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DRAFT

COMBUSTION HUMAN HEALTH RISK ASSESSMENT
FOR
GEORGIA GULF
PLAQUEMINE, LOUISIANA

PREPARED BY

US EPA REGION 6
CENTER FOR COMBUSTION SCIENCE AND ENGINEERING
DALLAS, TEXAS

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FOREWORD

On May 18, 1993, the United States Environmental Protection Agency (EPA) announced a series of steps that the Agency would undertake, first, to achieve reductions in the amount of hazardous waste generated in this country and, second, to ensure the safety and reliability of hazardous waste combustion in incinerators, boilers, and industrial furnaces. With this announcement, EPA released its Draft Hazardous Waste Minimization and Combustion Strategy. Eighteen months later, EPA's released its Final Strategy which solidified the Agency's policy on "how best to assure the public of safe operation of hazardous waste combustion facilities." EPA's Final Strategy specifically recognized the multi-pathway risk assessment as a valuable tool for evaluating and ensuring protection of human health and the environment in the permitting of hazardous waste combustion facilities.

Region 6 believes that those combustion facilities which are in close proximity to population centers, sensitive ecosystems, sensitive receptors, or areas that may have high potential for cumulative environmental impacts, can be evaluated by a multi-pathway risk assessment to ensure that permit limits are protective of human health. Furthermore, EPA Region 6 believes that multi-pathway risk assessments should consider the specific nature of process operations and the type of combustion units and air pollution control equipment utilized at each facility in order to be representative of actual facility operations. Region 6 staff met with facility representatives and Louisiana Department of Environmental Quality (LDEQ) staff prior to completing this assessment, in order to develop site-specific information. Therefore, although certain provisions of the Resource Conservation and Recovery Act (RCRA) program have since been delegated to the States, EPA Region 6 is committed to reviewing facilities on a site specific basis to evaluate the protectiveness of permits for combustion operations.

EPA Region 6, in partnership with the LDEQ, requested more comprehensive testing for boiler and industrial furnace (BIF) combustion facilities in the State of Louisiana as part of the regulatory trial burn testing conducted during early 1997 through 1998. Although the science of combustion risk assessments was still under development, BIF facilities agreed to conduct more comprehensive testing prior to EPA's completion of the revised national guidance documents for combustion emissions testing and risk assessment protocols. Based upon the nature of their operations, EPA allowed BIF facilities to demonstrate their performance at "normal operating conditions" during the trial burn by adding a separate "risk burn" test condition. The information from the risk burn was collected with the intent of EPA conducting facility-specific human health risk assessments.

In October 1998, EPA released its **Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Peer Review Draft** (EPA530-D-98-001 A, B, and C; dated July 1998), commonly referred to as the HHRAP. In February 2000, EPA released its **Guidance on Collection of Emissions Data to support Site-Specific Risk Assessments at Hazardous Waste Combustion Facilities, Peer Review Draft** (EPA530-D-98-002; dated August 1998). EPA has also released an **Errata to the HHRAP** (EPA Memo, July 1999), which addresses issues specific to conducting human health risk assessments. EPA Region 6 has utilized the information provided in the above listed guidance documents, as well as information gained from the External Peer Review of the HHRAP and Errata, and best professional judgement to complete this human health risk assessment. This risk assessment report documents the Agency's effort in ensuring protective permit limits so that normal combustion facility operations do not pose unacceptable risks to surrounding communities.

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EXECUTIVE SUMMARY

Georgia Gulf Corporation applied to the LDEQ for a RCRA permit to burn hazardous waste in two BIF units at its facility located in Plaquemine, Iberville Parish, Louisiana. In order to assist LDEQ in identifying any additional permit conditions which might be necessary to ensure protection of human health, EPA has conducted this risk assessment. This assessment evaluates those potential emissions from the RCRA point source at the Georgia Gulf facility, the Nebraska Boiler (NB), as well as potential fugitive emissions associated with the RCRA facility operations. In addition to this unit, Georgia Gulf operates an Industrial Furnace (IF) that is currently permitted as a hazardous waste incinerator (permit effective date is June 12, 1991). The facility has requested that the permit be renewed, but that the unit be classified as a BIF instead of an incinerator. Georgia Gulf conducted trial burn testing for the IF unit in December 2001. Although data has been received, EPA has decided to utilize permit conditions as presented in the June 12, 1991 final permit for the IF unit to provide a preliminary risk evaluation for the overall facility at this time. Upon review of trial burn data, the IF unit will be evaluated alongside the NB unit in an addendum to this report. At that time, EPA may recommend risk based permit conditions for the IF unit in consideration of permit limits being proposed for or in effect for the NB unit.

EPA's risk assessment evaluates risk-based permit limits that can be incorporated into the RCRA permit in order to *supplement* regulatory maximum allowable limits and ensure protection of human health over the long term.

