	0204081805	0204092005	21	3rd	
DC-91	9082-PN LOCATION - LR	0204151735	0204161756	5	3rd	
DC-91	9082-PN LOCATION - LR	0204151735	0204161755	5	3rd	
DC-91	9082-PN LOCATION - KIT	0204151737	0204161755	5	3rd	
DC-91	9082-PN LOCATION - KIT	0204151737	0204161755	5	3rd	
DC-91	9117-PN LOCATION - LR	0301211943	0301221704	28	3rd	
DC-91	9117-PN LOCATION - LR	0301211943	0301221706	27	3rd	

[1] Dates and times when sampling event started and ended. Format for field: YYMMDDHHMM (Year-Month-Date-Hour-Minute); time is in military time.

PEER REVIEW PLAN

Title:	IRIS TOXICOLOGICAL REVIEW AND SUMMARY DOCUMENTS FOR TETRACHLOROETHYLENE
Subject/Purpose:	This review document summarizes the toxic effects of tetrachloroethylene (also called perchoroethylene, the dry cleaning solvent) and derives quantitative estimates of the dose-response characteristics for human exposure (RfC, RfD, cancer unit risks). The document will be used as the source for summaries of perchloroethylene risk characterization to be entered into the Integrated Risk Information System. This is the Agency-approved source of toxicological and risk information accessible to the public, EPA regional offices, state governments and EPA regulatory program offices. This evaluation was requested by the Office of Air Quality Planning and Standards-Office of Air and Radiation to support hazardous air pollutant assessments of chemicals listed as greatest threat to public health under the 1990 Clean Air Act Amendments Section 112c(3) and for the list of urban air toxics for periodic national scale assessments under Section 112k.
Peer Review Leader:	Cheryl Itkin email:itkin.cheryl@epa.gov

This work product has been determined to meet the OMB criteria of a Highly Influential Scientific Assessment.

The peer review activity for this work product is expected to begin on September 15, 2005.

The peer review mechanism selected for this work product is National Academy of Sciences, and constitutes a panel review.

Public comment on this work product is being requested through As Part of the NAS Review Procedures.

Any public comments will be provided to the peer reviewers before they conduct the review.

This work product will be reviewed by more than 10 reviewers. The primary disciplines required for this peer review include Risk Assessment-Human Health, Toxicology-Behavior, Toxicology-Developmental, Toxicology-General, Toxicology-Neurotoxicology, Toxicology-Pharmacokinetics/Dosimetry/Modeling, Toxicology-Reproductive and Toxicology-Xenobiotic Metabolism. These are being selected by Other. The public, including scientific or professional

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Tetrachloroethylene

Assessment Start Date: 01/02/1998

Assessment End Date: TBD

Tracking Report Last Updated: 07/18/2005

Lead Office: NCEA-W

EXPECTED/ACTUAL DATES OF ACTIVITIES AND EVENTS

Activity/Event	Expected Completion Date	Actual Completion Date
1. Literature Search:		
2. First Draft:		
3. Second Draft:		
4. Internal Peer Consultation:		04/06/2004
5. Agency Review:		09/23/2005
6. External Peer Review and Public Availability:	02/22/2007	
7. Final Draft:	04/08/2007	
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Cancer in Persons Working in Dry Cleaning in the Nordic Countries

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LIST OF ABBREVIATIONS

CI	Confidence interval
ICD-O	International Classification for Diseases on Oncology
ISCO	International Standard Classification of Occupations
ISIC	International Standard Industrial Classification
NHL	Non Hodgkin lymphoma
NR	Not relevant
OR	Odds ratio
RR	Rate ratio
SIR	Standardised Incidence Ratio
SMR	Standardised Mortality Ratio

OUTLINE OF MANUSCRIPT SECTION HEADERS

ABSTRACT

OBJECTIVE

US studies found an increased risk of esophageal and some other cancers in dry cleaners exposed to tetrachloroethylene. We investigated whether the US findings could be reproduced in the Nordic countries.

DESIGN

Using a series of case-control studies nested in cohorts of laundry and dry cleaning workers identified from the 1970-censuses in Denmark, Norway, Sweden and Finland.

RESULTS

Dry cleaning work in the Nordic countries during the period when tetrachloroethylene was the dominant solvent was not associated with an increased risk of esophageal cancer, risk ratio (RR): 0.76 (95 percent confidence interval (CI): 0.34, 1.69), but our study was hampered by some unclassifiable cases. The risks of gastric cardia, liver, pancreas, kidney cancer and NHL were not significantly increased. Assistants in dry cleaning shops had a borderline significant excess risk of cervical cancer not found in women directly involved in dry cleaning. We found an excess risk of bladder cancer, (RR): 1.44 (95 percent (CI): 1.07, 1.93) not associated with length of employment.

CONCLUSION

Finding of no excess risk of esophageal cancer in Nordic dry cleaners differs from US findings. Chance, differences in level of exposure to tetrachloroethylene and confounding may explain the findings. The overall evidence on bladder cancer in dry cleaners is equivocal.

