Air Quality Impact Analysis in Support of the New Production Reactor Environmental Impact Statement

D. L. Hadley

April 1991

Prepared for the
U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
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AIR QUALITY IMPACT ANALYSIS
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Pacific Northwest Laboratory
Richland, Washington 99352

SUMMARY

The Pacific Northwest Laboratory (PNL) conducted this air quality impact analysis for the U.S. Department of Energy (DOE). The purpose of this work was to provide Argonne National Laboratory (ANL) with the required estimates of ground-level concentrations of five criteria air pollutants at the Hanford Site boundary from each of the stationary sources associated with the new production reactor (NPR) and its supporting facilities.

The DOE proposes to provide new production reactor capacity for the primary production of tritium and secondary production of plutonium to support the U.S. nuclear weapons program. Three alternative reactor technologies are being considered by DOE: the light-water reactor, the low-temperature, heavy-water reactor, and the modular high-temperature, gas-cooled reactor. In this study, PNL provided estimates of the impacts of the proposed action on the ground-level concentration of the criteria air pollutants for each of the alternative technologies. The criteria pollutants were sulfur dioxide, nitrogen dioxide, carbon monoxide, total suspended particulates, and particulates with a diameter of less than 10 microns. Ground-level concentrations were estimated for the peak construction phase activities expected to occur in 1997 and for the operational phase activities beginning in the year 2000.

Ground-level concentrations of the primary air pollutants were estimated to be well below any of the applicable national or state ambient air quality standards.

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1.0 INTRODUCTION

The U.S. Department of Energy (DOE) proposes to site, construct, and operate a new production reactor (NPR) for the primary production of tritium and secondary production of plutonium to support the U.S. nuclear weapons program. DOE is considering three technological alternatives: the low-temperature, heavy water reactor (HWR), the light-water reactor (LWR), and the modular high-temperature, gas-cooled reactor (MHTGR). The DOE has determined that this proposal constitutes an action that may significantly affect the quality of the environment and, therefore, is preparing an environmental impact statement (EIS) to assess the potential impacts of the proposed action and reasonable alternatives on the environment.

Argonne National Laboratory (ANL) has been selected as the lead contractor by the DOE to prepare the NPR EIS with supporting information provided by the DOE, federal and state agencies, and DOE contractors. The Pacific Northwest Laboratory (PNL)^(a) was to provide information about the Hanford Site and its environs to ANL.

This report documents the ambient air quality impact analysis for the three alternative technologies if implemented at the Hanford Site. Section 2.0 describes the dispersion model used in the determination of the impacts, the meteorological data used in the analysis, and the background ambient air quality. Also presented are the national and state ambient air quality standards applicable to the Hanford Site. The projected baseline ambient air quality for the baseline period of 1995 is summarized in Section 3.0, while the impacts of the NPR and its support facilities on the ambient air quality are described in Sections 4.0 and 5.0 for the construction phase and the operational phase activities, respectively. Section 6.0 describes the impacts from the reactor cooling towers.

(a) Operated by Battelle Memorial Institute for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.

2.0 BACKGROUND

The Environmental Protection Agency (EPA) Industrial Source Complex Short Term (ISC/ST) dispersion model was used to assess the potential air quality impacts from the proposed NPR and its support facilities. Meteorological data were obtained from the Hanford Meteorology Monitoring Program. This section describes the modeling methodology and the meteorological data used in the impact assessment. Also presented in this section are the results of ambient air quality monitoring programs conducted on-site and off-site by the Washington State Department of Ecology.

2.1 DISPERSION MODEL

The ISC/ST model (U.S. Environmental Protection Agency 1987a,b) was used to estimate hourly unit concentrations (X/Q) at each receptor point for each source during each of the three periods of activity (baseline, construction, and operation). A "post processor" program was used to calculate the 1-h, 3-h, 8-h, 24-h, and annual ground level concentration for each of the criteria pollutants, based on the specific source emission rates for each period of activity. The ISC/ST input and model option selections are listed in Table 2.1.

Receptor points were selected along the perimeter of the Hanford Site as well as along State Route 240 that runs through the western half of the Site. Building wake analysis was not considered in these preliminary impact analyses.

2.2 ONSITE METEOROLOGICAL MONITORING PROGRAM

The central meteorological monitoring station at Hanford is located between the 200-East and 200-West operating areas. Meteorological parameters recorded each hour include air temperature, relative humidity, precipitation, atmospheric pressure, solar radiation, and cloud cover. Wind speed and direction and air temperatures are measured at multiple levels on a 410-ft (125-m) tower. Atmospheric mixing depth is measured by a Doppler acoustic sounder.