Nebraska Boiler Waste Feed Rates (g/s)

Metals of Concern	Recommended Risk-Based [1] Permit Limit Annual Average	"Normal Operations" Demonstrated via the Risk Burn [1] (3 Runs Evaluated)
Antimony (Tier I)	**1.14E-2**	**ND [2] = 2.43E-4**
Arsenic (Adj. Tier I)	**2.06E-4**	**ND [2] = 1.22E-4**
Barium (Tier I)	**1.90E-1**	**ND [2] = 3.89E-4**
Beryllium (Adj. Tier I)	**8.06E-5**	**ND [2] = 4.87E-5**
Cadmium (Adj. Tier I)	**8.06E-5**	**ND [2] = 4.87E-5**
Chromium, Total (Tier III)	**8.20E-4 [3]**	**2.58E-2 [4]**
Lead (Tier I)	**3.83E-2**	**ND [2] = 2.43E-4**
Mercury, Total (Tier I)	**ND @ 9.73E-5 [5]**	**ND [2] = 9.73E-5**
Nickel	**8.76E-2**	**ND [2] = 8.76E-3**
Silver (Tier I)	**1.14E-1**	**ND [2] = 4.87E-5**
Selenium	**1.46E-3**	**ND [2] = 1.46E-4**
Thallium (Tier I)	**1.14E-3**	**ND [2] = 2.43E-4**

NOTES:

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1. Recommended RCRA Permit Limits are based upon the average stack gas temperature of 498 **K** and an average stack gas flow rate of 26.4 m^3/s; these parameters were demonstrated during the risk burn.
2. **ND** means that the metal was ***not detected*** in the waste feed; the detection limit was used to calculate the emission rate shown.
3. Recommended RCRA Permit Limit for Total Chromium is actually based upon the assumption that Hexavalent Chromium is equal to 100% of the Total Chromium measured during the risk burn.
4. Detection of Total Chromium exceeds Recommended RCRA Permit Limit (Annual Average).
5. Mercury is not believed to be present in the waste feed, but the analytical method used in the risk burn did not provide low enough detection limits for comparison with the Recommended RCRA Permit Limit.

EPA back-calculated the risk-based annual average permit limits listed above from the Tier I and Adjusted Tier I limit for each metal of concern, with the exception of chromium. EPA back-calculated the risk-based annual average permit limit for hexavalent chromium from the Tier III limit. For total chromium and for those metals not having regulatory maximum limits specified by the regulations (i.e., nickel and selenium), EPA calculated risk-based limits from the available risk burn data as appropriate. EPA then *used the calculated limits in the risk assessment* in order to show permit protectiveness over the long term for the NB unit.

EPA evaluated the most current information available to estimate potential impacts to human health, both directly via inhalation, incidental soil ingestion, and ingestion of drinking water (via surface water intakes), and indirectly via modeled deposition and uptake through the food chain. Emissions data collected as part of the risk burn, operational data specific to the Georgia Gulf facility, and site-specific information based upon the facility's location, were evaluated and considered in making assumptions and in predicting risks associated with long term operations. The risk estimates provided in this risk assessment are conservative in nature and represent possible future risks, based upon those operating conditions evaluated for issuance of a final RCRA combustion permit. If operations change significantly, or land use changes occur which would result in more frequent potential exposure to receptors, risks from facility operations may need to be reevaluated. EPA has received a copy of the 3/20/2002 letter from Georgia Gulf to LDEQ, stating the intent to replace the Nebraska Boiler with a new unit. Since testing of this new unit will occur, risk-based permit limits can be reevaluated if the replacement unit results in different operating parameters and/or increased emissions.

BACKGROUND INFORMATION

This risk assessment report presents a brief description of the facility and the emission sources evaluated, the air modeling effort conducted, the risk modeling effort conducted, and EPA's evaluation of risk estimates for Georgia Gulf's Nebraska Boiler and Industrial Furnace located in Plaquemine, Louisiana. The EPA utilized the Industrial Source Complex Short Term Version 3 Program (EPA, ISCST3 software) for air modeling and the Industrial Risk Assessment Program - Health (Lakes Environmental, IRAP-h View software Version 1.7) for risk modeling. EPA utilized the ArcView Program (Environmental Systems Research Institute, software Version 3.2), for desktop Geographical Information Systems (GIS), for all mapping efforts. All available information used to assess risks attributable to the Georgia Gulf facility can be found in electronic format, converted mainly to pdf files, in appendices enclosed via compact disc with this risk assessment report as follows:

Appendix A: Air Modeling
Audit Files
Input and Output Air Files from the ISCT3 Model
Plot Files

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ISC File (file built for import into the IRAP-h Project File)

Appendix B: Spreadsheets
Surface Roughness Calculation
Source Emission Rate Calculations
Transport & Fate Parameters
Total Organic Emissions (TOE) Factor

Appendix C: Mapping
Background Maps
Land Use Shape Files

Appendix D: Risk Modeling
Source Information from the IRAP-h Project File
Receptor Information from the IRAP-h Project File
Risk Summary Information from the IRAP-h Project File

Appendix E: IRAP-h View Project Files
Readme File
Gagulf_fr.ihb - All Chemicals Run, with metals adjusted to risk-based permit limits
Gagulf_mt.ihb - Metals Only Run, Regulatory Metal Limits for Georgia Gulf facility evaluated

Since the HHRAP provides generic discussions of the uncertainties associated with each major component of the risk assessment process, this report only discusses those uncertainties particular to the site specific results evaluated for the Georgia Gulf facility. References are provided at the end of this document.

