WSRC-RP-97-288

HEALTH EFFECTS OF SRS NON RADIOLOGICAL AIR EMISSIONS (U)

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PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC09-89SR18035

DISCLAIMER

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SAFETY • RESPONSIBILITY • SECURITY
SRS
SAVANNAH RIVER SITE

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ABSTRACT

This report examines the potential health effects of non radiological emissions to the air resulting from operations at the Savannah River Site (SRS). The scope of this study was limited to the 55 air contaminants for which the US Environmental Protection Agency (EPA) has quantified risk by determining unit risk factors (excess cancer risks) and/or reference concentrations (deleterious non cancer risks). Potential health impacts have been assessed in relation to the maximally exposed individual. This is a hypothetical person who resides for a lifetime at the SRS boundary. The most recent (1994) quality assured SRS emissions data available were used. Estimated maximum site boundary concentrations of the air contaminants were calculated using air dispersion modeling and 24-hour and annual averaging times. For the emissions studied, the excess cancer risk was found to be less than the generally accepted risk level of 1 in 100,000 and, in most cases, was less than 1 in 1,000,000. Deleterious non cancer effects were also found to be very unlikely.

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CONTENTS

LIST OF TABLES

HEALTH EFFECTS OF SRS NON RADIOLOGICAL AIR EMISSIONS

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INTRODUCTION

Primary responsibility for regulatory oversight of non radiological air emissions from sources at the Savannah River Site (SRS) impacting the general public and the environment is vested in the South Carolina Department of Health and Environmental Control (SCDHEC). SCDHEC is responsible for enforcing the national ambient air quality standards determined by the US. Environmental Protection Administration (EPA) and any stricter state standards legislated in South Carolina. The ambient air quality standards applicable to sources in South Carolina are defined in SCDHEC Standards 2 and 8[1]. Standard 2 implements the national ambient air quality standards for the criteria air pollutants sulfur dioxide, total suspended particulates, particulates smaller than 10 microns, carbon monoxide, ozone, gaseous fluorides (as hydrogen fluoride), nitrogen dioxide and lead. Permissible ambient concentrations of air toxics are defined in Standard 8. This standard lists 257 substances. Of the chemicals covered by the two standards, over 140 are emitted to the air at SRS.

The enforcement of US. Department of Labor, Occupational Safety and Health Administration (OSHA) standards for ambient air quality in the workplace is the responsibility of the South Carolina Department of Labor. Workplace exposure standards for a large number of substances are defined in 29 CFR Part 1910, Subpart Z - Toxic and Hazardous Substances, and are listed in Tables Z-1 through Z-3.[2] Of the many substances referenced in Subpart Z, 102 are released in the workplace at SRS. These are listed in Appendix A.

Air contaminants released at SRS also come within the scope of amendments to the Clean Air Act and certain EPA programs. The 1990 Clean Air Act Amendments (CAAA) addressed the issue of defining priority chemicals for emissions reduction in the interests of public health. In Section 112(b), the CAAA listed air pollutants defined as "hazardous" (HAPs). Of this lengthy list, 132 are released at SRS. In Section 112(r), the CAAA listed 16 substances as "extremely hazardous" (EHS), primarily to facilitate regulations and guidance by EPA directed towards detecting or preventing accidental releases and planning emergency response to accidents. Eight of these substances are used and released in operations at SRS.

EPA implemented two programs directed towards securing rapid reductions in the quantities of hazardous chemicals released to the air. In 1991, EPA initiated a voluntary emissions reduction program, the 33/50 Program, under which over six hundred companies were asked to reduce the total releases and transfers of defined "high priority" toxic chemicals. The reduction goals were 33 percent by 1992, and 50 percent by 1995. Seventeen chemicals were listed for this program. Sixteen of them are released at SRS.

EPA also approached the objective of major emissions reductions by implementing the "early reduction" program, which ties the terms of operating permits to achieving a reduction of 90 percent or more in emissions. For this program, EPA defined a list of "high risk" pollutants, mostly carcinogens[3]. Of these

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1 South Carolina Department of Health and Environmental Control. Regulation 61-62.5 - Air Pollution Standards. *Environment Reporter, State Air Laws 5* (1992).

2 Occupational Safety and Health Act, 29 U.S.C., 655, 657.

3 56 FR 27354, June 13, 1991.

chemicals, 26 are released to the air at SRS. The distribution of SRS air contaminants over the categories defined under the CAAA and EPA's early reduction programs is shown in Appendix B.

It will be seen in this appendix that a number of air contaminants released at SRS and listed as HAPs, EHS or as high risk chemicals for rapid reduction programs appear in more than one list. A few are listed several times, e.g., phosgene, benzene, heavy metals, mercury and ethylene oxide. Clearly, operations at SRS involve the emission of many air contaminants potentially of concern to the public.

DISCUSSION

Methodology

This study of potential health risks resulting from releases of regulated air contaminants at SRS uses a very conservative approach. The assessments of risk are based on individual risk. The risks examined, and assessed, are to a hypothetical, maximally exposed individual who resides at the SRS boundary for a lifetime, i.e., 70 years. This is an improbable scenario. Further, this kind of approach assumes that the inhalation exposures experienced by this individual are the same indoors and outdoors. Research indicates that indoor exposures are normally considerably lower. The "maximum individual" methodology generally over predicts risk. However, unlike the total population risk assessment approach, it ensures that the risk experienced by individuals closest to the source is specifically quantified. The SRS air pollutants considered in details are the 55 for which the EPA has defined quantitative measures of risk.

Experience in modeling SRS emissions on time scales ranging from an hour to a year has shown that estimated maximum ambient concentrations at ground level fall off progressively with distance from the site boundary. The only exception noted is in the southwest quadrant of the site. Ambient concentrations of criteria pollutants emitted from the tall stacks of the D-Area powerhouse tend to be higher on the Savannah River bluffs in Georgia than along the river segment of the SRS boundary. This does not appear to be a significant phenomenon for emissions of air toxics from lower stacks in D-Area, TNX and elsewhere. Consequently, the health risks assessed for the maximally exposed individual represent a very conservative upper bound.

Initially, this study considers excess cancer risks posed by known, probable, suspected and possible carcinogens. Subsequently, deleterious non cancer risks are examined.

URFs and Carcinogens

The carcinogenicity of air contaminants in the workplace has been a concern of a number of governmental, professional and scientific organizations.[4] The evaluation of hazardous air contaminants is incomplete; findings are not always consistent; classification codes vary; and quantification of risk to humans from exposure is often very approximate, spotty or nonexistent. For example, unit risk factors (URF)[5] are available for only 32 of the 132 hazardous air pollutants listed in the CAAA, 112(b) and emitted at SRS.

For the purposes of this study, the ACGIH carcinogenicity classification has been adopted. As a conservative method for converting other classifications to ACGIH categories, the terms "possible", "probable" and "potential" human carcinogen have been equated to the ACGIH category, "suspected"

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[4] E.g., International Agency for Research on Cancer (IARC); National Toxicology Program (NTP); National Research Council (NRC), National Academy of Sciences (NAS); Occupational Safety and Health Administration (OSHA); National Institute of Occupational Safety and Health (NIOSH); Environmental Protection Administration (EPA); American Council of Government Industrial Hygienists (ACGIH).