TABLE 2.1. Air Quality Model Selection, Input Data, and Model Options

ISC/ST Input Parameter	Switch Setting
Calculate (Concentration=1, Deposition=2)	ISW(1) = 1
Receptor grid system (Rectangular=1 or 3, Polar=2 or 4)	ISW(2) = 1
Discrete receptor system (Rectangular=1, Polar=2)	ISW(3) = 1
Terrain elevations are read (Yes=1, No=0)	ISW(4) = 0
Calculations are written to tape (Yes=1, No=0)	ISW(5) = 1
List all input data (No=0, Yes=1, MET DATA ALSO=2)	ISW(6) = 1
Compute Average Concentration (or Total Deposition) with the Following Time Periods:	
Hourly (Yes=1, No=0)	ISW(7) = 1
2-Hour (Yes=1, No=0)	ISW(8) = 0
3-Hour (Yes=1, No=0)	ISW(9) = 0
4-Hour (Yes=1, No=0)	ISW(10) = 0
6-Hour (Yes=1, No=0)	ISW(11) = 0
8-Hour (Yes=1, No=0)	ISW(12) = 0
12-Hour (Yes=1, No=0)	ISW(13) = 0
24-Hour (Yes=1, No=0)	ISW(14) = 0
Print 'N'-day table(s) (Yes=1, No=0)	ISW(15) = 1
Print the Following Types of Tables Whose Time Periods are Specified by ISW(7) Through ISW(14):	
Daily tables (Yes=1, No=0)	ISW(16) = 0
Highest and second highest tables (Yes=1, No=0)	ISW(17) = 1
Maximum 50 tables (Yes=1, No=0)	ISW(18) = 0
Meteorological data input method (pre-processed=1, card=2)	ISW(19) = 2
Rural-Urban option (RU=0, UR mode 1=1, mode 2=2, UR mode 3=3)	ISW(20) = 0
Wind profile exponent values (Defaults=1, User Enters=2,3)	ISW(21) = 1
Vertical pot temp gradient values (Defaults=1, User Enters =2,3)	ISW(22) = 1
Scale emission rates for all sources (No=0, Yes=0)	ISW(23) = 0
Program calculates final plume rise only (Yes=1, No=2)	ISW(24) = 1
Program adjusts all stack heights for downwash (Yes=2, No=1)	ISW(25) = 2
Program uses buoyancy induced dispersion (Yes=1, No=2)	ISW(26) = 1
Concentrations during calm period set = 0 (Yes=1, No=2)	ISW(27) = 2
Reg. default option chosen (Yes=1, No=2)	ISW(28) = 2
Type of pollutant to be modeled (1=S02, 2=Other)	ISW(29) = 2
Debug option chosen (Yes=1, No=2)	ISW(30) = 2
Above ground (flagpole) receptors used (Yes=1, No=0)	ISW(31) = 1
Number of input sources	NSOURC = 1
Number of source groups (=0, All Sources)	NGROUP = 0
Time period interval to be printed (=0, All Intervals)	IPERD = 0
Number of X (range) grid values	NXPNTS = 0
Number of Y (theta) grid values	NYPNTS = 0
Number of discrete receptors	NXWYPT = 115
Number of hours per day in meteorological data	NHOURS = 24
Number of days of meteorological data	NDAYS = 354
Source emission rate units conversion factor	TK = 0.10000E+07
Height above ground at which wind speed was measured (meters)	ZR = 10.00
Logical unit number of meteorological data	IMET = 9
Logical unit of calculation 'save' tape	ITAP = 3

Meteorological monitoring is also conducted at another 24 locations on the Hanford Site and in the surrounding area. These monitoring sites consist of three 200-ft (60-m) towers, two 40-ft (12-m) towers, sixteen 30-ft (90-m) towers, a pole-mounted site on the crest of Rattlesnake Mountain, and two monitoring sites on the roof of airport control towers (Pasco and Richland airports). A detailed description of the Hanford monitoring program can be found in Glantz and Islam (1988).

Because of the diverse wind flow patterns that exist on the Hanford Site and the distances separating the various emission sources, it was not possible to identify a single monitoring station representative of conditions at all sites. In addition, detailed temperature and stability information was available for only one location. Therefore, a year of meteorological data was created by combining the ambient temperature, mixing height, and Pasquill stability class data from the 410-ft tower at the primary Hanford monitoring station, with the hourly wind speed and direction data from the monitoring station closest to the emission source. The Wye Barricade (WYEB) station was used for those facilities located in the Skagit/Hanford project area, while the Washington Public Power Supply System (WPPSS) station was used for the WNP-1 facilities.

2.3 WORST METEOROLOGICAL YEAR DATA SET

The ISC/ST model was run using 7 years (1983 through 1989) of on site weather data to select the one year that resulted in maximum short-term ground-level concentrations (GLC) for a single elevated source. Sulfur dioxide (SO_2) emissions from the 200-East boiler stack were used as the test source. The maximum GLC for each year is shown in Table 2.2. The maximum GLC for each short-term averaging interval is underlined.

The year 1986 with the highest 1-h and second highest 3-h concentrations was selected as the worst-case year. All subsequent model runs were based on the weather data for 1986.

TABLE 2.2. Maximum Predicted Short-Term GLCs for Single Elevated Source for Each Year from 1983 Through 1989

<u>Year</u>	<u>Ground-Level Concentration, $\mu\text{g}/\text{m}^3$</u>		
	<u>1-Hour</u>	<u>3-Hour</u>	<u>8-Hour</u>
1983	65.7	46.6	<u>34.9</u>
1984	59.6	33.9	27.0
1985	61.6	<u>53.8</u>	23.6
1986	<u>75.7</u>	50.1	28.7
1987	64.0	30.6	14.3
1988	71.9	33.4	14.8
1989	58.7	39.1	15.1

2.4 MEASURED AMBIENT AIR QUALITY

Periodically during the past 10 years, carbon monoxide, sulfur dioxide, and nitrogen dioxide have been monitored in communities and commercial areas southeast of Hanford (U.S. Nuclear Regulatory Commission, 1982). These urban measurements are typically used to estimate the maximum background pollutant concentrations for the Hanford Site because of the lack of specific on site monitoring. Because these measurements were made in the vicinity of local sources of pollution, they will overestimate maximum background concentrations within the Hanford Site or at the site boundaries.