Facility and Source Information

Georgia Gulf Corporation (GGC) is located at 26100 Highway 405, Iberville Parish, Plaquemine, Louisiana. GGC is an integrated chemical manufacturer of electro-chemicals, aromatic chemicals, and natural gas derived chemicals. Products manufactured within the electrochemical product line include caustic soda, chlorine, sodium chlorate, vinyl chloride monomer (VCM), and vinyl resin compounds. The aromatic chemical product line includes acetone, cumene, and phenol. Methanol is the single product manufactured within the natural gas derived chemicals product line. Currently, the facility operates two combustion units: a boiler (Nebraska Boiler), and an industrial furnace (IF).

The Nebraska Boiler, an “A-type” water-tube boiler utilized for energy recovery purposes, is located within the Methanol Production Unit area. Hazardous waste feed streams to the NB unit are produced as a by-product of the methanol (fusel oil) and acetone/phenol (K022 Waste) manufacturing processes. The predominant waste fed to the NB unit is the K022 waste stream identified in 40 CFR Part 261 as distillation bottom tars from the production of phenol/acetone from cumene. The NB unit has been in operation under interim status pursuant to 40 CFR 266.103, “Interim Status Standards for Burners” since its installation in 1992.

The unit is monitored continuously for both carbon monoxide and oxygen emissions by dedicated analysis equipment. In addition, the Nebraska Boiler is equipped with an automatic waste feed cutoff system governing liquid feed flow rate, steam production rate, carbon monoxide concentration, and combustion chamber temperature. The facility is capable of storing about 227,900 gallons of waste feed material for the Nebraska Boiler from the process area. Georgia Gulf reports that the typical feed rate to the unit is 7 gpm.

Georgia Gulf operates the NB unit under a Tier I status for Antimony, Barium, Lead, Mercury, Silver and Thallium; Adjusted Tier I status for Arsenic, Beryllium, and Cadmium. This simply means that all of the

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metals fed to the unit are assumed to be emitted in the stack gas. Therefore, the regulations limit stack metal emissions for those Tier I and Adjusted Tier I metals based on the hourly feed rate of individual metals into the combustion unit. For chromium, Georgia Gulf operates the NB unit under a Tier III status, which means that permit limits for chromium are based on the average of stack emissions data collected during the trial burns rather than waste feed rates. A destruction and removal efficiency (DRE) test for organic compounds was performed on the NB unit at a maximum KO22 (worst case) waste feed flow rate. The trial burn testing for the NB unit demonstrated greater than 99.999 % efficiency for destruction and removal of organic materials.

A risk burn is an additional operating condition of the trial burn during which data are collected to demonstrate that the hazardous waste-burning unit does not pose an unacceptable health risk when operating at typical (or normal) operating conditions over the long term. In addition, risk burns utilize "worst case" wastes and provide speciated organic emissions testing to a greater extent than what is accomplished by traditional DRE testing. The target feed rate for the NB unit was 7.0 gpm and consequently, the measurements taken during the risk burn demonstrated a stack gas flow rate of 26.4 m^3/sec, a stack gas exit velocity of 8.15 m/sec, and an exit temperature of 498 K (437 °F) for normal operating conditions (i.e., these measurements are averages for runs reported in the Georgia Gulf Risk Burn Report, December 1997, Volume I). LDEQ and EPA provided oversight at the risk burn testing for the Nebraska Boiler at the Georgia Gulf facility.

The IF unit is located within the Ethylene Dichloride (EDC)/Vinyl Chloride monomer (VCM) unit, and was initially permitted as an incinerator under LDEQ Hazardous Waste Permit No. LAD057117434 (effective date of June 12, 1991). As of February 4, 2000, the IF unit was reclassified as a Boiler/Industrial Furnace through a Class 1 Permit Modification. The IF unit is used to produce hydrochloric acid by thermally treating waste by-products generated in the production of EDC/VCM. Wastes used to produce the product hydrochloric acid consist of EPA listed waste K019 (Heavy Ends from the distillation of ethylene dichloride in ethylene dichloride production), EDC light ends, equipment cleaning material, de-inventory of the direct chlorination reactor, and EDC/VCM process and tank vent gases consisting of dry vent gas, wet vent gas, and storage tank vent gases.