[5] The risk of someone contracting cancer by being exposed by inhalation to 1 $\mu g/m^3$ of a substance continuously over a 70 year period. URFs are determined by the EPA.

human carcinogen. In cases where a substance has been reviewed for evidence of carcinogenicity, but no determination has been made, the substance has been assigned to the ACGIH category "not classifiable as a human carcinogen". A summary of the ACGIH classification follows[6]:

> **A1** -- *Confirmed Human Carcinogen* based on the weight of evidence from appropriate studies.
>
> **A2** -- *Suspected Human Carcinogen.* Carcinogenic in experimental animals but available epidemiological studies are conflicting or insufficient to confirm an increased risk of cancer in exposed humans.
>
> **A3** -- *Animal Carcinogen.* Available evidence suggests that the agent is not likely to cause cancer in humans except under uncommon or unlikely routes or levels of exposure.
>
> **A4** -- *Not Classifiable as a Human Carcinogen.* There are inadequate data on which to classify the agent in terms of its carcinogenicity in humans and/or animals.
>
> **A5** -- *Not Suspected as a Human Carcinogen.* The agent is not suspected to be a human carcinogen on the basis of properly conducted epidemiological studies in humans.

Known carcinogenic air contaminants (A1) released at SRS comprise eight agents. All are included in Category III, High Toxicity, of South Carolina's Standard No. 8. They are listed below in Table 1. EPA has defined URFs for six of them.

TABLE 1

Known Carcinogens Released to the Air at SRS (A1)

Arsenic	Chloromethyl Methyl Ether
Benzene	Chromium (+6) Compounds
Benzidine	Nickel
Bis (Chloromethyl) Ether	Nickel Oxide

The list of suspected human carcinogens (A2) released to the air at SRS is much more extensive. Table 2 below includes 56 substances, 55 of which are listed in South Carolina Standard No. 8 and one in South Carolina Standard No. 2 (lead). Table 2 is broken down by toxicity category, as defined in South Carolina Standard No. 8. Two chemicals appear in Toxicity Class I; eight in Toxicity Class II; and 45 in Toxicity Class III.

There are six ACGIH Category A3 (animal carcinogen) air contaminants released at SRS. They are listed in Table 3.

The list of ACGIH Category A4 (not classifiable as a human carcinogen) air contaminants released at SRS is quite extensive, and is shown in Table 4. It includes 36 substances listed in South Carolina Standard No. 8 and two listed in South Carolina Standard No. 2.

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6 ACGIH. *1995-1996 Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs).* Appendix A: Carcinogenicity, p.43. ACGIH, Cincinatti, OH (1995).

A number of air contaminants designated hazardous apparently have not been considered as potential carcinogens. In the literature available, there is no reference to a carcinogenicity review or classification for the chemicals listed in Table 5. Consequently, these must be designated "unclassified". Note that this terminology does not correspond to Category A5 (not suspected as a human carcinogen) in the ACGIH classification scheme. Understandably, no regulated SRS air contaminants were found to be classified as A5 in the literature available.

As noted earlier, URFs are available[7] for only 32 of the 132 hazardous air pollutants emitted at SRS. In the case of known carcinogens (Table 1), quantification of risk in the form of a URF is the most complete, EPA having determined URFs for six of the eight substances listed. There are no URFs for chloromethyl methyl ether and nickel oxide. The URFs available for known carcinogens are listed below in Table 6.

TABLE 2

Possible, Probable, Potential and Suspected Carcinogens Released to the Air at SRS (A2)

SC Toxicity Class I	Methylene Chloride	*SC Toxicity Class III* (contd.)	Epichlorohydrin
	Trichloroethylene		Ethylene Dichloride
SC Toxicity Class II	Acetaldehyde		Ethylene Oxide
	Acrylamide		Ethylene Thiourea
	p-Dichlorobenzene		Ethylenimine
	Bis-(2-Ethylhexyl)-Phthalate		1,1-Dichloroethane
	Ethylene Dibromide		Formaldehyde
	Pentachlorophenol		Heptachlor
	Sulfuric acid		Hexachlorobenzene
	Perchloroethylene		Hexachlorobutadiene
SC Toxicity Class III	Acrolein		Hexachloroethane
	Acrylonitrile		Hydrazine
	Aniline		Methoxychlor
	Benzotrichloride		Methyl Chloride
	Benzyl Chloride		Methyl Hydrazine
	Beryllium		Methyl Iodide
	Bromoform		Curene
	1,3-Butadiene		2-Nitropropane
	Cadmium and Cadmium Oxide		Parathion
	Carbon Tetrachloride		Polychlorinated Biphenyls
	Chlordane		1,1,2,2-Tetrachloroethane
	Chloroform		Toxaphene
	3,3'-Dichlorobenzidine		1,1,2-Trichloroethane
	1,3-Dichloropropene		2,4,6-Trichlorophenol
	3,3-Dimethoxybenzidene		Vinyl Chloride
	Dimethyl Sulfate		1,1-Dichloroethylene
	2,4-Dinitrotoluene		
	Dioxane	*Standard No. 2*	Lead
	1,2-Diphenyl Hydrazine		

The coverage of URFs determined for possible, probable, potential and suspected human carcinogens (Table 2) is much less complete. EPA has defined URFs for only 26 of the 56 SRS chemicals having this classification. The URFs available for the air contaminants in Table 2 are listed below in Table 7.

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[7] U. S. Environmental Protection Agency. *Integrated Risk Information System (IRIS).* EPA, Research Triangle Park, NC (1996).

EPA has not determined any URFs for the SRS air contaminants listed in Tables 3 (animal carcinogens), Table 4 (chemicals not classifiable as human carcinogens), and Table 5, (chemicals not referenced in any classification scheme).

TABLE 3

Animal Carcinogens Released to the Air at SRS (A3)

SC Tox. Class I	Furfural	*SC Toxicity*	Chlorobenzene
SC Toxicity	Hydroquinone	*Class III*	Lindane
Class II	Isophorone		Nitrobenzene

TABLE 4

SRS Air Pollutants Not Classifiable as a Human Carcinogen (A4)

SC Toxicity	Acetonitrile	*SC Toxicity*	Biphenyl (Diphenyl)
Class I	Chlorine	*Class III*	2,4-Dichlorophenoxy Acetic Acid
	Cyanide	(contd.)	Dibutyl Phthalate
	Formic Acid		Diethyl Phthalate
	Methyl Ethyl Ketone		Dimethylformamide
	Methyl Methacrylate		Dimethyl Phthalate
	Naphthalene		Hexachlorocyclopentadiene
	Styrene		Hexane
SC Toxicity	Aldicarb		Manganese
Class II	Ethyl Benzene		Mercury
	Ethyl Chloride		1,1,1-Trichloroethane
	Phenol		Pentachloronitrobenzene
	Phosphorus (Yellow or White)		Phthalic Anhydride
	1,2,4-Trichlorobenzene		Selenium
	Xylene		Toluene
	m-Xylene		Vinyl Acetate
	o-Xylene		
	p-Xylene	*Standard No. 2*	Nitrogen Dioxide
SC Toxicity	Acetophenone		Sulfur Dioxide
Class III	Acrylic Acid		

Acceptable Risk from Emissions of Carcinogens

As noted earlier, the URF is the risk of someone contracting cancer through being exposed to 1 $\mu g/m^3$ of a substance continuously over a 70 year period, i.e., a lifetime risk. The actual risk to an individual is given by 1/(annual concentration x URF). The result of this calculation is then compared with a conventionally accepted level of risk. The ideal goal is usually to keep risk less than 1:1,000,000 (1×10^{-6}). However, there is no universally acceptable level of risk. It is common to find a risk level of 1:100,000 regarded as acceptable. In some circumstances, the level of acceptable risk has been set as high as 1:10,000, but this value is usually considered not conservative enough. These ratios are interpreted as one excess cancer death from exposure to a specific pollutant in the population group size represented by the denominator. The background cancer rate in the United States is approximately one in four, i.e., 250,000 in 1,000,000.