INTRODUCTION

Previous studies of dry cleaners, primarily from the US, indicated that exposure to tetrachloroethylene may entail an increased risk of cancer of the esophagus and cervix uteri, and of non-Hodgkin lymphoma (NHL) (IARC 1995). We investigated the incidence of selected cancers in Nordic dry cleaners to determine whether the US findings could be reproduced in an other setting.

The study was undertaken as a series of case-control studies nested in the cohorts of laundry and dry cleaning workers identified from the 1970-censuses in Denmark, Norway, Sweden and Finland. The cancer incidence of these cohorts have been reported on previously (Andersen et al. 1999), and the Danish cohort has been used for a nested case-control study of liver and kidney cancer (Lynge et al. 1995). Use of tetrachloroethylene reached its peak in the Nordic countries around 1970 (Danmarks Statistik 2000a; 2000b; 2000c; Statistiska Centralbyrån 1995a; 1995b; 2000a; 2000b; 2000c Statistik Sentralbyrå 2000a; 2000b; 2000c; Tilastokeskus 2000a; 2000b; 2000c), figure 1, almost all of it was used for dry cleaning (Mikkelsen et al. 1983), and tetrachloroethylene was the dominant solvent in dry cleaning at the time (Anonymous 1968; Anonymous 1971). Based on findings in previous studies we included esophageal and cervical cancer and NHL (IARC 1995). We included also liver cancer found in tetrachloroethylene exposed mice (IARC 1995), renal cell cancer found in workers exposed to trichloroethylene (Henschler et al. 1995), and bladder and pancreas cancer found in recently updates of US cohorts (Blair et al. 2003; Ruder et al. 2001). Gastric cardia cancer was included as adenocarcinomas are on increase in esophagus and

cardia in some Western countries (Botterweck et al. 2000).

The purpose of this study was to determine whether dry cleaning work in the Nordic countries around 1970 where tetrachloroethylene was the dominant dry cleaning solvent was associated with an increased risk of the selected cancers. We used the nested case-control design to avoid confounding from socio-economic group and related life style risk factors.

MATERIAL AND METHODS

Study base, cases and controls

The cohorts included all laundry and dry cleaning workers from the 1970-censuses in Denmark, Finland, Norway and Sweden. They had either the occupation code "laundry and dry cleaning worker" or the industry code "laundry and dry cleaning" (International Labour Office 1981; Statistical Office of the United States 1958) table 1. The cohorts comprised 46,768 persons. Each person was followed up for death, emigration and incident cancer based on linkage with the nation-wide Population, Death and Cancer Registers using unique personal identifiers.

The study included incident cancers of the esophagus, gastric cardia, pancreas, cervix uteri, bladder, kidney, primary liver cancer and NHL, table 2, from beginning of follow up, 9 November 1970 in Denmark and 1 January 1971 in the other countries, until end of follow up between 1997 and 2001.

Controls were randomly selected from the cohort using frequency match by country, sex, five-year age group and five-year calendar period at the time of diagnosis of the case. For esophageal cancer, we selected controls equal to six times the number of cases. For the other cancer sites, three times the number of cases.

The register part of this study was approved by each of the national Data Protection Agencies. The interview part of this study was approved by the Ethics Committees in Norway and Sweden, respectively, and following national legislation all participants gave active informed consent prior to participating in the interview.

Exposure categories

Cases and controls were, based on various data sources and without knowledge of their case/control status, categorized into:

1. Exposed, persons explicitly described as dry cleaners and other workers in dry cleaning shops with less than 10 workers. The latter group was included due to the shared work tasks and physical proximity in small shops.
2. Other workers in dry cleaning shops.
3. Unexposed, laundry workers and other persons not working in dry cleaning.
4. Unclassifiable.

Exposed cases and controls were categorized by length of employment in the shop where they worked in 1970. For practical reasons only the period 1964 to 1979 was included. Data on smoking and alcohol drinking were collected from Norway and

Sweden, table 3.

The person's specific occupational task as dry cleaner or laundry worker at the 1970-census was written in free text on the original census form. These forms were retrieved from the National Archives in Denmark and Norway. The forms had not been stored in Finland and Sweden.

A blinded personal, telephone interview, eventually with a next-of-kin, was undertaken with cases and controls in Norway and Sweden. The questionnaire asked about occupational tasks in 1970, and if this was dry cleaning then about length of employment in the shop, size of the work force, solvents used, and smoking and drinking habits. In Norway, interviews were obtained with 57 percent of cases (72 percent with next-of-kin) and with 64 percent of controls (42 percent next-of-kin). In Sweden, interviews were obtained with 63 percent of cases (77 percent next of kin) and with 60 percent of controls (39 percent next-of-kin). One-fourth of interviewed next-of-kin was 1970-spouses, and one-third of non-interviewed subjects had no next-of-kin.

Denmark and Finland have nationwide data bases with individual records on all paid pension scheme contributions. These pension scheme data were used for this study. In Denmark, these data started for employees in 1964, and they were used to assess length of employment and size of the work force where the employees worked in 1970. In Finland, these data started in 1962 for employees and in 1970 for self-employed persons, and the data were used to assess length of employment where the persons worked in 1970. Pension scheme data were found for 91 percent (=151 out of 166) of

Danish records for employees in dry cleaning, with five missing explained by sick leave etc. at the 1970-census. Pension scheme data were found for 75 percent of Finnish records.