The IF unit is a unique-design liquid injection, forced draft system constructed by the Trane Thermal Company. Components include a Trane Thermal LV-70 main burner, a horizontal furnace, and an integrally designed horizontal boiler. The K019 waste stream and process vents are fed into the combustion chamber through the main burner, which is rated at 70 MM BTU per hour. Air is provided to the IF unit at 75 to 90 psig for atomization and to promote complete combustion.

The unit is monitored continuously for carbon monoxide, oxygen, and vinyl chloride emissions, as well as combustion chamber temperature, by dedicated analysis equipment. In addition, the Industrial Furnace is equipped with an automatic waste feed cut off system governing liquid feed flow rate, atomizing air pressure, carbon monoxide concentration, oxygen concentration, combustion chamber temperature, and combustion air flow rate. Correspondence with both the facility and LDEQ suggests that the maximum permitted limit for waste feed rate to the unit is 10 gpm, while the typical feed rate of the waste feed to the unit is 8 gpm.

Georgia Gulf conducted trial burn testing for the IF unit in December 2001. Although data has been received, EPA has decided to utilize permit conditions as presented in the June 12, 1991 final permit for the IF unit to provide a preliminary risk evaluation for the overall facility at this time.

Air Modeling

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EPA used the ISCST3 for determining air dispersion and deposition of compounds resulting from operations at the Georgia Gulf facility in accordance with the HHRAP. EPA evaluated emission sources using primarily the data and information provided in the Georgia Gulf Risk Burn Report dated December 1997 and supplemental information requested by EPA and provided by Georgia Gulf in the "Fugitive Emissions Data for Georgia Gulf's Nebraska Boiler" memo dated August 18, 1998.

EPA modeled four separate emission sources for the Georgia Gulf facility: two stack sources - Nebraska Boiler (2-90) and Industrial Furnace (14-78); and two volume sources to account for fugitive emissions associated with the Nebraska Boiler (F1A and F1B).

Universal Transverse Mercator (UTM) projection coordinates in North American Datum revised in 1983 (NAD83) for each source are as follows: for 2-90, (674662.69, 3349335.50); for F1A (674636.31, 3349350.22); for F1B (674768.32, 3349449.94); and for 14-78 (674363.38, 3348717.37). EPA used a stack gas flow rate of 26.4 m^3/sec, a stack gas exit velocity of 8.15 m/sec, and a stack gas exit temperature of 498 K (437°F) for 2-90 as input to ISCST3. EPA used a height of 2.5 meters (default value) for both fugitive areas, an area of approximately 127 square meters (m^2) for evaluation of F1A, and an area of approximately 86 square meters (m^2) for evaluation of F1B. EPA used a stack gas flow rate of 5.39 m^3/sec, a stack gas exit velocity of 11.89 m/sec, and a stack gas exit temperature of 310.93 K for 14-78 as input to ISCST3.

Modeling for the Georgia Gulf facility was based upon an array of receptor grid nodes at 100-meter spacing out to a distance of 3 kilometers from the facility and an array of receptor grid nodes at 500-meter spacing between a distance of 3 kilometers and out to a distance of 10 kilometers from the facility. Unitized concentration and deposition rates were determined by the ISCST3 model for each receptor grid node for use in assessing risks. Consistent with the HHRAP, water body and watershed air parameter values were obtained from the single receptor grid node array without need for executing values to a separate array.

Terrain elevations based on 90-meter spaced USGS digital elevation data were specified for all receptor grid nodes. Other site-specific information used to complete the ISCST3 model included the most current surrounding terrain information, surrounding land use information, facility building characteristics, and meteorological data available. Meteorological data collected over a 5-year period from representative National Weather Service (NWS) stations near the facility were used as inputs to the ISCST3 model. The surface data was collected from the Baton Rouge NWS station. The upper air data was collected from the Lake Charles NWS station.

Model runs were executed for accurate evaluation of partitioning of all compounds specific to vapor phase, particle phase, and particle-bound phase runs. In addition, particle diameter size distributions and mass fractions for each source stack were based on the values determined during the risk burn. **Appendix A** contains all air modeling information utilized and generated for the Georgia Gulf facility.

Compounds of Potential Concern (COPCs)

EPA identified Compounds of Potential Concern (COPCs) in accordance with the HHRAP. EPA eliminated some compounds from the quantitative risk analysis based upon availability of toxicity data and/or transport and fate data. Those few chemicals which were detected, but dropped from the risk analysis, are qualitatively discussed in the Uncertainty Section of this report. **Appendix B** contains EPA-calculated COPC-specific emission rates used in the risk assessment for each source, including the fugitives areas, and provides justification for all chemicals dropped from the risk analysis. EPA input these COPC-specific emission rates directly into the risk model, which allowed calculation of compound-specific media concentrations in order to

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estimate risks.