Once an acceptable risk level has been set, it is possible to calculate an acceptable risk concentration. This

TABLE 5

SRS Air Pollutants Unreferenced in Carcinogenic Classifications

SC Toxicity Class I	Ammonium Chloride	*SC Toxicity Class III*	Arsenic Pentoxide
	Antimony		Carbon Disulfide
	Ethanolamine		Cobalt
	Hydrochloric Acid		2,4-Dinitrophenol
	Hydrogen Cyanide		1,2-Butylene Oxide
	2-Methoxy-2-Methyl Propane		Ethylene Glycol
	Nitric Acid		Glycol Ethers
	Phosphoric Acid		Hexachloronaphthalene
	2,2,4-Trimethylpentane		Kepone
SC Toxicity Class II	Cresol		Manganese Oxide
	Cumene		Potassium Permanganate
	Diethanolamine		Methyl Alcohol
	Dioctyl Phthalate		p-Nitrophenol
	Furfuryl Alcohol		p-Nitrosophenol
	1,6-Diisocyanatohexane		Polycyclic Organic Matter
	Hydrogen Sulfide		Triethylamine
	Maleic Anhydride		
	Methylene Biphenyl Isocyanate	*Standard No. 2*	Carbon Monoxide
	Methyl Isobutyl Ketone		Hydrogen Fluoride
	Oxalic Acid		Ozone
	Phosgene		Particulate Matter <10 microns
	Sodium Hydroxide		Total Particulates
			Volatile Organic Compounds

TABLE 6

EPA Unit Risk Factors for SRS Category A1 Carcinogens

Pollutant	URF	Pollutant	URF
Arsenic	4.3E-03 per ($\mu g/m^3$)	Bis (Chloromethyl) Ether	6.2E-02 per ($\mu g/m^3$)
Benzene	8.3E-06 per ($\mu g/m^3$)	Chromium (+6) Comp.	1.2E-02 per ($\mu g/m^3$)
Benzidine	6.7E-02 per ($\mu g/m^3$)	Nickel	2.4E-04 per ($\mu g/m^3$)

is determined by dividing the level of acceptable risk by the URF. The result is an annual concentration in $\mu g/m^3$ that may be compared with the annual concentration obtained by modeling for evaluation.

EPA's stated approach is to "(i) protect the greatest number of persons possible to an individual lifetime cancer risk level no higher than approximately 1 x 10^{-6} and (ii) limit to no higher than approximately 1 x 10^{-4} the estimated cancer risk that a person living near a source would have if he or she were exposed to the maximum pollutant concentrations for 70 years."[8]

Most state air quality control agencies regulate emissions of carcinogens from new stationary sources when estimated maximum individual risks are in the range of 1:10,000 ($1x10^{-4}$) to 1:1,000,000 ($1x10^{-6}$) or greater. South Carolina and Georgia do not have mandatory maximum risk levels. The baseline for acceptable risk in states having mandatory maximum risk levels is mostly 1:100,000 ($1x10^{-5}$). Public interest organizations usually favor maximum individual lifetime cancer risks of 1:1,000,000. It should be

[8] 54 FR 38044, September 14, 1989.

noted that the use of individual risk generally over predicts risk because the assumptions are conservative. The maximally exposed individual is assumed to be at the same location for a 70 year period, and indoor exposures at the location are assumed to be the same as outdoor exposures.

When risk assessment is based on the results from air dispersion modeling, additional uncertainties favoring overprediction are introduced. Atmospheric chemical removal is ignored and particles are assumed to be mostly inhalable and unlikely to be deposited before arrival at the boundary. At best, the approach yields an estimate of risk that is unlikely to understate the true risk to any significant extent and could well overstate the true risk.

Initially, this study will examine lifetime cancer risks for the maximally exposed individual residing at the SRS boundary.

Two useful statistics can be calculated from the URF and the annual average concentration for a given pollutant. These are the actual (estimated) risk, which may be compared to an acceptable level of risk, and the acceptable risk concentration. The actual risk is obtained from the inverse of the product of the URF and the annual concentration. The acceptable risk concentration (for a specific acceptable level of risk) is

TABLE 7

EPA Unit Risk Factors for SRS Category A2 Carcinogens[9]

Pollutant	URF	Pollutant	URF
Methylene Chloride	4.7E-07 per ($\mu g/m^3$)	Epichlorohydrin	1.2E-06 per ($\mu g/m^3$)
Acetaldehyde	2.2E-06 per ($\mu g/m^3$)	Ethylene Dichloride	2.6E-05 per ($\mu g/m^3$)
Acrylamide	1.3E-03 per ($\mu g/m^3$)	Formaldehyde	1.3E-05 per ($\mu g/m^3$)
Ethylene Dibromide	2.2E-04 per ($\mu g/m^3$)	Heptachlor	1.3E-03 per ($\mu g/m^3$)
Acrylonitrile	6.8E-05 per ($\mu g/m^3$)	Hexachlorobenzene	4.6E-04 per ($\mu g/m^3$)
Beryllium	2.4E-03 per ($\mu g/m^3$)	Hexachlorobutadiene	2.2E-05 per ($\mu g/m^3$)
Bromoform	1.1E-06 per ($\mu g/m^3$)	Hexachloroethane	4.0E-06 per ($\mu g/m^3$)
1,3-Butadiene	2.8E-04 per ($\mu g/m^3$)	Hydrazine	4.9E-03 per ($\mu g/m^3$)
Cadmium and compounds	1.8E-03 per ($\mu g/m^3$)	1,1,2,2-Tetrachloroethane	5.8E-05 per ($\mu g/m^3$)
Carbon Tetrachloride	1.5E-05 per ($\mu g/m^3$)	Toxaphene	3.2E-04 per ($\mu g/m^3$)
Chlordane	3.7E-04 per ($\mu g/m^3$)	1,1,2-Trichloroethane	1.6E-05 per ($\mu g/m^3$)
Chloroform	2.3E-05 per ($\mu g/m^3$)	2,4,6-Trichlorophenol	3.1E-06 per ($\mu g/m^3$)
1,2-Diphenyl Hydrazine	2.2E-04 per ($\mu g/m^3$)	1,1-Dichloroethylene	3.0E-05 per ($\mu g/m^3$)

obtained by dividing the acceptable risk by the URF for the pollutant. The result can then be compared with the annual concentration obtained by modeling.

For example, in a hypothetical situation considering benzene concentrations at a plant boundary, the actual risk posed by an estimated maximum annual concentration of 111.7 $\mu g/m^3$, when the URF for benzene is 8.3E-06, is 1 in 1,079. This actual level of risk would be unsatisfactory when the maximum acceptable level of risk is set at the widely adopted conventional value of 1:100,000. The acceptable risk concentration, under the same constraints, is 1.2 $\mu g/m^3$. The calculated maximum plant boundary concentration of 111.7 $\mu g/m^3$ is clearly too high to be considered acceptable.[10]

(Text continued on p. 10)

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[9] EPA has been unable to determine a generally applicable URF for lead owing to the complexity of the considerations involved.

[10] In this example, the actual risk is calculated by $1/111.7 \times (8.3 \times 10^{-6}) = 1.0/0.000927 = 1{:}1{,}079$ and the acceptable risk concentration is $0.00001/0.0000083 = 1.2\ \mu g/m^3$.