Particulate concentrations can reach relatively high levels in eastern Washington because of exceptional natural events (i.e., dust storms, volcanic eruptions, and large brushfires) that periodically occur in the region. Washington State ambient air quality standards do not consider "rural fugitive dust" from exceptional natural events when estimating the maximum background concentrations of particulates in the area east of the Cascade Mountain crest. Similarly, the EPA also exempts the rural fugitive dust component of background concentrations when considering permit applications and enforcement of air quality standards.

Currently, only background concentrations of total suspended particulates and nitrogen dioxide are monitored at the Hanford site. Monitoring of

TSP was discontinued in 1988 when the Basalt Waste Isolation Project, for which those measurements were required, was stopped. Total suspended particulate (TSP) is monitored at four locations near the Hanford Site by the Washington State Department of Ecology (DEQ).

In 1987, NO_2 was monitored at nine locations within or near the Hanford Site. Background concentrations at all locations were well below the applicable federal and state annual ambient standard for NO_2 ($100 \mu\text{g}/\text{m}^3$). The highest annual average was $<16 \mu\text{g}/\text{m}^3$, measured at the Wye Barricade and the 100-D sampling locations.

Total suspended particulates were sampled near the 200-West Area beginning in 1986. In 1987 the annual geometric mean was $33 \mu\text{g}/\text{m}^3$ and the maximum 24-h value was $91 \mu\text{g}/\text{m}^3$, both well below the federal and state standards. Total suspended particulates were monitored by the DEQ at four locations near the Hanford Site. PM_{10} was monitored at one location. The results are shown in Table 2.3.

2.5 REGULATORY ENVIRONMENT

National ambient air quality standards (AAQS) have been set by the EPA, as mandated in the 1970 Clean Air Act. "Ambient air" is defined in the U.S. Code of Federal Regulations (1985) as "that portion of the atmosphere,

TABLE 2.3. Results of Particulate Monitoring ($\mu\text{g}/\text{m}^3$) Near Hanford Site in 1987 (Washington State Department of Ecology 1988)

<u>Location</u>	<u>Annual Geo. Mean</u>	<u>Max. Conc.</u>	<u>No. of Occurrences</u>		
			<u>>150</u>	<u>>260</u>	<u>>375</u>
<u>TSP</u>					
Hanford Site (200-East)	33	91	0	0	0
Kennewick, Columbia Center	52	178	1	0	0
Richland, Pumping Station	41	197	1	0	0
Pasco, Court Courthouse	61	360	3	1	0
Sunnyside, Intermediate School	70	211	3	0	0
<u>PM₁₀</u>					
Kennewick, Columbia Center	27	81	0	0	0

external to buildings, to which the general public has access." The standards define levels of air quality that are necessary, with adequate margin of safety, to protect the public health (primary standards) and the public welfare (secondary standards). Standards exist for sulfur oxides (measured as sulfur dioxide), nitrogen dioxide, carbon monoxide, total suspended particulates, lead, and ozone.^(a) The standards specify the maximum pollutant concentrations and frequencies of occurrence that are allowed for specific averaging periods (e.g., the 1-hour concentration of carbon monoxide averaged is allowed to exceed 40 mg/m³ only once per year). The averaging periods vary from 1 h to 1 yr, depending on the pollutant.

In 1987, EPA proposed a revision to the particulate standard to include only particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (referred to as PM₁₀). These standards became effective July 31, 1987, replacing the TSP standards. In the interim, while states (including Washington) are developing Implementation Plans for PM₁₀, the TSP standards are still being enforced.

State and local governments have the authority to impose standards for ambient air quality that are stricter than the national standards. Washington State has established more stringent standards for sulfur dioxide and total suspended particulates. In addition, Washington has established standards for volatile organic compounds (VOC), arsenic, fluoride, and other pollutants that are not covered by national standards. The state standards for carbon monoxide and nitrogen dioxide are identical to the national standards. At the local level, the Tri-County (Benton, Franklin, and Walla Walla) Air Pollution Control Authority has the power to adopt more stringent AAQS in the vicinity of the Hanford Site, but has established no local standards. The national and Washington State Supplemental Air Quality Standards are shown in Table 2.4.

Areas not in compliance with the NAAQS are termed "nonattainment," while areas meeting the NAAQS are referred to as "attainment" areas. Areas with insufficient data to make a determination are unclassified, but are treated as

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(a) Lead and ozone are not discussed in this report because significant concentrations of these pollutants will not result from NPR activities.