In Denmark, a biography book on dry cleaning shop owners (Hammershøj 1971) and the yellow pages of local telephone books were used for self-employed persons to assess length of employment, with 37 percent from the biography book, 57 percent from telephone books, and no data for 6 percent. Family workers were assumed to have worked for the same length as their spouses. The biography book and pension scheme data for the self-employed persons' shops were used to assess size of work force.

In Finland, the pension scheme data in combination with other sources (Kyyronen el al. 1989; Anonymous 1984) were used to assess type and size of company, table 3. For Finland and Sweden we furthermore coded as unexposed cases and controls assumed from the census codes not to be dry cleaners, e.g. "presser" in "textile industry".

We identified 1616 cases and 2398 controls, table 2. Together they represented 3883 persons. In Denmark and Norway about 20 percent of the records were classified as coming from the exposed dry cleaner group, and 70-80 percent from the unexposed group, table 4. In Finland 41 percent and in Sweden 35 percent of the records were unclassifiable as to whether or not the persons had dry cleaning work in 1970.

Use of tetrachloroethylene peaked in the Nordic countries around 1970, and the compound was used almost exclusively for dry cleaning, figure 1. In Denmark, import of

the new German and English fully automated machines using tetrachloroethylene started in 1959 (Direktoratet for Arbejdstilsynet 1959). In 1967, 30 percent of conventional shops had machines obtained within the last 10 years (Schleisner 1967), and new coin-operated machines using only tetrachloroethylene amassed 40 percent of the market in 1968 (Anonymous 1968). In 1968, tetrachloroethylene constituted 75 percent of the solvents used for dry cleaning in Denmark, 85 percent in Finland, and 72 percent in Sweden (Anonymous 1968), and in 1971 it was estimated to constitute 90 percent of dry cleaning solvent used in Scandinavia (Anonymous 1971). In the questionnaires, 76 percent of dry cleaners in Norway and 84 percent in Sweden reported use of tetrachloroethylene in 1970, but information on chemicals and time periods was missing in many interviews. Tetrachloroethylene was thus clearly the dominant dry cleaning solvent throughout our study period. Work as a dry cleaner in 1970 was therefore a good proxy for exposure to tetrachloroethylene, which is the underlying exposure variable of interest in this study. The probability of being exposed to tetrachloroethylene outside dry cleaning was extremely low, as virtually all tetrachloroethylene was used in this industry (Mikkelsen et al. 1983). Available data did not allow further subdivision of dry cleaners as to whether or not they had used tetrachloroethylene. Other solvents in use were white spirit and chlorofluorocarbons (Johansen et al 2005).

In 1970, the occupational safety limit for tetrachloroethylene was 670 mg/m^3 in Finland, 350 mg/m^3 in Denmark and Norway, and 200 mg/m^3 in Sweden. In 1980, these limits were 335 mg/m^3, 200 mg/m^3, and 135 mg/m^3, respectively. Only 168 tetrachloroethylene measurements were made in dry cleaning shops in the Nordic countries between 1964

and 1979. There was a large variation in exposure level across shops, the median annual level of all measurements was, however, fairly stable during the period 1964 to 1979, figure 2. In the analysis, we therefore assumed exposure level to tetrachloroethylene to be constant from 1964 to 1979, and used length of employment as a proxy for relative, cumulated dose. For comparison with external data it should be added that 53 ≥60 minutes measurements for dry cleaners had a mean of 164 mg/m^3.

Analysis

The analysis was based on records for cases and controls, as a given person could appear more than once. For a given cancer site, all controls fulfilling the selection criteria were used in the analysis. We estimated rate ratios (RRs) for dry cleaners versus unexposed using logistic regression adjusted for matching criteria and where relevant for smoking and drinking. For a comprehensive reporting of the data, we calculated also the (RRs) for the other persons in dry cleaning and for the unclassifiable persons, although the underlying hypothesis did not include these groups. (RRs) were estimated for all countries together, and for Denmark and Norway together. (RRs) were calculated for the exposed group by length of employment. We used the R survival package (R Development Core Team 2004; Therneau & Lumbley 2004).

RESULTS

Eight esophageal cancer cases belonged to the dry cleaner group giving a (RR): 0.76

(95 percent (CI): 0.34, 1.69), table 5. The estimate for Denmark and Norway gave a (RR): 0.91 (95 percent (CI): 0.38, 2.20). Six exposed cases came from Denmark. Eighteen cases were unclassifiable, giving a (RR): 2.04 (95 percent (CI): 0.91, 4.62), nine cases came from Finland, seven with missing pension scheme record, and nine non-interviewed cases came from Sweden. Nine gastric cardia cancer cases belonged to the dry cleaner group giving a (RR): 0.69 (95 percent (CI): 0.31, 1.53).