TABLE 8

SRS Air Pollutants

Estimated Maximum SRS Site Boundary Concentrations

1994 Maximum Potential Emissions Data

SC Toxicity Class	Pollutant	Short-term Average [11] ($\mu g/m^3$)	SC Ambient Standard ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
I	Furfural	<0.01	200.0	<0.01
	Hydrochloric Acid	24.06	175.00	2.25
	Hydrogen Cyanide	0.15	250.00	<0.01
	Methyl Ethyl Ketone (2-Butone)	0.62	14750.00	0.02
	Methylene Chloride	0.69	8750.00	0.06
	2-Methoxy-2-Methyl Propane	0.01	TBD	<0.01
	Phosphoric Acid	0.05	25.00	<0.01
	Styrene	0.15	5325.00	<0.01
	Trichloroethylene	6.22	6750.00	0.57
II	Acetaldehyde	0.04	1800.00	<0.01
	Acrylamide	<0.01	0.30	<0.01
	Cumene	0.82	9.00	0.04
	p-Dichlorobenzene	<0.01	4500.00	<0.01
	Bis- (2-Ethylhexyl) Phthalate	<0.01	0.03	<0.01
	Ethyl Benzene	6.95	4350.00	0.31
	Ethylene Dibromide	<0.01	770.00	<0.01
	Hydrogen Sulfide	1.18	140.00	0.08
	Hydroquinone	<0.01	20.00	<0.01
	Isophorone	<0.01	250.00	<0.01
	Methylene Biphenyl Isocyanate	0.02	2.00	<0.01
	Pentachlorophenol	<0.01	5.00	<0.01
	Sulfuric Acid	59.27	10.00	3.46
	Tetrachloroethylene	8.70	3350.00	0.79
III	Acrolein	<0.01	1.25	<0.01
	Acrylic Acid	<0.01	147.50	<0.01
	Acrylonitrile	<0.01	22.50	<0.01
	Aniline	0.05	50.00	<0.01
	Arsenic	0.04	1.00	<0.01
	Benzene	27.74	150.00	3.19
	Benzidine	<0.01	TBD	<0.01
	Benzotrichloride	<0.01	300.00	<0.01
	Benzyl Chloride	<0.01	25.00	<0.01
	Beryllium	<0.01	0.01	<0.01
	Bis (Chloromethyl) Ether	<0.01	0.03	<0.01
	Bromoform	0.13	25.85	<0.01
	1,3-Butadiene	0.01	110.50	<0.01
	Cadmium Oxide	<0.01	0.25	<0.01
	Cadmium	<0.01	0.25	<0.01
	Carbon Disulfide	0.17	150.00	0.01
	Carbon Tetrachloride	<0.01	150.00	<0.01

[11] Short-term average is 24 hours except for lead, which is by calendar quarter. The SC standards correspond to these averaging times.

TABLE 8 (contd.)

SRS Air Pollutants

Estimated Maximum SRS Site Boundary Concentrations

1994 Maximum Potential Emissions Data

SC Toxicity Class	Pollutant	Short-term Average [12] ($\mu g/m^3$)	SC Ambient Standard ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
III(contd.)	Chlordane	<0.01	2.50	<0.01
	Chlorobenzene	<0.01	1725.00	<0.01
	Chloroform	1.11	250.00	0.06
	Chloromethyl Methyl Ether	<0.01	TBD	<0.01
	Chromium (+6) Compounds	<0.01	2.50	<0.01
	3,3 -Dichlorobenzidine	<0.01	0.15	<0.01
	1,3-Dichloropropene	<0.01	7.00	<0.01
	3,3 Dimethoxybenzidene	<0.01	0.30	<0.01
	Dimethyl Phthalate	<0.01	25.00	<0.01
	Dimethyl Sulfate	<0.01	2.50	<0.01
	2,4-Dinitrotoluene	<0.01	1.50	<0.01
	Dioxane	<0.01	450.00	<0.01
	1,2-Diphenyl Hydrazine	<0.01	TBD	<0.01
	Epichlorohydrin	<0.01	50.00	<0.01
	Ethylene Dichloride	<0.01	200.00	<0.01
	Ethylene Oxide	<0.01	10.00	<0.01
	Ethylene Thiourea	<0.01	TBD	<0.01
	Ethylenimine	0.02	5.00	<0.01
	1,1-Dichloroethane	<0.01	2025.00	<0.01
	Formaldehyde	0.48	7.50	0.02
	Glycol Ethers	0.02	TBD	<0.01
	Heptachlor	0.01	2.50	<0.01
	Hexachlorobenzene	<0.01	TBD	<0.01
	Hexachlorobutadiene	<0.01	1.20	<0.01
	Hexachloroethane	<0.01	48.50	<0.01
	Hexane	3.70	200.00	0.41
	Hydrazine	<0.01	0.50	<0.01
	Lindane	<0.01	2.50	<0.01
	Manganese	0.31	25.00	0.02
	Mercury	0.01	0.25	<0.01
	Methoxychlor	<0.01	50.00	<0.01
	Methyl Chloride	<0.01	515.00	<0.01
	Methyl Hydrazine	<0.01	1.75	<0.01
	Methyl Iodide	<0.01	58.00	<0.01
	Curene	<0.01	1.10	<0.01
	Nickel Monoxide	<0.01	5.00	<0.01
	Nickel	0.12	0.50	<0.01
	Nitrobenzene	<0.01	25.00	<0.01
	2-Nitropropane	<0.01	182.00	<0.01
	Parathion	0.01	0.50	<0.01

[12] Short-term average is 24 hours except for lead, which is by calendar quarter. The SC standards correspond to these averaging times.

TABLE 8 (contd.)

SRS Air Pollutants

Estimated Maximum SRS Site Boundary Concentrations

1994 Maximum Potential Emissions Data

SC Toxicity Class	Pollutant	Short-term Average [13] ($\mu g/m^3$)	SC Ambient Standard ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
III (contd.)	Polychlorinated Biphenyls (PCB)	<0.01	2.50	<0.01
	1,1,2,2-Tetrachloroethane	<0.01	35.00	<0.01
	Toluene	2.83	2000.00	0.18
	Toxaphene	0.02	2.50	<0.01
	1,1,2-Trichloroethane	<0.01	273.00	<0.01
	2,4,6-Trichlorophenol	<0.01	TBD	<0.01
	Vinyl Acetate	<0.01	176.00	<0.01
	Vinyl Chloride	<0.01	50.00	<0.01
	1,1-Dichloroethylene	<0.01	99.00	<0.01
Standard No. 2	Lead	<0.01	1.50	<0.01

The estimated maximum site boundary concentrations of the SRS air pollutants for which EPA has defined quantitative toxicity criteria (carcinogenic and non carcinogenic) are included in Table 8 above. Also listed are the estimated maximum site boundary concentrations of A1, A2 and A3 carcinogens for which EPA has not defined URFs. The boundary concentration values were calculated using dispersion modeling and 24-hour[14] and annual averaging times. The air dispersion model used was the EPA Industrial Source Complex (ISC3) short-term model. The meteorological data input were hourly observations for the year 1991. It should be noted that the site boundary concentrations listed in the table are based on "maximum potential" emissions for 1994. These are emission levels that would occur if sources were either operated continuously under "worst case" conditions or were emitting at the maximum operating throughput for the period of time the state operating permit allows. These are essentially hypothetical scenarios since very few sources emit pollutants at maximum levels. The approach indicates the ambient concentrations that could occur if all sources were operated in such extreme ways.

Even with the use of such a conservative approach in estimating ambient concentrations, it can be seen from Table 8 that these improbably high emission rates do not result in violations of South Carolina's air quality standards. Most calculated maximum concentrations at the SRS boundary are very small in relation to the applicable standard. A more realistic approach is to calculate the estimated maximum site boundary concentrations that would result from the actual emissions in 1994. These would be representative of prevailing operating conditions. The calculated maximum site boundary concentrations resulting from emissions of a few pollutants of particular interest are compared in Table 9. It can be seen that there is a significant difference between ambient concentrations calculated from actual emissions as compared with the concentrations obtained using maximum potential emissions. The estimated maximum site boundary concentrations resulting from actual emissions are much lower.