TABLE 2.4. Ambient Air Quality Standards and Maximum Measured Background Concentrations ($\mu\text{g}/\text{m}^3$) of Significant Pollutants at the Hanford Site

<u>Pollutant</u>	<u>National Primary Standard</u>	<u>National Secondary Standard</u>	<u>Washington State Standard</u>	<u>Maximum Background Concentration</u>
Nitrogen Dioxide (NO_2)				
Annual Arith. Mean	100	100	--	36
Sulfur Dioxide (SO_2)				
Annual Arith. Mean	80	80	52	0.5
24-h maximum ^(a)	365	365	260	6
3-h maximum ^(b)	--	1,300	--	20
1-h maximum ^(b)	--	--	1,018	49
1-h maximum ^(b)	--	--	655	49
Carbon Monoxide (CO)				
8-h maximum ^(b)	10,000	10,000	--	6,500
1-h maximum ^(b)	40,000	40,000	--	11,800
Total Suspended Particulates^(c)				
Annual Geo. Mean	75	60	40+background	56
24-h maximum ^(d)	260	150	120+background	356

(a) Not to be exceeded more than once per year.

(b) Not to be exceeded more than two times in any consecutive 7 days.

(c) If the annual background concentration in eastern Washington State exceeds $20 \mu\text{g}/\text{m}^3$, or if the 24-h background concentrations exceeds $30 \mu\text{g}/\text{m}^3$ due to high levels of rural fugitive dust, the primary and secondary AAQS are replaced by a state standard that specifies the maximum allowable pollutant concentration independent of the background concentration of that pollutant.

(d) Lead and ozone are not discussed in this report because significant concentrations of these pollutants will not result from NPR activities.

attainment areas until proven otherwise. The designation of an area is made on a pollutant-specific basis. Attainment (and unclassified) areas are subject to the Prevention of Significant Deterioration (PSD) regulations.

PSD regulations require the owner or operator of a facility to obtain a permit before construction of a major new source or modification of an existing major source located in an attainment or unclassified area. A major new stationary source (as defined by PSD regulations) is any facility identified from a list of 28 specific categories that has the potential to emit 100+ tons per year (tpy) of any of the pollutants regulated by PSD. A facility is also considered a major source if it has the potential to emit 250+ tpy of any of the regulated pollutants.

Sources are allowed to consume only part of the available increment for new emissions. For attainment areas, maximum allowable increases in ambient pollutant concentrations have been established for SO_2 and TSP to prevent significant deterioration of the baseline air quality. PSD increments have not yet been established for PM_{10} .

3.0 BASELINE AMBIENT AIR QUALITY

To determine the potential impacts of the proposed NPR and support facilities on the ambient air quality, it is first necessary to establish the baseline or conditions that would occur if the NPR were not constructed at Hanford. An assessment of the impacts of operation of the various facilities (either existing or planned) on the ambient air quality at the Hanford Site boundary was completed using those facilities that were projected to be in operation in 1995.

3.1 STATIONARY EMISSION SOURCE INVENTORY

Emission inventories for significant pollution sources in Benton, Franklin, and Walla Walla Counties, including the Hanford Site, are routinely compiled by the Tri-County Air Pollution Control Board. In 1987 (the most recent year available at the time of preparation of the baseline conditions), 80 stationary sources were identified within the Tri-County area. Of these, only eight sources exceeded 100 tpy for one or more of the criteria pollutants. The vast majority of the sources emitted less than 10 tpy of any of the criteria pollutants.

Table 3.1 lists those stationary sources within the Hanford Site boundaries that are projected to be in operation during the 1995 baseline period. The PUREX plant emissions were included as an upper bound for projected emissions from the new Hanford Vitrification Plant planned to be in operation by 1995. Column 1 indicates the approximate distance of the source from the HWR/MHTGR reactor site.

3.2 MODEL RESULTS

The baseline ambient air quality was estimated for the Hanford Site boundary using those stationary emission sources projected to be in operation in 1995. The maximum GLCs are presented in Table 3.2. Also shown are the national and state ambient air quality standards. As can be seen, in all instances the projected baseline conditions are well below any national or state standards.

TABLE 3.1. Emission Inventory for Hanford Site Stationary Sources

Source	Distance ^(a) (km)	Activity Level (hr/yr)	Stack Parameters				Emission Rate (g/sec)					
			Height (m)	Diam. (m)	Temp. (°C)	Flow (m ³ /sec)	TSP	PM ₁₀	SO ₂	NO _x	VOC	CO
Combustion Sources												
Boiler #2 300 Area	15	5880	15.2	1.2	204.4	13.5	0.05	0.00	0.82	0.19	0.00	0.05
Boiler #3 300 Area	15	8064	21.3	0.9	232.2	19.8	0.17	0.00	3.22	1.82	7.07	0.24
Boiler #4 300 Area	15	1344	45.7	1.8	287.8	36.3	0.21	0.00	1.89	0.63	0.00	0.21
Boiler #5 300 Area	15	7560	21.3	2.1	232.2	19.8	0.15	0.00	3.36	1.90	0.00	0.26
Boiler #6 300 Area	15	2016	25.3	1.4	315.6	13.8	0.00	0.00	0.00	0.00	0.14	0.00
5 Boilers 200-E Area	13	8760	76.2	3.4	204.4	21.5	7.20	1.13	26.85	15.12	1.00	2.00
Boiler 1100 Area/1171	15	4872	18.3	0.8	373.0	10.0	0.06	0.00	0.17	0.29	0.06	0.00
Fugitive Sources												
Fugitive Coal Piles 200-E & 200-W	25	8760	NA	NA	NA	NA	2.13	1.07	0.00	0.00	0.00	0.00
Fugitive Emissions--Rockwell	15	8760	NA	NA	NA	NA	0.03	0.00	0.00	0.00	0.00	0.00
Process Sources												
NO _x Absorber Exit	15	6240	61.0	3.0	30.0	16.6	0.00	0.00	0.00	11.23	0.00	0.00
Main Stack	15	6240	61.0	3.0	30.0	16.6	0.00	0.00	0.00	18.87	0.00	0.00
UO ₃ Plant	15	6240	46.0	1.4	30.0	15.5	0.00	0.00	0.00	3.70	0.00	0.00