Eleven exposed liver cancer cases gave a (RR): 0.76 (95 percent (CI): 0.38, 1.52), and 57 exposed pancreatic cancer cases gave a (RR): 1.27 (95 percent (CI): 0.90, 1.80). The highest risks were found for those with short or unknown length of employment, table 6. Thirty-six exposed cervical cancer cases gave a (RR): 0.98 (95 percent (CI): 0.65, 1.47) with the highest risk for those with short length of employment. There was a borderline significantly elevated risk of cervical cancer among other workers in dry cleaning shops based on 22 cases with a (RR): 1.73 (95 percent (CI): 1.00, 2.97). Eleven cases were Danish (four pressers, three shop assistants, three office workers, one seamstress), seven were Finnish (six in laundries where dry cleaning was probable, one packer in a dry cleaning shop of unspecified size), and four were Norwegian (two shop assistants, one laundry help, one spot cleaner).

Twenty-nine kidney cancer cases belonged to the dry cleaner group giving a (RR): 0.67 (95 percent (CI): 0.43, 1.05). There was an elevated risk of bladder cancer among the dry cleaners based on 93 exposed cases, (RR): 1.44 (95 percent (CI): 1.07, 1.93), with 62 exposed cases coming from Denmark and Norway giving a (RR): 1.69 (95 percent (CI): 1.18, 2.43). The risk did not increase with length of employment. Significantly

elevated risks were found for two to four years and 10+ years of employment. A similar pattern was seen when the analysis was based only on the uncensored employment periods from 1965 to 1978. The combined estimate for interviewed cases and controls from Norway and Sweden was (RR): 1.34 (95 percent (CI) 0.86, 2.08), which was only slightly reduced after control for smoking (RR): 1.25 (95 percent (CI): 0.79, 1.98). The excess risk within the exposed group did not come from the owners of dry cleaning shops and their employed dry cleaners, 33 exposed cases, (RR): 0.98 (95 percent (CI): 0.64, 1.51), but from the supporting staff in small shops, 17 exposed cases, (RR): 2.20 (95 percent (CI): 1.18, 4.11), and from owners of combined laundry and dry cleaning shops, 40 exposed cases, (RR): 1.92 (95 percent (CI): 1.23, 2.98). There were 42 exposed NHL cases giving a (RR): 0.95 (95 percent (CI) 0.65, 1.41).

DISCUSSION

We studied the cancer risk in Nordic dry cleaners during the period where tetracholoethylene was by far the dominant solvent, and we used laundry workers as the comparison group. Dry cleaning work was not associated with an increased risk of esophageal cancer, but we found a borderline increased risk among persons we were unable to classify as dry cleaners or laundry workers. Dry cleaning work was not associated with significantly increased risks of cancer of the gastric cardia, liver, pancreas and kidney, nor with NHL. Supportive staff in large dry cleaning shops had a borderline significant excess risk of cervical cancer, not found among women directly involved in dry cleaning. We found a 44 percent excess risk of bladder cancer among Nordic dry cleaners. The excess risk came from Denmark and Norway, the two countries

with the best data. There was no clear pattern with length of employment. Adjustment for smoking in Norway and Sweden changed the estimated risk only slightly. The risk was concentrated to supporting staff in small dry cleaning shops and to owners of combined laundry and dry cleaning shops.

Strengths and weaknesses of the study

Our study had several advantages. First, we covered a period where tetrachloroethylene was the dominant solvent. Second, the study was nation-wide including all persons working in dry cleaning in 1970. Third, we used a series of case control studies nested in the national cohorts of laundry and dry cleaning workers. The cancer risks of dry cleaners were therefore compared with that of laundry workers, two groups with similar jobs apart from the use of solvents. Smoking was equally frequent among exposed (72 percent) and unexposed (78 percent) male controls in Norway, and equally so in Sweden (66 percent and 69 percent). In Norway, smoking was slightly less frequent in exposed (45 percent) than in unexposed (54 percent) women, while the opposite was true in Sweden (49 percent and 37 percent). Alcohol drinking was very limited with only four of 675 interviewed controls reporting at least 21 drinks per week. Fourth, Population, Death and Cancer registers and unique personal identifiers ensured complete assertainment of incident cancers (Pukkala et al. 2001). Fifth, all original census forms were found in Denmark and Norway and they all included detailed job descriptions.

The study did, however, also have disadvantages. First, due to the limited data sources and mixture of processes a high proportion of cases and controls from Sweden and Finland were unclassifiable as to whether they had dry cleaning or laundry work in 1970. We therefore reported risk estimates for all countries and for Denmark and Norway only. Second, data on employment were available only from 1964-1979, but the 16 year period allowed a clear distinction to be made between short-term and stable workers. Third, the limited number of air measurements did not allow subdivision of study subjects by exposure level. However, as the data indicated a fairly stable exposure level throughout the study period duration of employment was an acceptable proxy-measure for relative, cumulated dose.

Esophageal cancer

There was a clear excess risk of esophageal cancer in the two US cohort studies of tetrachloroethylene exposed dry cleaning workers with Standardized Mortality Ratios (SMRs): of 2.2 (95 percent (CI): 1.5, 3.3) (Blair el al. 2003) and 2.47 (95 percent (CI): 1.35,3.14) (Ruder el al. 2001), respectively. A non-significantly elevated risk was seen in the US aircraft manufacture workers exposed to tetrachloroethylene (SMR): 1.47 (95 percent (CI): 0.54, 3.21) (Boice et al 1999). Two dry cleaners with squamous cell carcinoma of the esophagus were found in a US case-control study, odds ratio (OR): 3.6 (95 percent (CI): 0.5, 27.0) (Vaughan et al. 1997).