The actual (estimated) levels of risk for known (A1) carcinogens emitted to the air at SRS are shown in Table 10. The actual (estimated) levels of risk for suspected (A2) carcinogens are shown in Table 11.

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[13] Short-term average is 24 hours except for lead, which is by calendar quarter. The SC standards correspond to these averaging times.

[14] South Carolina's ambient air quality standards for air toxics are based on this averaging time.

TABLE 9

Estimated Maximum Site Boundary Concentrations

1994 Maximum Potential and Actual Emissions Data

Average Annual Concentrations in Micrograms/Cubic Meter ($\mu g/m^3$)

Pollutant	Class of Carcinogen	Maximum Potential Emissions	Actual Emissions
Arsenic	A1	3.67544E-03	1.50084E-03
Benzene	A1	3.18658E+00	6.02125E-01
Nickel	A1	6.48720E-03	0.34017E-03
Chloroform	A2	5.90702E-02	2.96613E-02

TABLE 10

Actual Levels of Risk for SRS A1 Carcinogens

1994 Maximum Potential Emissions

Reference Level of Risk - 1:1,000,000

Pollutant	Annual Average Concentration ($\mu g/m^3$)	Maximum Acceptable Concentration ($\mu g/m^3$)	Actual Risk[15]
Arsenic	3.67544E-03	0.23261E-03	1:63,000
Benzene	3.18658E+00	0.12048E+00	1:38,000
Benzidine	0.17453E-03	0.14910E-04	1:86,000
Bis (Chloromethyl) Ether	0.17453E-03	0.20000E-04	1:92,000
Chromium (+6) Compounds	0.20030E-04	0.83310E-04	1:4,160,000
Nickel	0.64872E-02	0.41667E-02	1:642,000

These levels of risk have been calculated from the estimated maximum site boundary concentrations obtained from air dispersion modeling using maximum potential emissions data and annual averaging.

It can be seen in Table 10 that the calculated levels of risk for A1 carcinogens exceed the 1:1,000,000 level, with the exception of chromium compounds. The level of risk for maximum potential nickel emissions is smaller than 1:100,000, however. The others, arsenic, benzene, benzidine and bis (chloromethyl) ether, all have actual (estimated) levels of risk, based on maximum potential emissions, greater than 1:100,000, but less than 1:10,000.

Table 11 gives the actual (estimated) risks from A2 carcinogens. It can be seen that only chloroform has a calculated actual risk, based on boundary concentrations resulting from maximum potential emissions, greater than 1:1,000,000. However, it is considerably smaller than 1:100,000.

From these results, it is apparent that the A1 and A2 carcinogens having maximum potential emissions that cause the actual level of risk to the maximally exposed individual to exceed the 1:1,000,000 level are the

[15] Estimated risk based on maximum potential emissions in 1994.

following air contaminants: arsenic, benzene, benzidine, bis (chloromethyl) ether; chloroform and nickel.

When actual emissions are substituted for maximum potential emissions in the air dispersion model inputs, where available, the actual risks indicated for these pollutants are much smaller. The excess cancer risks for arsenic, benzene, chloroform and nickel are shown in Table 12 below (p. 13). All four pollutants have calculated actual (estimated) risks smaller than 1:100,000. Chloroform and nickel have calculated actual (estimated) risks smaller than 1:1,000,000.

TABLE 11

Actual Levels of Risk for SRS A2 Carcinogens

1994 Maximum Potential Emissions

Reference Level of Risk - 1:1,000,000

Pollutant	Annual Average Concentration ($\mu g/m^3$)	Maximum Acceptable Concentration ($\mu g/m^3$)	Actual Risk[16]
Methylene Chloride	0.58565E-01	2.12766E+00	1:36,329,000
Acetaldehyde	0.33792E-02	4.54546E-01	1:134,514,000
Acrylamide	0.17453E-03	0.76920E-03	1:4,407,000
Ethylene Dibromide	0.17453E-03	0.45455E-02	1:26,044,000
Acrylonitrile	0.17453E-03	0.14706E-01	1:84,260,000
Beryllium	0.04960E-03	0.41670E-03	1:8,401,000
Bromoform	3.47229E-03	0.90909E+00	1:261,813,000
1,3-Butadiene	0.73882E-03	0.35714E-02	1:4,834,000
Cadmium	0.01089E-03	0.55560E-03	1:51,015,000
Carbon Tetrachloride	0.40924E-03	0.66667E-01	1:162,904,000
Chlordane	0.18005E-03	0.27027E-02	1:15,011,000
Chloroform	0.59070E-01	0.43478E-01	1:736,000
1,2-Diphenyl Hydrazine	0.17453E-03	0.45455E-02	1:26,044,000
Epichlorohydrin	0.17453E-03	0.83333E+00	1:479,761,000
Ethylene Dichloride	0.17512E-03	0.38461E-01	1:219,630,000
Formaldehyde	1.69933E-03	0.76923E-01	1:4,527,000
Heptachlor	0.53240E-03	0.76920E-03	1:1,445,000
Hexachlorobenzene	0.17461E-03	0.21739E-02	1:12,450,000
Hexachlorobutadiene	0.17453E-03	0.45455E-01	1:260,440,000
Hexachloroethane	0.17453E-03	0.25000E+00	1:1,432,419,000
Hydrazine	0.17454E-03	0.02041E-02	1:1,169,000
1,1,2,2-Tetrachloroethane	0.17461E-03	0.17241E-01	1:98,742,000
Toxaphene	0.91602E-03	0.31250E-02	1:3,411,000
1,1,2-Trichloroethane	0.17453E-03	0.62500E-01	1:358,105,000
2,4,6-Trichlorophenol	0.17453E-03	0.32258E+00	1:1,848,282,000
1,1-Dichloroethylene	0.47606E-03	0.33333E-01	1:70,019,000

Benzidine and bis (chloromethyl) ether are omitted from Table 12. At SRS, there have been no actual emissions of benzidine and bis (chloromethyl) ether, consequently only projected maximum potential emission rates are available as air dispersion model inputs. These air toxics will be released primarily from

[16] Estimated risk based on maximum potential emissions in 1994.

the Consolidated Incineration Facility. The maximum potential emission rates used in the air dispersion modeling are estimates made without actual operating experience.

TABLE 12

Actual Levels of Risk for SRS A1 and A2 Carcinogens

1994 Actual Emissions

Reference Level of Risk - 1:1,000,000

Pollutant	Class of Carcinogen	Annual Average Concentration ($\mu g/m^3$)	Maximum Acceptable Concentration ($\mu g/m^3$)	Actual Risk[17]
Arsenic	A1	0.15008E-02	0.23261E-03	1:155,000
Benzene	A1	6.02125E-01	1.20482E-01	1:200,000
Chloroform	A2	2.96613E-02	0.43478E-02	1:1,466,000
Nickel	A1	0.34017E-03	4.16671E-03	1;12,249,000

On the basis of the maximum potential and actual emissions data available for pollutants for which there are EPA URFs, there no air toxics currently released at SRS that pose an actual (estimated) risk to the maximally exposed individual at the site boundary that exceeds 1:100,000. In the great majority of cases, the actual (estimated) risk posed by SRS emissions of air toxics is smaller than 1:1,000,000.

Deleterious Non Cancer Effects and the Rfc

Quantitative estimates of the risk of deleterious non cancer effects from exposures to air contaminants are focused on determining levels of exposure on a continuous basis that are without observed harmful results. The EPA has defined Reference Concentrations (Rfc). The Rfc is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure (daily) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious non cancer effects during a lifetime. EPA makes the point that this type of estimate is a "soft" estimate[18]. While exposures higher than the estimate are associated with increased probability of adverse effects, that probability is not a certainty. Similarly, while the estimate indicates a low probability of adverse effects, the absence of all risk to all people cannot be assumed at that level.