(a) Approximate distance from the NPR site.

TABLE 3.2. Summary of Baseline Ambient Air Quality Impacts from 1995 Stationary Emissions

<u>Pollutant</u>	<u>Averaging Period</u>	<u>Model Estimated Conc., $\mu\text{g}/\text{m}^3$</u>	<u>Background Conc., $\mu\text{g}/\text{m}^3$</u>	<u>State or NAAQS, $\mu\text{g}/\text{m}^3$</u>
SO ₂	1-h highest	127	49	1,018
	Second highest	120		
	3-h highest	76	20	1,300
	Second highest	55		
	24-h highest	19	6	365
	Second highest	15		
PM ₁₀	Annual highest	2	0.5	80
	24-h highest	3	TBD	150
	Second highest	2		
TSP	Annual highest	0	TBD	50
	24-h highest	6	356	156
	Second highest	1		
CO	Annual highest	0	56	60
	1-h highest	10	11,800	40,000
	Second highest	9		
NO ₂	8-h highest	3	6,500	10,000
	Second highest	2		
	Annual highest	3	36	100

4.0 CONSTRUCTION PHASE IMPACTS

This section describes the construction phase activities and the impacts those activities have on the ambient air quality surrounding the Hanford Site.

The impact of the activities associated with the construction of the NPR and its support facilities on ambient air quality was completed using detailed equipment and operational activities provided by Westinghouse personnel. At Hanford, NPR and its support facilities would be located at three different areas, separated by as much as 25 km (15 mi.). Table 4.1 identifies the location by facility.

4.1 STATIONARY EMISSION SOURCES

Table 4.2 identifies the principal construction activity and typical heavy construction equipment used. The following approach was used to estimate the maximum impacts from the construction phase emissions:

1. The construction equipment that has been identified was used to estimate the associated emission rates for each facility/location.
2. The three main construction activities (excavation, backfill, and concrete) were assumed to occur simultaneously (unrealistic but conservative).
3. Construction activity was limited to one 10-h shift, 7 days per week.
4. Construction activity was assumed to occur at only one facility at a time.

The estimated construction phase stationary source emission rates are presented in Table 4.3.

TABLE 4.1. Location of the NPR and Support Facilities

<u>Facility</u>	<u>Reactor Technology</u>	
	<u>LWR</u>	<u>MHTGR & HWR</u>
Reactor	WNP-1	Skagit/Hanford
Target Fabrication	400 Area FMEF	Skagit/Hanford
Fuel Fabrication	400 Area FMEF	Skagit/Hanford
Target Processing	400 Area FMEF	400 Area FMEF
Spent Fuel Reprocessing	200-East Area	200-East Area

TABLE 4.2. WNP-1 Construction Activity/Equipment List

<u>Activity/Type</u>	<u>Horsepower</u>	<u>Fuel Consumption gal/h</u>	<u>No. of Units</u>	<u>Fuel Consumption gal/h</u>	<u>h/day</u>
<u>Excavation</u>					
Pan scraper/cat	285	6	2	12	10
D9 push cat	285	6	1	6	10
Front-end loader	225	10	1	10	10
Haul trucks	185	15	3	45	10
<u>Back-Fill</u>					
Pan scraper/cat	285	6	2	12	10
D9 push cat	285	6	1	6	10
Sheet roller	185	10	1	10	10
25t roller	185	10	1	10	10
<u>Concrete</u>					
Concrete trucks	185	15	5	75	10
Belly dump truck	185	15	1	15	10
Batch plant loader	185	15	1	15	10
D9 push cat	285	6	1	6	10
<u>Dust Control</u>					
Watering trucks	145	15	2	30	10
<u>Cranes</u>					
Small crane	175	10	3	30	10
Large crane	225	10	2	20	10
<u>Compressor</u>					
1200 cfm	225	10	1	10	10