Our estimated risk of esophageal cancer following dry cleaning work in the Nordic

countries of (RR): 0.76 (95 percent (CI): 0.34, 1.69) is in contrast with the US findings, although the difference in the outcome of the four studies could be due to chance. No case of esophageal cancer was found in a small Finnish cohort (Anttila et al. 1995). Unfortunately, in our study 18 cases were unclassifiable, and they had a statistically, non-significantly increased risk, (RR): 2.04 (95 percent (CI): 0.91, 4.62). We know little about these cases. However, even in the extreme and unlikely situation where all unclassifiable persons were exposed, our risk estimate would be, (RR): 1.19 (95 percent (CI) 0.67, 2.12). If all unclassifiable persons were unexposed, our risk estimate for the exposed group would be (RR): 0.66 (95 percent (CI): 0.30, 1.45).

The excess risk of esophageal cancer in US not found in Nordic dry cleaners may be due to chance, different confounders and/or different exposures. Esophageal cancer is associated with smoking, alcohol consumption, hot drinks and poor nutrition (Muños and Day 1996). The mortality of the US dry cleaners was compared with that of the national population, without control for possible confounders. However, national smoking data showed laundry and dry cleaning workers to be only marginally more frequent smokers than the general US population (Blair et al. 2003; Ruder et al. 2001), but the average earning of dry cleaners was only two-thirds of the average for private sector workers (Blair et al. 2003). We used laundry workers with similar jobs apart from the solvents as the comparison group. The self-employed Danish dry cleaners were members of Lions Club, Rotary, etc. (Hammershøj 1971).

In 1991, about one-third of US dry cleaning plants used an open transfer process where solvent-wet clothes were manually moved from washer to dryer (Mundt et al. 2003).

Based on large US samples of time-weighted-average measurements for machine operators from the 1960s, the exposure level was higher at transfer machines than at dry-to-dry machines, mean concentrations were 338 mg/m^3 and 157 mg/m,^{3} respectively (IARC 1995). This transfer process was not needed in the Danish, widely exported, semi-automated machines used already from the 1930s (Ingvordsen 1975), and manual handling of wet clothes became prohibited in 1953 (Arbejds- og Fabrikstilsynet 1953). The mean concentration of ≥60 minutes Nordic measurements for machine operators from 1980-1990 was 95 mg/m^3. The currently recommended threshold from the American Conference of Governmental Industrial Hygienists is 170 mg/m^3, while the current safety limit is 70 mg/m^3 in Denmark, Finland and Sweden, and 30 mg/m^3 in Norway. US dry cleaners thus had a higher probability of dermal tetrachloroethylene exposure than Nordic dry cleaners, and they were very probably exposed to a higher air concentration. Differences in exposure to tetrachloroethylene may therefore have contributed along with differences in socioeconomic status to the excess risk of esophageal cancer found in US but not in Nordic dry cleaners.

Other cancers

Data on primary liver cancer were reported from only two of US studies (Blair et al. 2003; Ruder et al. 2001) with no excess risk. This is in line with the present result.

One US dry cleaner cohort had a borderline excess risk of pancreatic cancer, (SMR): 1.53 (95 percent (CI): 0.91, 2.42) (Ruder et al. 2001), and so had aircraft manufacture

workers, (SMR): 1.50 (95 percent (CI): 0.72, 2.76) (Boice et al. 1999). However, neither the other US dry cleaner cohort (Blair et al. 2003), the Finnish cohort (Anttila et al. 1995) or the present study confirmed this finding.

The two US dry cleaner cohorts had excess risks of cervical cancer, (SMR): 1.95 (95 percent (CI): 1.00, 3.40) (Ruder et al. 2001), and (SMR): 1.6 (95 percent CI 1.0, 2.3) (Blair et al. 2003), an observation confirmed in the Finnish cohort based on small numbers (Anttila et al. 1995), but not among the US aircraft workers (Boice et al. 1999). In US dry cleaners the risk was increased both for work with tetrachloroethylene only and for mixed solvents (Ruder et al. 2001), and the risk did not vary with exposure status (Blair et al. 2003). In our study, dry cleaners had no excess risk of cervical cancer, (RR): 0.98 (95 percent (CI): 0.65, 1.47). There was, however, a borderline significant elevated risk among supporting staff in larger dry cleaning shops (RR): 1.73 (95 percent (CI): 1.00, 2.97). We thus confirmed previous findings of an excess risk of cervical cancer among women in dry cleaning shops, but the fact that they were not engaged in the dry cleaning process did not point to tetrachloroethylene as the explanatory risk factor. Nor did it point to social class as the comparison group was laundry workers.

Kidney cancer was not increased in the previous cohort studies (Blair et al. 2003; Boice et al. 1999; Ruder et al. 2001) nor in our study.