The availability of the Rfc for air contaminants emitted at SRS is incomplete. In some cases, EPA has been unable to arrive at an Rfc because no relevant data on effects of exposure exist or because the data available are inadequate on which to define a reference concentration. The SRS air contaminants for which there is no Rfc for these reasons are listed below in Table 13. It will be seen that the full range of South Carolina Standard 8 toxicity classes is represented. There are 65 air toxics in this group. In addition, no Rfc has been defined for eight pollutants in South Carolina Standard 2.

(Text continued on p. 15)

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[17] Estimated risk based on actual emissions in 1994.

[18] EPA, 1993: *Integrated Risk Information System (IRIS). Background document 1A. Reference Dose (RfD): Description and Use in Health Risk Assessments.* EPA, Research Triangle Park, NC (1996).

TABLE 13

SRS Pollutants for Which EPA Reference Concentration (Rfc) Is Unavailable[19]

SC Toxicity Class I

Acetonitrile
Antimony
Cyanide
Formic Acid
Furfural
Methylene Chloride
Naphthalene
2,2,4-Trimethylpentane

SC Toxicity Class II

Acrylamide
Aldicarb
Cresol (Tricresol)
Bis- (2-Ethylhexyl) -Phthalate
Ethylene Dibromide
Hydroquinone
Isophorone
Maleic Anhydride
Methyl Isobutyl Ketone
Pentachlorophenol
Phenol
Phosgene (Carbonyl Chloride)
Phosphorus (yellow or white)
Perchloroethylene (Tetrachloroethylene)
Xylenes

SC Toxicity Class III

Arsenic
Benzidine
Benzotrichloride
Benzyl Chloride
Beryllium
Biphenyl (Diphenyl, Phenyl Benzene)
Bis (Chloromethyl) Ether
Bromoform
1,3-Butadiene
Carbon Tetrachloride

SC Toxicity Class III (contd.)

2,4-Dichlorophenoxy Acetic Acid
Dibutyl Phthalate
3,3'-Dichlorobenzidine
3,3'-Dimethylbenzidine (o-Tolidine)
Dimethyl Phthalate
Dimethyl Sulfate
2,4-Dinitrophenol
2,4-Dinitrotoluene
Dioxane
1,2-Diphenyl Hydrazine
Ethylene Dichloride
Ethylene Glycol
Ethylenimine (Aziridine)
Formaldehyde
Heptachlor
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hydrazine
Methoxychlor
p-Nitrophenol (4-Nitrophenol)
Parathion
Pentachloronitrobenzene
Phthalic Anhydride
Polychlorinated Biphenyls
Selenium
1,1,2,2-Tetrachloroethane
Toxaphene
2,4,6-Trichlorophenol

SC Standard No. 2

Carbon Monoxide
Hydrogen Fluoride
Lead
Nitrogen Dioxide
Ozone
Particulates <10 microns
Sulfur Dioxide
Total Particulates

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[19] No data or inadequate data available.

TABLE 14

SRS Pollutants for Which EPA Reference Concentration (Rfc) Is Pending

SC Toxicity Class I

Acetonitrile
Chlorine
Furfural
Methylene Chloride (Dichloromethane)
Trichloroethylene

SC Toxicity Class II

Ethylene Dibromide (1,2-Dibromoethane)
Methyl Isobutyl Ketone (Hexane)
Pentachlorophenol
Phosphorus (Yellow or White)
1,2,4-Trichlorobenzene
Xylenes

SC Toxicity Class III

Acetophenone

SC Toxicity Class III (contd.)

Benzene
Cadmium
Chlordane
Chlorobenzene
Chloroform
Chloromethyl Methyl Ether
Chromium (+6) Compounds
Ethylene Thiourea
1,1-Dichloroethane
Hexachloroethane
Lindane (gamma-Hexachlorocyclohexane)
Methyl Alcohol
1,1,1-Trichloroethane (Methyl Chloroform)
Methyl Iodide (Iodomethane)
Nickel
Nitrobenzene
1,1,2-Trichloroethane
1,1-Dichloroethylene (Vinylidene Chloride)

Deleterious Non Cancer Effects and the Rfc (contd.)

For another group of air toxics emitted at SRS, EPA has an Rfc in process of determination. The SRS air contaminants for which an Rfc is pending are listed in Table 14. Once again, the full range of South Carolina Standard 8 toxicity classes is represented. There are 33 SRS air contaminants in this group.

The 26 air toxics emitted at SRS for which there are Rfc estimates are listed in Table 15. The EPA Rfc is given, together with the South Carolina 24-hour ambient air quality standard. Micrograms per cubic meter ($\mu g/m^3$) are used for both values. It will be seen that the Rfc is generally a good deal smaller than the ambient standard.

EPA advises caution in equating Rfc exposures to specific modeling averaging times. Twenty-four hours may be reasonable in some cases, and the annual average more appropriate in others. The Rfc is a chronic, long-term exposure value and a comparison between the Rfc, a state or federal ambient air quality standard, and an estimated maximum ambient concentration depends on the toxicity of the substance and its long-term effects on the exposed person. For example, heavy metals, when inhaled, tend to accumulate in critical tissues. EPA is studying this problem but has not yet developed guidance[20].

A comparison of the EPA Rfc with the estimated maximum site boundary concentrations calculated using maximum potential emissions data and both 24-hour and annual averaging is shown in Table 16. There are 26 SRS air contaminants in this list. From this table, it can be seen that the estimated maximum site boundary concentrations calculated using maximum potential data are mostly very small in relation to the

(Text continued on p. 18)

[20] Private communications from Terry Forman, NCEA, EPA, Research Triangle Park, 1/23/97 and 1/27/97.

TABLE 15

EPA Reference Concentrations (Rfc)[21] for SRS Pollutants and SC Air Quality Standards

Micrograms per Cubic Meter (μg/m3)

Pollutant	EPA Rfc	24-hour SC Standard
SC Toxicity Class I		
Hydrochloric Acid	20.00	175.00
Hydrogen Cyanide	3.00	250.00
Methyl Ethyl Ketone (2-Butanone)	1000.00	4750.00
2-Methoxy-2-Methyl Propane (Methyl Tert Butyl Ether)	3000.00	TBD
Phosphoric Acid	10.00	25.00
Styrene	1000.00	5325.00
SC Toxicity Class II		
Acetaldehyde	9.00	1800.00
Cumene	9.00[22]	9.00
p-Dichlorobenzene (1,4-Dichlorobenzene)	800.00	4500.00
Ethyl Benzene	1000.00	4350.00
Hydrogen Sulfide	1.00	140.00
Methylene Biphenyl Isocyanate	0.02	2.00
SC Toxicity Class III		
Acrolein	0.02	1.25
Acrylic Acid	1.00	147.50
Acrylonitrile	2.00	22.50
Aniline	1.00	50.00
Carbon Disulfide	700.00	150.00
1,3-Dichloropropene	7.00[23]	7.00
Epichlorohydrin (1-Chloro-2,3-Epoxypropane)	1.00	50.00
Glycol Ethers (2-Ethoxyethanol)	200.00	TBD
Hexane	200.00	200.00
Manganese	0.05	25.00
Mercury	0.30	0.25
2-Nitropropane	20.00	182.00
Toluene	400.00	2000.00
Vinyl Acetate	200.00	176.00

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[21] An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure (daily) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious non cancer effects during a lifetime.

[22] South Carolina Department of Health and Environmental Control. Regulation 61-62.5 - Air Pollution Control Standards: Standard No. 8. Toxic Air Pollutants. *Environment Reporter,* 506:1055 (1992).