TABLE 4.3. Characterization of Stationary Construction Sources

Source/Category/No.	Capacity, horsepower	Activity Level, hp/h	Emission Rate, g/sec				
			SO ₂	PM ₁₀	CO	VOC	NO _x
<u>Excavation</u>							
Pan scrappers (2)	285	570	0.15	0.16	0.48	0.18	2.22
D-9 push cat	285	285	0.07	0.08	0.24	0.09	1.11
Front-end loader	225	225	0.06	0.06	0.19	0.07	0.88
10-yd ³ dump trucks (3)	185	555	0.14	0.15	0.47	0.17	2.16
Fugitive dust				0.67			
<u>Back-Fill</u>							
Pan scrapper (2)	285	570	0.15	0.16	0.48	0.18	2.22
D-9 push cat	285	285	0.07	0.08	0.24	0.09	1.11
Sheep foot roller	185	185	0.05	0.05	0.16	0.06	0.72
25-ft proof roller	185	185	0.05	0.05	0.16	0.06	0.72
Fugitive dust				0.48			
<u>Dust Control</u>							
Watering trucks (2)	145	290	0.07	0.08	0.24	0.09	1.13
Fugitive dust				0.19			
<u>Concrete</u>							
Concrete trucks (5)	145	725	0.19	0.20	0.61	0.23	2.82
Aggregate transporter	285	285	0.07	0.08	0.24	0.09	1.11
Batch plant loader	225	225	0.06	0.06	0.19	0.07	0.88
Batch plant push cat	285	285	0.07	0.08	0.24	0.09	1.11
Fugitive dust				0.67			
<u>Cranes</u>							
2900 series (2)	175	350	0.09	0.10	0.29	0.11	1.36
<u>Compressor</u>							
1200 cfm	225	225	0.06	0.06	0.19	0.07	0.88

4.2 MODEL RESULTS

Maximum GLCs at the site boundary are shown in Table 4.4 for each of the three technologies for the construction phase. The WYEB weather station data for 1986 were used for those construction phase emissions sources associated with the HWR and the MHTGR and their support facilities. The WPPSS station data for 1986 were used for the LWR and its support facilities.

TABLE 4.4. Summary of Maximum Ground-Level Concentrations from the Construction Phase Activities

<u>Pollutant</u>	<u>Average Period</u>	<u>LWR,₃ μg/m³</u>	<u>HWR,₃ μg/m³</u>	<u>MHTGB, μg/m³</u>
SO ₂	1 hour	179	82	84
	3 hour	96	28	28
	24 hour	12	4	4
	Annual	0	0	0
NO _x	Annual	3	1	1
CO	1 hour	690	312	323
	8 hour	138	40	41
PM ₁₀	24 hour	16	31	24
	Annual	0	1	0
TSP	24 hour	43	86	66
	Annual	1	2	1

5.0 OPERATIONAL PHASE IMPACTS

Operation of the Hanford Site NPR and its support facilities was assumed to begin in approximately 2005. This section describes the projected emissions and operational phase impacts on the ambient air quality at the site boundary.

5.1 STATIONARY EMISSION SOURCES

Operational phase stationary source emission inventory for each of the support facilities and each reactor technology was based on information contained in the Hanford site adaptation reports prepared by Westinghouse Hanford Company (Amara and Edmondson 1991a,b; Amara et al. 1991; Carlson et al. 1991a,b,c). Stationary emissions are a combination of process emissions (spent fuel reprocessing facility only) and combustion emissions (intermittent backup generator operation and steam production). Steam production at the spent fuel reprocessing facility will use the existing 200-East boilers. The other facilities will use electrical package boilers.

Emergency electrical motor generators were assumed to be tested for 2 h each month for each of the facilities. In addition, a set of electrical generators for the HWR was assumed to run continuously.

Tables 5.1 and 5.2 list the emission source characteristics and emissions rates for the MHTGR and HWR technologies. The LWR and its support facilities were evaluated in three different operating scenarios: 1) tritium production mode, 2) plutonium production mode, and 3) low-exposure tritium production mode. The greatest emissions rates were for the plutonium production mode and are shown in Table 5.3.

5.2 MODEL RESULTS

Maximum estimated GLCs during the operational phase for each criterion pollutant are shown in Table 5.4 for the three technologies. The LWR impacts were based on the plutonium production mode. The WYEB weather data were used for those facilities at the Skagit/Hanford Site, while the WPPSS data were used for the facilities located at or near the WNP-1 site.

TABLE 5.1. Characterization of Stationary Sources - Proposed New - MHTGR

Source Category	Location	Activity level	Stack Parameters				Emission Rate, g/sec					
			Ht. m	ID. m	Vel. m/s	T. °C	SO ₂	PM ₁₀	CO	VOC	NO _x	CO ₂
A. Onsite												
1. Combustion Source Emissions												
a. Boilers (steam)												
	Fuel and Target Fab. Facility	(electric boiler)	None	None	None	None	None	None	None	None	None	None
	Target Processing Facility	(electric boiler)	None	None	None	None	None	None	None	None	None	None
	Spent Fuel Reprocessing Facility	14.5 Mlb/yr	76	3.4	21.5	204	0.119	0.006	0.005	0.001	0.286	62.6
b. Emergency Generators												
	Fuel and Target Fab. Facility	1000 gal/yr	9	0.1	3.6	444	0.16	0.18	0.54	0.23	2.46	60.3
	Target Processing Facility	2000 gal/yr	9	0.1	3.6	444	0.33	0.35	1.07	0.47	4.92	116.
	Spent Fuel Reprocessing Facility	2750 gal/yr	9	0.1	3.6	444	0.45	0.48	1.47	0.64	6.77	166.
	Reactor	34,000 gal/yr	9	0.1	3.6	444	5.57	5.98	18.2	7.90	83.7	4100.
2. Process Emissions												
	Fuel and Target Fab. Facility		12	1	16	30	0	0	0.09	0	4.63	0
	Target Processing Facility		61	3	17	30	0	0	0	0	0	0
	Spent Fuel Reprocessing Facility	210 gal/yr	46	1	16	30	0	0	0	0	0.01	0.04
	Reactor		None	None	None	None	None	None	None	None	None	None