The risk of bladder cancer was increased in one US dry cleaner cohorts, (SMR): 2.22 (95 percent (CI) 1.06, 4.08) (Ruder et al. 2001), but not in the other, (SMR): 1.3 (95 percent (CI): 0.7, 2.4) (Blair et al. 2003), and not in aircraft workers (Boice et al. 1999).

The Finnish study did not report on bladder cancer (Anttila et al. 1995). The excess risk in the US was limited to those working with mixed solvents (Ruder et al. 2001), found only in whites, and equally so in those with little/no exposure and those with medium/high exposure (Blair et al. 2003). The US bladder cancer case control study reported an excess risk for dry cleaning work in non-white men, (OR): 2.80 (95 percent (CI): 1.10, 7.40) (Silverman et al. 1989b), but not in white women, (OR): 1.40 (95 percent (CI): 0.80, 2.50) (Silverman et al. 1990), and data were not reported for white men (Silverman et al. 1989a). The risks for all laundry and dry cleaners of both sexes and races were 1.31 (95 percent (CI): 0.85, 2.03) for non-smokers, 2.99 (95 percent (CI): 1.80, 4.97) for former smokers, and 3.94 (95 percent (CI): 2.39, 6.51) for current smokers (Smith et al. 1985). The joint analysis of European case-control studies showed a smoking adjusted (RR): 1.24 (95 percent (CI): 0.67, 2.31) for male launderers, dry cleaners and pressers (Kogevinas et al. 2003). The case-control study from Montreal, Canada, gave a (RR): 1.6 (90 percent (CI): 0.9, 3.1) for launderers and dry cleaners, but the risk was not elevated for exposure to tetrachloro-ethylene (Siemiatycki 1991). We found an elevated bladder cancer risk among dry cleaners, (RR): 1.44 (95 percent (CI): 1.07, 1.93), which did not increase with length of employment. Taking the studies together there appears to be an excess risk of about 45 percent, which does not seem to be explained by excessive smoking. The risk does not vary with the exposure indicies. Overall, the current picture of the association between dry cleaning work with tetrachloroethylene and risk of bladder cancer is equivocal.

In the 1995 monograph on dry cleaning (IARC 1995) an excess risk of NHL was found based on studies then available (Anttila et al. 1995; Blair et al. 1990; Boice et al. 1999).

However, while the previous analysis of the largest cohort included only ICD-8 200 (Blair et al. 1990), the update included ICD-8 200 and 202 (Blair et al. 2003), showing no excess risk. At present, the three studies together give 22 observed cases and 18.80 expected. Our results are in line with this.

Conclusion

In conclusion, dry cleaning work in the Nordic countries, during a period where tetrachloroethylene was the dominant solvent, was not associated with significantly increased risks of cancer of the gastric cardia, pancreas and kidney, primary liver cancer and NHL. Dry cleaning work was not associated either with an increased risk of esophageal cancer, but our study was hampered by some unclassifiable cases. The result for esophageal cancer contrasts findings from US tetrachloroethylene exposed cohorts either due to chance, confounding or difference in exposure level. In line with findings from previous studies, our study indicated an excess risk of cervical cancer in supporting staff in larger dry cleaning shops, but not in women directly involved in dry cleaning. We found an elevated risk of bladder cancer among Nordic dry cleaners. The international data together point to an excess risk of bladder cancer in dry cleaners of about 45 percent, but there is no pattern with exposure indices. The evidence for an association between exposure to tetrachloroethylene and risk of bladder cancer is equivocal.

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Table 1. Nordic dry cleaner study. Industry and occupation codes in the 1970 censuses used for selection of the cohort of laundry and dry cleaning workers.

Country	Occupation		Industry		Number of
	Code	Text	Code	Text	persons
Denmark	411[a]	Laundry worker, ironer	860[b]	Laundry, dry cleaning	15559
Finland	85[c]	Laundry and pressing	952[b]	Laundry service	6885
Norway	95[c]	Laundering, dry-cleaning and pressing work	931[b]	Laundries and laundry service, cleaning and drying	6874
Sweden	943[c] 944[c]	Laundry and dry cleaning work, Pressing work	9520[b]	Laundry and dry cleaning service	17450
Total					46768

Notes:

[a]) Special Danish Occupational Code.

[b]) International Standard Industrial Classification, ISIC (Statistical Office of the UN 1958).

[c]) Nordic Occupational Classification which is equivalent to the International Standard Classification of Occupations, ISCO (International Labour Office 1981).

Table 2. Nordic dry cleaner study. Identified cases according to the International Classification of Diseases for Oncology (Percy 1990), and selected controls.