EPA evaluated stack emissions data for organic compounds and waste feed data for inorganic compounds collected during the risk burn conducted between August 28 and September 2, 1997, in order to calculate emission rates. EPA reviewed a letter report from the Louisiana Chemical Association dated October 27, 1999, in order to determine a site-specific upset factor of 1.01 for use in calculation of COPC-specific emission rates for organic compounds. EPA used an upset factor of 1.00 for inorganic compounds since operation under Tier I and Adjusted Tier I status meant evaluation of waste feed measurements and not actual emissions data (i.e., all of the metals fed to the unit are assumed to be emitted in the stack gas). Evaluation of total chromium under Tier III status relied upon stack emissions data. EPA also reviewed the Recertification of Compliance (ROC) form on file, dated 1999, for the Georgia Gulf facility in order to compare associated Tier levels with operations data collected during the risk burn. Finally, in order to properly assess fugitive emissions associated with Georgia Gulf's typical operations, EPA evaluated supplemental information provided by Georgia Gulf in the "Fugitive Emissions Data for Georgia Gulf's Nebraska Boiler" memo dated August 18, 1998. This document provided historical information on the typical mix of specific compounds in the waste feed and the engineering details for equipment in the areas being evaluated.

Of special note, EPA initially evaluated Georgia Gulf's maximum allowable regulatory limits for the Nebraska Boiler (i.e., most metals being either Tier I or Adjusted Tier I Feed Rate Limits, total chromium being a Tier III Emission Rate Limit) and found that the limits for several metals would need to be supplemented with lower annual average limits (i.e., risk-based limits) in order for the *permit* to be protective of human health. EPA back-calculated risk-based annual average permit limits from the associated Tier I, Adjusted Tier I or Tier III limit for each metal of concern. For those metals not having regulatory maximum limits specified by the regulations (i.e., nickel and selenium), EPA calculated risk-based limits from the available risk burn data as appropriate (e.g., hexavalent form considerations for chromium). EPA then *used the calculated limits in the risk assessment* in order to show permit protectiveness over the long term for the NB unit. In addition, EPA has received a copy of the 3/20/2002 letter from Georgia Gulf to LDEQ, stating the intent to replace the Nebraska Boiler with a new unit. Since testing of this new unit will occur, risk-based permit limits can be reevaluated if the replacement unit results in a significant change of operations or emissions.

EPA also evaluated the data results from one particular run of the Recertification of Compliance conducted for the Nebraska Boiler in September 2002. This particular run was conducted in order to evaluate emissions that may occur during the facility's soot-blowing activities for the Nebraska Boiler. Soot-blowing activities are conducted as a routine maintenance operation for the removal of particulate matter from this unit. Considered a "process upset" condition, soot-blowing activities amount to only 4.2% of the unit's operational year (each soot-blowing event occurs four times daily for a duration of 15 minutes each time). Specifically, soot-blowing involves increasing both the stack velocity and corresponding stack flow rate. Data from the September 2002 testing event indicated that soot-blowing operations result in emission rate increases for several metals: Antimony, Barium, Chromium, Hexavalent Chromium, Lead and Nickel. Although there is also an expected increase in particulate matter emissions, analysis of this increase could not be conducted due to a lack of particle size data for soot-blowing activities for this unit (current or historical).

Increases in metal emission rates as noted above were evaluated for both short-term (acute) and long-term (chronic) potential health impacts. Since EPA-recommended risk-based permit limits address both acute and chronic potential impacts, the metal emission rate demonstrated during soot-blowing operations were compared directly with these recommended limits. The increased emission rates that occur during the soot-blowing activities do not exceed the EPA-recommended risk-based permit limits as represented in this report, and therefore, adverse impacts are not anticipated from soot-blowing activities as currently conducted.

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Nebraska Boiler Waste Feed Rates
(g/s)

Metals of Concern	Regulatory Tier Permit Limit Maximum Allowable	Recommended Risk-Based [1] Permit Limit Annual Average	"Normal Operations" Demonstrated via the Risk Burn [1] (3 Runs Evaluated)
Antimony (Tier I)	**1.14E-1**	**1.14E-2**	**ND [2] = 2.43E-4**
Arsenic (Adj. Tier I)	**2.06E-4**	**2.06E-4**	**ND [2] = 1.22E-4**
Barium (Tier I)	**1.90E+1**	**1.90E-1**	**ND [2] = 3.89E-4**
Beryllium (Adj. Tier I)	**8.06E-5**	**8.06E-5**	**ND [2] = 4.87E-5**
Cadmium (Adj. Tier I)	**8.06E-5**	**8.06E-5**	**ND [2] = 4.87E-5**
Chromium (Total) (Tier III)	**4.10E-3 [3]**	**8.20E-4 [3]**	**2.58E-2 [4]**
Lead (Tier I)	**3.83E-2**	**3.83E-2**	**ND [2] = 2.43E-4**
Mercury (Total) (Tier I)	**1.14E-1**	**9.73E-5 [5]**	**ND [2] = 9.73E-5**
Nickel	**N/A**	**8.76E-2**	**ND [2] = 8.76E-3**
Silver (Tier I)	**1.14E+0**	**1.14E-1**	**ND [2] = 4.87E-5**
Selenium	**N/A**	**1.46E-3**	**ND [2] = 1.46E-4**
Thallium (Tier I)	**1.14E-1**	**1.14E-3**	**ND [2] = 2.43E-4**