TABLE 5.2. Characterization of Stationary Sources - Proposed New - HWR

[illegible]

TABLE 5.3. Characterization of Stationary Sources - Proposed New - LWR Plutonium Production Mode

Source Category	Location	Activity Level	Stack Parameters				Emission Rate, g/sec					
			Ht. m	ID. m	Vel. m/s	T. °C	SO ₂	PM ₁₀	CO	VOC	NO _x	CO ₂
A. Onsite												
1. Combustion Source Emissions												
a. Boiler (steam)												
	Fuel/Target Fab.and Target Processing Facility (FMEF)	(electric boiler)	None	None	None	None	None	None	None	None	None	None
	Spent Fuel Reprocessing Facility	250 Mlb/yr	76	3.4	21.5	204	2.05	0.108	0.086	0.014	4.93	1078
b. Emergency Generators												
	Fuel/Target Fab. and Target Processing Facility (FMEF)	2400 gal/yr	9	0.1	3.6	444	0.39	0.42	1.29	0.56	5.91	145
	Spent Fuel Reprocessing Facility	2600 gal/yr	9	0.1	3.6	444	0.43	0.46	1.39	0.61	6.40	154
	Reactor	1150 gal/hr	9	0.1	3.6	444	4.52	4.86	14.8	6.45	68.0	0
2. Process Emissions												
	Fuel/Target Fab. and Target Processing Facility (FMEF)		None	None	None	None	None	None	None	None	None	None
	Spent Fuel Reprocessing Facility	333,000 gal/yr HNO ₃										
	MPB		61	3.0	16.6	30	0	0	0	0	0.10	0
	UPB		46	1.4	15.5	30	0	0	0	0	0.49	0
	Reactor		None	None	None	None	None	None	None	None	None	None

TABLE 5.4. Summary of Maximum Ground-Level Concentrations from the Operational Phase Activities

<u>Pollutant</u>	<u>Average Period</u>	<u>LWR,₃ μg/m³</u>	<u>HWR,₃ μg/m³</u>	<u>GLC,₃ μg/m³</u>
SO ₂	1 hour	344	127	282
	3 hour	115	42	94
	24 hour	2	1	2
	Annual	0	0	0
NO _x	Annual	0	0	2
CO	1 hour	492	411	928
	8 hour	23	24	50
PM ₁₀	24 hour	1	1	2
	Annual	0	0	0
TSP	24 hour	6	2	5
	Annual	0	0	1

6.0 PRELIMINARY COOLING TOWER IMPACTS

A preliminary assessment of the impact of the NPR cooling towers on the environment was conducted by EBASCO Environmental for Pacific Northwest Laboratory using the Electric Power Research Institute (EPRI) SACTI cooling tower model (Policastro et al. 1984). This section summarizes the results of that work.

6.1 COOLING TOWER DESIGN

Table 6.1 lists the NPR cooling tower design basis data for the Hanford Site (Amara and Edmondson 1991a,b; Amara et al. 1991). There were three circular mechanical-draft counterflow cooling towers for each reactor. Each tower consisted of 19 cells, each 8.5 m in diameter. It was assumed that plumes from each cell would immediately merge into one plume above each tower. The effective tower diameter was 37.2 m, and the tower height was 19.8 m. It was also assumed that only two of the three towers would be operating at one time. The third tower would be used as a standby unit. Therefore, only two plumes were actually modeled for each reactor technology.

The total thermal energy generated by the reactor was used as the heat dissipation rate for the towers. This is an extreme case that assumes that all heat is dissipated to the atmosphere.

Hourly meteorological data for the WPPSS station for 1986 were used in the modeling. The monthly clearness index and average daily insolation data for each month were based on Spokane, Washington, NWS data.

TABLE 6.1. Hanford Site Cooling Tower Design Basis Data

<u>Reactor Type</u>	<u>Hot Water Temp, °F</u>	<u>Cold Water Temp, °F</u>	<u>Power MWt</u>	<u>Circ. Water Flow, m/s</u>	<u>Tower Air Flow, m/s</u>
HWR	155	90	2590	17.2	8,600
LWR	126	85	3800	39.9	25,400
MHTGR	130	90	2800	30.2	12,500

6.2 COOLING TOWER IMPACTS

The SACTI model (PolICASTRO et al. 1984) was used to generate estimates of drift deposition, visible plume length, plume shadowing, waste disposition, fogging and icing.

6.2.1 Drift Deposition

Cooling tower drift salts were derived from the general chemical composition of cooling tower effluent characteristics. Average salt concentration is based on five cycles. The following constituents were used to derive the salt content of the cooling tower drift:

• alkalinity (as CaCO_3)	• copper
• calcium	• iron
• chloride	• lead
• sodium	• manganese
• sulfate	• mercury
• cadmium	• nickel
• chromium	• zinc

Estimates of the drift deposition rate are summarized in Table 6.2 for the direction sector with maximum deposition and the average across all sectors at selected distances downwind from the cooling tower. The first row for each technology lists the direction sector with the maximum frequency of occurrence and the direction from the cooling tower. The second row lists the sum of the frequencies across all direction sectors.