Cancer site	Topography	Morphology	Men					Women					All[a]
			Den-mark	Fin-land	Nor-way	Swe-den	Total	Den-mark	Fin-land	Nor-way	Swe-den	Total	
Esophagus	C15.0-C15.9	8000-8580[b]	15	2	3	6	26	19	12	5	10	46	72
Gastric cardia	C16.0	8000-8580[b]	10	1	2	16	29	7	4	4	6	21	50
Liver, primary	C22.0-C22.1	8000-8580[b]	9	2	2	10	23	26	16[c]	4	26	72	95
Pancreas	C25	8000-8580[b]	26	5	14	19	64	74	39	39	83	235	299
Cervix uteri	C53.0-C53.9	8000-8580[b]						128	29	44	87	288	288
Kidney	C64.9	8312.3	17	3	12	24	56	37	21	19	77	154	210
Bladder	C67	8000-8580[b]	71	4	32	70	177	60	20[c]	36	60	176	353
Non-Hodgkin's lymphoma (NHL)	All	9590-9595, 9670-9698, 9711-9723[b]	18	7[c]	12	30	67	42	48[c]	30	62	182	249
Total cases			166	24	77	175	442	393	189	181	411	1174	1616
Controls			294	72[d]	160	291	817	537	282[d]	297	465	1581	2398

Table 2. continued

Notes:

a) In total 3883 subjects, as a given subject can be present more than once.

b) Behaviour code 3 only.

c) 1 male NHL, 1 female liver, 2 female bladder and 1 female NHL have been excluded from the analysis, as they had no control.

d) 12 male controls and 6 female controls have been excluded from the analysis, as they had no case.

Table 3. Nordic dry cleaner study. Data sources used for the exposure classification.

Variable	Denmark	Finland	Norway	Sweden
Inclusion in the study	1970 census	1970 census	1970 census	1970 census
Occupation code in 1970	Computerized census data	Computerized census data	Computerized census data	Computerized census data
Industry code in 1970	Computerized census data	Computerized census data	Computerized census data	Computerized census data
Detailed occupation in 1970	Census forms	No data	Census forms	Interviews
Detailed industry in 1970	Census forms	Pension schemes + other sources[a]	Census forms	Interviews

Table 3. continued

Size of the work place where the person worked in 1970	*Employees:* Pension schemes. *Self-employed+ family workers:* Industry book+ pension schemes	Pension schemes +other sources[a]	Interviews	Interviews
Length of employment in the work place where the person worked in 1970	*Employees:* Pension schemes. *Self-employed+ family workers:* Industry book+ telephone books[b]	Pension schemes	Interviews	Interviews
Tobacco smoking and alcohol intake	No data	No data	Interviews	Interviews

Table 3. continued

Note:

[a]) Questionnaire data on shop characteristics collected from employers in 1984 for a study on tetrachloroethylene and reproductive outcome (Kyyronen et al 1989), records of persons biologically monitored for exposure at the Finnish Institute of Occupational Health, register of industrial hygiene measurements from the same institute, yearly calendars of the Finnish Association of Laundry and Dry Cleaning Employers, and a directory of Finnish companies and company facilities (Anonymous 1984).

[b]) All shops had a telephone, and the telephone book will in most cases list the telephone number together with both the name of the shop and the name of the shop owner.

Table 4. Nordic dry cleaner study. Cases and controls by country and exposure category.

Exposure category	Denmark		Finland		Norway		Sweden		Total	
	N	percent	N	percent	N	percent	N	percent	N	percent
Unexposed	1088[a]	78	234	41	498[b]	70	600	45	2420	60
Dry cleaner and other exposed	244	18	41	7	153	21	257	19	695	17
Other in dry cleaning	58	4	62	11	51	7	12	1	183	5
Unclassifiable	0	0	230	41	13	2	473	35	716	18
Total	1390	100	567	100	715	100	1342	100	4014	100

Notes:

[a]) Including 12 original forms erroneously coded as laundry and dry cleaning workers at the 1970 census.

[b]) Including 55 original forms erroneously coded as laundry and dry cleaning workers at the 1970 census.

Table 5. Nordic dry cleaner study. Rate ratios for studied cancer sites for dry cleaners in the Nordic countries 1970 to 2000.

Cancer site	Denmark, Finland, Norway and Sweden				Denmark and Norway only			
	Exposure category				Exposure category			
	Unexposed	Dry cleaner [a])	Other in dry cleaning	Unclas-sifiable	Unexposed	Dry cleaner [a])	Other in dry cleaning	Unclas-sifiable
ESOPHAGUS								
Cases	41	8	5	18	33	7	2	0
Controls	342	86	31	108	242	55	20	1
RR	1	0.76	1.22	2.04	1	0.91	0.66	NR
95%CI	NR	0.34,1.69	0.41,3.63	0.91,4.62	NR	0.38,2.20	0.14,3.01	NR
GASTRIC CARDIA								
Cases	31	9	1	9	19	4	0	0
Controls	201	80	8	68	125	42	7	0
RR	1	0.69	0.84	0.76	1	0.51	NR	NR
95%CI	NR	0.31,1.53	0.10,7.10	0.31,1.90	NR	0.16,1.62	NR	NR

Table 5. continued

LIVER								
Cases	58	11	2	23	36	4	1	0
Controls	398	95	22	121	248	42	15	1
RR	1	0.76	0.42	1.11	1	0.62	0.41	NR
95%CI	NR	0.38,1.52	0.09,1.89	0.59,2.09	NR	0.21,1.89	0.05,3.25	NR
PANCREAS								
Cases	173	57	18	51	109	32	10	2
Controls	769	206	59	242	512	112	42	1
RR	1	1.27	1.26	0.87	1	1.38	1.06	6.17
95%CI	NR	0.90,1.80	0.70,2.26	0.59,1.31	NR	0.87,2.20	0.50,2.25	0.56,68.21
CERVIX								
Cases	186	36	22	44	136	19	15	2
Controls	744	150	51	186	516	77	34	3
RR	1	0.98	1.73	1.11	1	0.92	1.64	2.62
95%CI	NR	0.65,1.47	1.00,2.97	0.72,1.71	NR	0.54,1.59	0.87,3.11	0.42,16.26