NOTES:

1. Recommended RCRA Permit Limits are based upon an average stack gas temperature of 498 K and average stack gas flow rate of 26.4 m^3/s; both of these parameters were demonstrated during the risk burn.
2. **ND** means that the metal was ***not detected*** in the waste feed; the detection limit was used to calculate the emission rate shown.
3. Recommended RCRA Permit Limit for Total Chromium is actually based upon the assumption that Hexavalent Chromium is equal to 100% of the Total Chromium measured during the risk burn.
4. Detection of Total Chromium exceeds Regulatory Tier Permit Limit as well as Recommended RCRA Permit Limit (Annual Average).
5. Mercury is not believed to be present in the waste feed, but the analytical method used in the risk burn did not provide low enough detection limits for comparison with the Recommended RCRA Permit Limit.

As the above comparison shows, Georgia Gulf demonstrated during the risk burn that feed rate limits during "normal operations" should fall below the recommended permit feed rate limits, with exception of Total Chromium (see Footnote 4, above, and proceeding discussion). *Therefore, EPA used the calculated (or "recommended risk-based") permit limits in the final risk assessment model–along with actual emissions data for all the other COPCs being evaluated–in order to show permit protectiveness over the long term*.

EPA did consider the potential emissions from the IF unit in the overall risk evaluation, following the same

back-calculation approach to generate risk-based limits as was applied to the NB unit. Permit limits and conditions for the IF unit were modeled and considered prior to recommending the protective limits for the NB unit. However, additional limits for the IF unit may also be appropriate once risk burn data from that unit are evaluated and accepted by the Louisiana Department of Environmental Quality.

Industrial Furnace Permit Limits
(g/s)

Metals of Concern	**1991 Incinerator Permit Limit [1]**	**Recommended Risk-Based Permit Limit Annual Average [2]**
Antimony	**3.02E-1**	**3.02E-3**
Arsenic	**2.27E-3**	**2.27E-3**
Barium	**5.04E-1**	**5.04E-3**
Beryllium	**4.16E-3**	**4.16E-4**
Cadmium	**5.54E-3**	**5.54E-4**
Chromium	**8.32E-4**	**4.16E-4**
Lead	**8.95E-2**	**8.95E-2**
Total Mercury	**3.03E-1**	**3.03E-7**
Silver	**3.02E+0**	**3.02E-2**
Thallium	**3.02E-1**	**3.02E-4**

NOTES:

1. Values taken from Georgia Gulf Corporation Final Permit, effective as of June 12, 1991. Treated as emission rates and evaluated in the risk model for the entire facility.
2. Recommended RCRA Permit Limits may be refined upon review and use of the December 2001 Trial Burn data. Current evaluation of the 1991 Permit Limits demonstrates risks associated with Antimony, Barium, Beryllium, Cadmium, Chromium (100% Hexavalent assumption), Total Mercury, Silver, and Thallium. Recommended Risk-Based Permit Limit (Annual Average) values were developed in order to provide protection to human health based upon facility source emissions (Nebraska Boiler, Industrial Furnace, and associated fugitive emissions).

EXPOSURE ASSESSMENT

Exact locations where people can potentially be exposed to contaminants in the air, surface water, or soil are determined by the grid spacing used in the air model and subsequently imported into the risk model. These specific locations can be used for assessing exposure for a particular type of receptor based upon the land use type being evaluated (i.e., farming or residential). Since plants or animals can also be exposed to contaminants at these coordinates points, possible uptake through the food chain can be assessed based upon the type of land use designated.

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The potential exposure scenarios evaluated in this risk assessment include both adult and child receptors for the following land use types: residential, limited agricultural, and fishing. In all cases, EPA used default values for receptor specific parameters, as outlined in the HHRAP. However, for dioxins and furans, EPA used updated bioaccumulation factors and toxicity equivalency values based upon the results of the External Peer Review of the HHRAP Guidance (External Peer Review Meeting, May 2000). Please see the Uncertainty Section of this risk assessment for a discussion of those parameters modified for specific dioxin/furan congeners. Current land use was considered in determining those receptors potentially impacted by identified emission sources, while potential future land use was assumed to be the same as current land use.

Study Area Characterization

Although the study area for air modeling purposes extends out approximately 10 kilometers from the Nebraska Boiler, the risk assessment evaluated possible exposure based upon potential receptors located closer to the facility where the ***reasonable maximum risks*** to various types of receptors might occur. Specifically, discrete land use areas where results of the air modeling indicated maximum air concentration or maximum deposition of COPCs might occur typically fell within a 3 kilometer radius from the Nebraska Boiler. EPA then evaluated multiple locations within each discrete land use area potentially impacted, in accordance with the HHRAP. This ensured that all possible receptors were evaluated for identifying reasonable maximum risks for each exposure scenario type.