Maximum drift deposition was predicted to occur near the base of the cooling tower at the minimum distance calculated by the model (100 m) for the HWR and MHTGR technologies and at 200 m for the LWR. Maximum rate of drift deposition for the three technologies was 93,000 $\text{kg}/\text{km}^2/\text{month}$ (LWR), 126,000 $\text{kg}/\text{km}^2/\text{month}$ (HWR), and 190,000 $\text{kg}/\text{km}^2/\text{month}$ (MHTGR). The maximum direction frequency was to the north of the cooling tower with a secondary maximum to the south.

6.2.2 Visible Plume Length

Model estimates of the visible plume characteristics are summarized in Table 6.3 for the three technologies. The format of this table is the same as

TABLE 6.2. Annual Rate of Plume Drift Deposition ($\text{kg}/\text{km}^2/\text{year}$)

Technology		Distance, km					
		0.5	1.0	2.0	3.0	4.0	5.0
LWR	Max	1304/N	426/N	81/N	29/N	11/N	9/N
	Avg	583	56	28	14	5	3
HWR	Max	515/N	132/N	30/N	8/N	5/N	2/N
	Avg	207	50	11	3	2	1
MHTGR	Max	755/NNE	266/N	44/N	11/N	7/N	4/N
	Avg	344	99	16	5	3	2

TABLE 6.3. Visible Plume Length Frequency (%)

Technology		Distance, km					
		0.5	1.0	2.0	3.0	4.0	5.0
LWR	Max	7.5/N	4.7/N	3.7/N	2.9/N	2.1/N	0.0
	Sum	47.7	29.6	24.9	19.0	12.8	0.0
HWR	Max	8.2/N	4.7/N	3.2/N	3.2/N	1.3/N	1.3/N
	Sum	53.3	30.6	21.9	21.4	8.9	8.1
MHTGR	Max	8.1/N	4.7/N	3.6/N	3.6/N	2.8/N	0.6/N
	Sum	51.4	29.5	24.9	24.4	18.8	3.1

that of Table 6.2. The visible plumes are predicted to extend to 1 km downwind of the tower approximately 30% of the time and to 5 km less than 10% of the time.

6.2.3 Plume Shadowing

The results of the model estimates of the percentage loss of total solar energy due to plume shadowing are summarized in Table 6.4. The format of this table is similar to that of the previous two tables. The table was not extended to 5 km because of the insignificant losses beyond 3 km.

TABLE 6.4. Total Solar Energy Loss at a Given Distance Due to Plume Shadow (%)

Technology		Distance, km			
		0.2	1.0	2.0	3.0
LWR	Max	11.0/NNE-NE	1.0/NNW-N	0.5/NNW-N	0.5/N
	Avg	7.5	0.6	0.3	0.2
HWR	Max	13.8/NNE	1.1/N	0.5/NNW-N	0.4/NNW-N
	Avg	8.7	0.6	0.3	0.2
MHTGR	Max	15.0/NNE	1.1/ESE	0.6/ESE	0.4/NNW-N
	Avg	9.3	0.6	0.3	0.2

A maximum predicted solar energy loss of 10% to 15% is expected to occur within 200 m of the tower. At a downwind distance of 1 km, the maximum annual solar energy loss from plume shadowing estimated drops to approximately 1%. At 3 km, the loss is predicted to be less than 0.5%.

6.2.4 Water Deposition

Table 6.5 summarizes the rate of liquid water deposition from the cooling tower plumes. Again, the format of this table is the same as that of the previous tables. Maximum deposition was predicted to occur at the minimum distance from the tower calculated by the model. At 0.5 km, the rate of deposition was 1900×10^3 kg/km²/month, 730×10^3 kg/km²/month, and 1000×10^3 kg/km²/month for the LWR, HWR and MHTGR technologies, respectively. Maximum water deposition is expected to occur to the north of the cooling tower, with a secondary maximum to the south. These deposition values are equivalent to monthly rainfall amounts of 0.19 cm (0.07 in.), 0.073 cm (0.03 in.) and 0.04 in.) for the LWR, HWR, and MHTGR cooling towers, respectively.

6.2.5 Fogging and Icing

The model predicted no occurrence of fogging and/or icing.

TABLE 6.5. Rate of Liquid Water Deposition (10^3 kg/km²/month)

<u>Technology</u>		<u>Distance, km</u>					
		<u>0.5</u>	<u>1.0</u>	<u>2.0</u>	<u>3.0</u>	<u>4.0</u>	<u>5.0</u>
LWR	Max	1900/N	590/N	93/N	35/N	10/N	6/N
	Avg	830	210	31	16	4	2
HWR	Max	730/N	170/N	29/N	8/N	4/N	1/N
	Avg	290	65	10	3	2	<1
MHTGR	Max	1000/N	340/N	42/N	12/N	6/N	2/N
	Avg	490	120	15	5	2	1

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