Table 5. continued

KIDNEY								
Cases	129	29	9	43	63	15	6	1
Controls	589	196	34	241	342	99	21	3
RR	1	0.67	1.15	0.76	1	0.77	1.50	1.22
95%CI	NR	0.43,1.05	0.52,2.53	0.50,1.16	NR	0.41,1.44	0.55,4.08	0.12,12.11
BLADDER								
Cases	189	93	12	57	129	62	7	0
Controls	904	292	52	234	639	173	38	3
RR	1	1.44	1.08	1.24	1	1.69	1.13	NR
95%CI	NR	1.07,1.93	0.55,2.11	0.83,1.83	NR	1.18,2.43	0.51,2.50	NR
NHL								
Cases	145	42	8	52	83	16	3	0
Controls	720	219	48	255	424	107	25	2
RR	1	0.95	0.70	0.91	1	0.73	0.64	NR
95%CI	NR	0.65,1.41	0.31,1.55	0.61,1.36	NR	0.40,1.32	0.19,2.23	NR

a) Includes persons stated as dry cleaners, owners of dry cleaning shops, and other persons employed in dry cleaning shops with less than 10 workers.

Table 6. Nordic dry cleaner study. Rate ratios for the studies cancer sites in dry cleaners in the Nordic countries 1970 to 2000 by length of employment.

Cancer site	Unexposed	Dry cleaner a)					
		Length of employment					
		0-1 year	2-4 years	5-9 years	10 + years	Unknown	
ESO-PHAGUS							
Cases	41	0	1	3	3	1	
Controls	261	0	5	29	27	4	
RR	1	NR	1.20	0.66	0.70	1.65	
95%CI	NR	NR	0.14,10.41	0.19,2.29	0.20,2.49	0.18,14.98	
GASTRIC CARDIA							
Cases	31	0	0	2	6	1	
Controls	189	4	5	26	36	2	
RR	1	NR	NR	0.46	0.97	3.00	
95%CI	NR	NR	NR	0.10,2.02	0.36,2.58	0.24,38.19	
LIVER							
Cases	58	0	0	5	5	1	
Controls	359	5	7	26	45	2	
RR	1	NR	NR	1.21	0.70	2.88	
95%CI	NR	NR	NR	0.43,3.44	0.26,1.92	0.21,38.81	

LEGEND TO FIGURE

Figure 1. Use of tetrachloroethylene in the Nordic countries 1950-2000.

Note:

Kg tetrachloroethylene used in a given country was calculated as (kg manufactured + kg imported – kg exported). For calculation of kg per inhabitant per year we used the average of kg tetrachloroetylene used in a five-year period divided by the population size in the middle of the period.

Figure. 2. Tetrachloroethylene exposure in Nordic dry cleaning shops 1947-2001. Median concentration in mg/m^3 of all measurements, log-scale.

Figure 1.

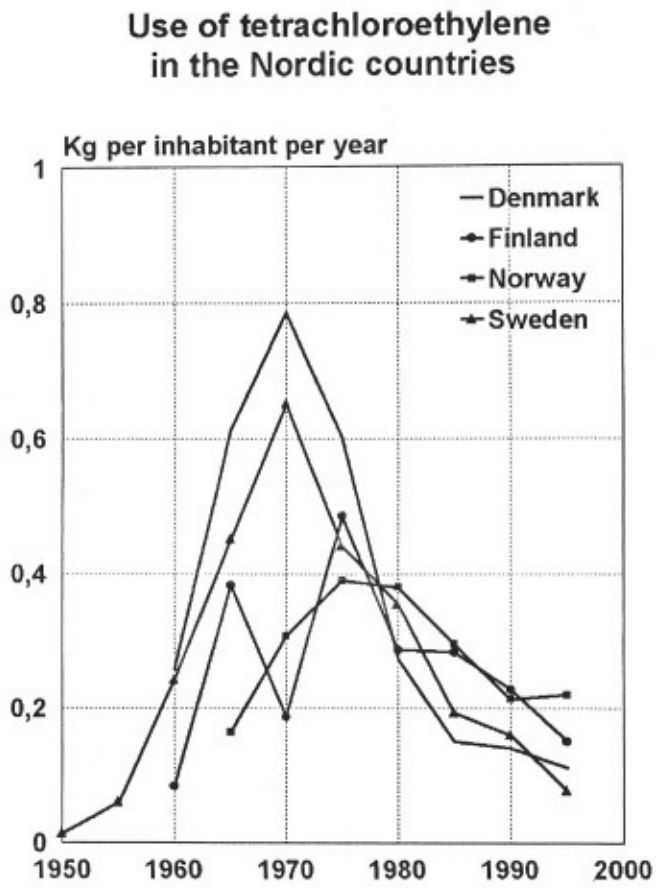

Figure 2