Potentially impacted water bodies and their associated effective watershed areas were also evaluated as part of the risk assessment. EPA evaluated the following water bodies: Mississippi River, Bayou La Butte, and Crayfish Farms 1, 2. EPA evaluated fishing consumption based upon the potential for fishing to occur. Additionally, Plaquemine currently obtains its drinking water from deep wells rather than any surface water bodies within the study area. However, for the risk modeling effort, EPA specified the river adjacent to the facility as a potential future drinking water source. These assumptions may have been overly conservative for evaluation of current use, but did not require further evaluation since resulting risks for the drinking water pathway were well below EPA levels of concern.

EPA conducted a site visit to verify information shown on digitized land use land cover maps, topographic maps, and aerial photographs. EPA utilized the internet to locate and verify local schools and daycare facilities on the topographic maps. EPA also requested and obtained input from LDEQ and facility representatives on actual land use designations used. **Appendix C** contains the topographic, land use, and watershed maps which show the specific areas evaluated as part of the study area–as well as those effective watershed areas specific to this risk assessment.

Exposure Scenario Locations

The exposure scenario locations in this risk assessment were chosen to be representative of potential maximally exposed individuals, or receptors, within each representative land use type. EPA also evaluated receptors where actual land use dictated consideration of *special sub-populations*, as defined in the HHRAP. Infant potential exposure to dioxins and furans via the ingestion of their mother's breast milk is evaluated at corresponding adult scenario locations (i.e., locations where the mother may live). Receptor locations for a child's potential exposure to lead in soil and air are the same as the various child scenario locations.

Selection of agriculture scenario locations required special consideration. The predominant form of agriculture for the area being evaluated is sugar cane farming (confirmed by the LSU Agriculture Center and

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EPA/LDEQ site reconnaissance). Since sugar cane is processed prior to consumption, and actual exposures would be more in line with commercial farming, the default farmer scenario would not be representative for these areas. Therefore, EPA modified the default scenario for all sugar cane areas by setting the food ingestion pathways equal to zero. Since farmer receptors typically raise products for consumption (e.g., produce, livestock, etc.), it is unrealistic to evaluate all of these pathways for those sugar cane areas surrounding the facility. However, EPA believes that evaluation of beef ingestion is necessary for an agricultural scenario pertaining to Georgia Gulf. During an EPA tour of nearby facilities, grazing cattle were seen in fenced stretches along the levee of the Mississippi River, and LDEQ personnel acknowledges the presence of cattle as common in these areas. Therefore, EPA modified the default scenario for this particular agricultural area by setting all ingestion pathways equal to zero except for ingestion of beef. Fisher receptors were placed at residential scenario locations near each water body evaluated. All exposure scenario locations are shown on those topographic maps provided in **Appendix C**, and are also provided via a coordinate list exported from the risk model project file in **Appendix D**.

Transport and Fate Parameters

EPA used transport and fate equations presented in the HHRAP to determine air, soil, and surface water COPC-specific concentrations. Those equations which determine uptake of specific COPCs in the food chain (i.e., COPC concentrations in fish, pork, milk, eggs, etc.) allow the use of parameters derived as either default values, also provided in the HHRAP, or facility/site-specific values, as available and appropriate. Site-specific transport and fate parameters utilized for the Georgia Gulf facility include universal soil loss constants, delineation of water body and effective watershed areas potentially impacted by facility sources, water body depth, and average annual total suspended solids concentration.

Of special note is EPA's decision to use 40 years for the time of COPCs deposition (i.e., facility operational time), rather than the 100 years recommended by the HHRAP. EPA Region 6 considerations in using 40 years as opposed to 100 years include the following: 1) the longest receptor exposure duration is 40 years; and 2) RCRA permit renewals are required every 10 years so risks can be reevaluated at any time utilizing the most current transport and fate information available at that time.

Site-specific transport and fate parameters are provided in the spreadsheet provided in **Appendix B**. COPC-specific chemical and physical parameters are not provided in this risk assessment report since they can be found in Appendix A of the HHRAP and also in EPA's July 1999 Errata to the HHRAP. The IRAP-h View Version 1.7 utilizes all updated information found in EPA's Errata to the HHRAP.

RISK CHARACTERIZATION

In this risk assessment, EPA evaluated chronic excess risk estimates for both ***direct exposure pathways***, or those pathways where contact may occur with a contaminated media (i.e, inhalation, incidental soil ingestion, and ingestion of drinking water), and also ***indirect pathways*** (i.e., those risks associated with uptake through the food chain). EPA also evaluated the potential for non-carcinogenic health effects to occur by calculation of hazard indices (HIs) for the various COPCs identified at the Georgia Gulf facility. In addition, EPA assessed the following: 1) potential acute effects (i.e., risks associated with short-term emissions) from inhalation; 2) potential impacts from possible accumulation of dioxin and furan compounds in breastmilk; and 3) potential adverse impacts for small children (i.e., children under 6 years old) who are susceptible to lead exposure in surface soils and ambient air.