[23] South Carolina Department of Health and Environmental Control. Regulation 61-62.5 - Air Pollution Control Standards: Standard No. 8. Toxic Air Pollutants. *Environment Reporter,* 506:1057 (1992).

TABLE 16

EPA Reference Concentrations (Rfc) for SRS Pollutants and SRS Boundary Concentrations

1994 Maximum Potential Emissions

Micrograms per Cubic Meter (μg/m3)

Pollutant	EPA Rfc	24-hour Average	Annual Average
SC Toxicity Class I			
Hydrochloric Acid	20.00	24.06	2.25
Hydrogen Cyanide	3.00	0.15	<0.01
Methyl Ethyl Ketone (2-Butanone)	1000.00	0.62	0.02
2-Methoxy-2-Methyl Propane (Methyl Tert Butyl Ether)	3000.00	0.01	<0.01
Phosphoric Acid	10.00	0.05	<0.01
Styrene	1000.00	0.10	<0.01
SC Toxicity Class II			
Acetaldehyde	9.00	0.04	<0.01
Cumene	9.00	0.83	0.04
p-Dichlorobenzene (1,4-Dichlorobenzene)	800.00	<0.01	<0.01
Ethyl Benzene	1000.00	6.95	0.31
Hydrogen Sulfide	1.00	1.18	0.08
Methylene Biphenyl Isocyanate	0.02	0.02	<0.01
SC Toxicity Class III			
Acrolein	0.02	<0.01	<0.01
Acrylic Acid	1.00	<0.01	<0.01
Acrylonitrile	2.00	<0.01	<0.01
Aniline	1.00	0.05	<0.01
Carbon Disulfide	700.00	0.17	0.01
1,3-Dichloropropene	7.00	<0.01	<0.01
Epichlorohydrin (1-Chloro-2,3-Epoxypropane)	1.00	<0.01	<0.01
Glycol Ethers (2-Ethoxyethanol)	200.00	0.02	<0.01
Hexane	200.00	3.70	0.41
Manganese	0.05	0.31	0.02
Mercury	0.30	0.01	<0.01
2-Nitropropane	20.00	<0.01	<0.01
Toluene	400.00	2.83	0.18
Vinyl Acetate	200.00	<0.01	<0.01

TABLE 17

EPA Reference Concentrations (Rfc) for SRS Pollutants and SRS Boundary Concentrations

1994 Actual Emissions

Micrograms per Cubic Meter (μg/m3)

Pollutant	EPA Rfc	24-hour Average	Annual Average
SC Toxicity Class I			
Hydrochloric Acid	20.00	3.28	0.25
SC Toxicity Class II			
Hydrogen Sulfide	1.00	0.47	0.03
SC Toxicity Class III			
Manganese	0.05	0.02	<0.01

Deleterious Non Cancer Effects and the Rfc (contd.)

EPA Rfc for both averaging times. In such cases, the question of which averaging time is more appropriate to use for evaluating health risk from emissions of a pollutant becomes moot. Given the nature of the Rfc, it is clear that a risk of adverse health effects for the hypothetical maximally exposed individual is remote.

However, in a few cases in Table 16, it can be seen that the estimated maximum 24-hour average site boundary concentration determined from maximum potential emissions equals or exceeds the EPA Rfc statistic. As noted, the Rfc is a guideline concentration for daily exposure which carries negligible risk of adverse effects. The air contaminants in this group are:

hydrochloric acid
hydrogen sulfide
methylene biphenyl isocyanate
manganese.

Since maximum potential emissions are worst case quantities that are unlikely to reflect ongoing operating conditions, it is appropriate to repeat the modeling using the actual emissions data for sources emitting in 1994. There were no emissions of methylene biphenyl isocyanate in the period 1994-1995 (1996 air emissions inventory is incomplete), hence there are no applicable data. In any event, the projected maximum potential emissions of methylene biphenyl isocyanate result in an estimated maximum site boundary concentration carrying a health risk no greater than EPA's conservative assessment.

The results from modeling the actual emissions of hydrochloric acid, hydrogen sulfide and manganese are shown in Table 17. It can be seen that the estimated maximum 24-hour and annual site boundary concentrations resulting from actual emissions are well below the EPA Rfc statistics. The likelihood of deleterious health effects for the maximally exposed individual are thus remote.

CONCLUSIONS

With the exception of two air contaminants, benzidine and bis (chloromethyl) ether, of which there have been, and presently are, no emissions, the excess cancer risk posed by actual emissions of the 32 air contaminants released at SRS for which an EPA URF is defined is currently less than the conventionally accepted 1:100,000. In the great majority of cases, it is less than 1:1,000,000.

Non cancer deleterious health effects to the maximally exposed individual resulting from emissions of the 26 air contaminants at SRS, for which an EPA Rfc has been defined, also are unlikely at present.

As noted earlier, this assessment of potential health risks posed by air contaminants released at SRS has been limited. The 88 SRS air pollutants evaluated for risk to the maximally exposed individual are those for which EPA has determined either a URF or an Rfc statistic.

In the cases of those SRS air contaminants evaluated for which the level of actual risk is greater than 1:1,000,000, or for which the Rfc is exceeded when the maximum site boundary ambient concentrations are estimated using maximum potential emissions from site sources, a cautious approach is indicated. This would be to examine the assumptions on which the projected maximum potential emissions are based and make any revisions indicated, or to monitor the emissions to ensure that the safety margins indicated by the results obtained using actual emissions are not eroded.

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APPENDIX A

SRS Air Toxics and Criteria Pollutants Listed in 29 CFR Part 1910, Subpart Z

SC Toxicity Class	Chemical Name
I	Acetonitrile
	Antimony and compounds
	Chlorine
	Formic Acid
	Furfural
	Hydrogen Chloride
	Hydrogen Cyanide
	Methylene Chloride
	Methyl Ethyl Ketone
	Methyl Methacrylate
	Naphthalene
	Nitric Acid
	Phosphoric Acid
	Styrene
	Trichloroethylene
II	Acetaldehyde
	Acrylamide
	Cresol
	Cumene
	p-Dichlorobenzene
	Ethyl Benzene
	Ethylene Dibromide
	Furfuryl Alcohol
	Hydrogen Sulfide
	Isophorone
	Maleic Anhydride
	Methyl Isobutyl Ketone
	Methylene Biphenyl Isocyanate
	Oxalic Acid
	Pentachlorophenol
	Phenol
	Phosgene
	Phosphorus (yellow)
	Sodium Hydroxide
	Sulfuric Acid
	Tetrachloroethylene (Perchloroethylene)
	Xylenes; o-Xylene; m-Xylene; p-Xylene
III	Acrolein
	Acrylonitrile
	Aniline
	Arsenic
	Benzene
	Benzidine
	Benzyl Chloride
	Biphenyl
	Bromoform

APPENDIX A (contd.)

SC Toxicity Class	Chemical Name
III	1,3-Butadiene
	Cadmium
	Carbon Disulfide
	Carbon Tetrachloride
	Chlordane
	Chlorobenzene
	Chloroform
	Bis (Chloromethyl) Ether
	Chloromethyl Methyl Ether
	Chromium
	Cobalt
	2,4-D (Dichlorophenoxy Acetic Acid)
	Dibutyl Phthalate
	3,3'-Dichlorobenzidine
	Dimethyl Phthalate
	Dimethyl Sulfate
	Dioxane
	Di-sec Octyl Phthalate
	Epichlorohydrin
	Ethylene Dichloride
	Ethylenimine
	Ethylene Oxide
	Formaldehyde
	Glycol Monoethyl Ether
	Heptachlor
	Hexachloroethane
	n-Hexane
	Hydrazine
	Lindane
	Manganese
	Mercury
	Methoxychlor
	Methyl Alcohol
	Methyl Chloride
	Methyl Hydrazine
	Methyl Iodide
	Nickel and compounds
	Nitrobenzene
	2-Nitropropane
	Parathion
	Phthalic Anhydride
	Selenium
	1,1,2,2-Tetrachloroethane
	Toluene
	Toxaphene
	1,1,2-Trichloroethane
	Vinyl Chloride
Standard No. 2	Carbon Monoxide
	Lead

APPENDIX A (contd.)

SC Toxicity Class	Chemical Name
Standard No. 2	Nitrogen Dioxide
	Ozone (by precursors)
	Particulates
	Sulfur Dioxide

APPENDIX B

SRS Non Radiological Air Emissions Listed in CAAA and in EPA Programs

1. ***High Priority Toxic Chemicals for EPA 33/50 Program***

SC Toxicity Class	Chemical Name
I	Cyanide and compounds
	Methyl Ethyl Ketone (2-Butanone)
	Methylene Chloride (Dichloromethane)
	Trichloroethylene
II	Methyl Isobutyl Ketone (Hexone)
	Perchloroethylene (Tetrachloroethylene)
	Xylene; m-Xylene; o-Xylene; p-Xylene
III	Benzene
	Cadmium and compounds
	Carbon Tetrachloride
	Chloroform
	Chromium and compounds
	Mercury and compounds
	Nickel and compounds
	Toluene
Standard No. 2	Lead and compounds

3. ***Hazardous Air Pollutants (CAAA 112(b)(1)***

SC Toxicity Class	Chemical Name
I	Acetonitrile
	Antimony
	Chlorine
	Cyanide
	Hydrochloric Acid
	Methyl Ethyl Ketone (2-Butanone)
	Methyl Methacrylate
	Methylene Chloride (Dichloromethane)
	2-Methoxy-2-Methyl Propane (Methyl Tert Butyl Ether)
	Naphthalene
	Styrene
	Trichloroethylene
	2,2,4-Trimethylpentane
II	Acetaldehyde
	Acrylamide
	Cresol (Tricresol)
	Cumene
	p-Dichlorobenzene (1,4-Dichlorobenzene)
	Diethanolamine
	Bis-(2-Ethylhexyl)-Phthalate
	Ethyl Benzene
	Ethyl Chloride (Chloromethane)

APPENDIX B (contd.)

3. ***Hazardous Air Pollutants (CAAA 112(b)(1)*** (contd.)

SC Toxicity Class	Chemical Name
II	Ethylene Dibromide (1,2-Dibromomethane)
	1,6-Diisocyanatohexane
	Hydroquinone
	Isophorone
	Maleic Anhydride
	Methylene Biphenyl Isocyanate
	Methyl Isobutyl Ketone (Hexone)
	Pentachlorophenol
	Phenol
	Phosgene (Carbonyl Chloride)
	Phosphorus (Yellow or White)
	Perchloroethylene (Tetrachloroethylene)
	1,2,4-Trichlorobenzene
	Xylene
	m-Xylene
	o-Xylene
	p-Xylene
III	Acetophenone
	Acrolein
	Acrylic Acid
	Acrylonitrile
	Aniline
	Arsenic Pentoxide
	Arsenic
	Benzene
	Benzidine
	Benzotrichloride
	Benzyl Chloride
	Beryllium
	Biphenyl (Diphenyl, Phenyl Benzene)
	Bis (Chloromethyl) Ether
	Bromoform
	1,3-Butadiene
	Cadmium Oxide
	Cadmium
	Carbon Disulfide
	Carbon Tetrachloride
	Catechol
	Chlordane
	Chlorobenzene
	Chloroform
	Chloromethyl Methyl Ether
	Chromium (+6) Compounds
	Cobalt
	2,4-Dichlorophenoxy Acetic Acid (2,4-D)
	Dibutyl Phthalate
	3,3'-Dichlorobenzidine
	1,3-Dichloropropene

APPENDIX B (contd.)

3. ***Hazardous Air Pollutants (CAAA 112(b)(1)*** (contd.)

SC Toxicity Class	Chemical Name
III	3,3-Dimethoxybenzidine (o-Dianisidene)
	3,3'-Dimethylbenzidine (o-Tolidene)
	Dimethylformamide
	Dimethyl Phthalate
	Dimethyl Sulfate
	2,4-Dinitrophenol
	2,4-Dinitrotoluene
	Dioxane (1,4-Dioxane)
	1,2-Diphenyl Hydrazine
	Epichlorohydrin
	1,2-Butylene Oxide (1,2-Epoxybutane)
	Ethylene Dichloride (1,2-Dichloroethane)
	Ethylene Glycol
	Ethylene Oxide
	Ethylene Thiourea
	Ethyleneimine (Aziridine)
	1,1-Dichloroethane
	Formaldehyde
	Glycol Ethers (2-Ethoxyethanol)
	Heptachlor
	Hexachlorobenzene
	Hexachlorobutadiene
	Hexachloropentadiene
	Hexachloroethane
	Hexane
	Hydrazine
	Lindane
	Manganese Oxide
	Manganese
	Mercury
	Methyl Alcohol (Methanol)
	Methoxychlor
	Methyl Bromide (Bromoethane)
	Methyl Chloride (Chloromethane)
	1,1,1-Trichloroethane (Methyl Chloroform)
	Methyl Hydrazine (Monomethylhydrazine)
	Methyl Iodide (Iodomethane)
	Curene
	Nickel Oxide
	Nickel
	Nitrobenzene
	p-Nitrophenol
	2-Nitropropane
	Parathion
	Pentachloronitrobenzene
	Phthalic Anhydride
	Polychlorinated Biphenyls
	Polycyclic Organic Matter

APPENDIX B (contd.)

3. ***Hazardous Air Pollutants (CAAA 112(b)(1)*** (contd.)

SC Toxicity Class	Chemical Name
III	Propylene Dichloride (1,2-Dichloropropane)
	Selenium
	Tetrachlorinated Dibenzo-p-dioxins
	1,1,2,2-Tetrachloroethane
	Toluene
	Toxaphene (Chlorinated Camphene)
	1,1,2-Trichloroethane
	2,4,6-Trichlorophenol
	Triethylamine
	Vinyl Acetate
	Vinyl Chloride
	1,1-Dichloroethylene (Vinylidene Chloride)
Standard No. 2	Gaseous Fluorides
	Lead

4. ***High Risk Pollutants (56 FR 27354, June 13, 1991)***

SC Toxicity Class	Chemical Name
II	Acrylamide
	Ethylene Dibromide (1,2-Dibromomethane)
	Methylene Diphenyl Diisocyanate
	Phosgene (Carbonyl Chloride)
III	Acrolein
	Acrylic Acid
	Acrylonitrile
	Arsenic Pentoxide
	Benzene
	Benzidine
	Benzotrichloride
	Beryllium
	Bis (Chloromethyl) Ether
	1,3-Butadiene
	Cadmium Oxide
	Chlordane
	Chloromethyl Methyl Ether
	Chromium (+6) Compounds
	Ethylene Oxide
	Heptachlor
	Hexachlorobenzene
	Mercury
	Tetrachlorinated Dibenzo-p-dioxins
	1,1,2,2-Tetrachloroethane
	Vinyl Chloride
	1,1-Dichloroethylene (Vinylidene Chloride)

APPENDIX B (contd.)

5. ***Extremely Hazardous Substances (CAAA (112(r)(3) Initial List)***

SC Toxicity Class	Chemical Name
I	Chlorine
	Hydrogen Cyanide
II	Hydrogen Sulfide
	Phosgene
III	Ethylene Oxide
	Methyl Chloride
Standard No. 2	Hydrogen Fluoride