For those chemicals detected in stack gas emissions or quantified as fugitive source emissions at the Georgia

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Gulf facility, EPA found that RCRA operations should not pose adverse impacts for any of the receptors evaluated, with the exception of chromium (see risk-based limit recommendation). For those chemicals not actually detected in stack gas emissions or not detected in the waste feed analysis, please see the Uncertainty Section of this report. EPA used target action levels identified in the **Region 6 Risk Management Addendum -** ***Draft Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*** (EPA-R6-98-002, July 1998) to evaluate resulting risk estimates.

Excess Cancer Risks

For those COPCs detected in stack gas emissions or quantified as fugitive source emissions at the Georgia Gulf facility, chronic excess cancer risk estimates attributed to both ***direct exposure pathways*** and ***indirect exposure pathways*** are well below EPA's 1×10^{-5} level of concern for all receptors evaluated if recommended risk-based permit limits are incorporated into the RCRA permit. This means that there is less than once chance in one hundred thousand of a person getting cancer from possible exposure to RCRA combustion emissions associated with the Georgia Gulf facility.

Excess cancer risk estimates for each receptor, delineated by source and specific COPC, are provided via a summary table exported from the risk model project file, "copc_risk" in **Appendix D**. In addition, excess cancer risk estimates for each receptor, delineated by pathway, are provided in a summary table exported from the risk model project file, "pathway" in **Appendix D**. The next to last column of each table contains the excess cancer risk estimates.

Non-Carcinogenic Health Effects

For those COPCs detected in stack gas emissions or quantified as fugitive source emissions, the HIs associated with both direct and indirect pathways are all well below EPA's 0.25 level of concern for all receptors evaluated. This means that a person's health should not be adversely affected by possible exposure to RCRA combustion emissions at the Georgia Gulf facility.

The HI estimates for each receptor, delineated by source and specific COPC, are provided via a summary table exported from the risk model project file, "copc_risk" in **Appendix D**. In addition, HI estimates for each receptor, delineated by pathway, are provided in a summary table exported from the risk model project file, "pathway" in **Appendix D**. The last column of each table contains the HI estimates.

Other Risks

Acute Hazard Quotients are all less than 1.0 for those receptors evaluated. This means that a person's health should not be adversely affected from direct inhalation of the maximum 1-hour concentration of vapors and/or particulates associated with RCRA combustion emissions at the Georgia Gulf facility. An acute adverse health effect is defined here as a concentration intended to protect the general public from discomfort or mild adverse health effects over 1 hour of possible exposure. See the summary table exported from the risk model project file, "acute" in **Appendix D**.

For dioxin-like compounds, calculations show that projected possible intakes for babies who are breastfed are all well below the average infant intake target level of 60 pg/kg-day of 2,3,7,8-TCDD Equivalents. See the summary table exported from the risk model project file, "b-milk" in **Appendix D**. More detailed information relating to dioxins and potential exposure and risk characterization for dioxins can be found at the EPA website http://www.epa.gov/nceawww1/dioxin.htm (contains documents generated as part of the Dioxin Reassessment Initiative).

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For lead, calculations show that projected possible concentrations in surface soils and ambient air should not exceed EPA target levels of 100 mg/kg and 0.2 $\mu g/m^3$, respectively. This means that concentrations of lead predicted to occur in soils and ambient air from RCRA combustion emissions at the Georgia Gulf facility are at levels which should not adversely impact the health of children under the age of 6 years old (i.e., those children who are susceptible to health impacts from lead exposure). See the summary table exported from the risk model project file, "lead" in **Appendix D**.

UNCERTAINTY DISCUSSION

Uncertainty is inherent in any risk assessment process, and in the case of combustion risk assessments, can become complex in consideration of the necessary integration of various data, process parameters, and modeling efforts undertaken. Uncertainties and limitations of the risk assessment process are discussed in general in Chapter 8 of the HHRAP and in more detail in each separate chapter of the HHRAP. Therefore, this risk assessment will not reiterate that lengthy discussion, but will complement it by addressing specific key areas of interest which were identified during EPA's evaluation of resulting risk estimates at the Georgia Gulf facility. Some, if not all, of these areas of interest have been identified by other EPA regions and/or State partners conducting risk assessments at similar combustion facilities across the country.

Modified Parameters for Dioxins/Furans

Please see the "Modified Parameters" file in **Appendix D** for an all-inclusive parameter list of chemical-specific values used in this human health risk assessment (i.e., a side-by-side comparison of the modified value versus the original default value for each COPC-specific parameter). For the Georgia Gulf facility, the only compounds where chemical-specific values were modified include individual dioxin/furan congeners. Modifications are based upon input from the External Peer Review of EPA's HHRAP and Errata (External Peer Review Meeting, May 2000).

In determining the bioaccumulation factors for chickens ($Ba_{chicken}$) and eggs (Ba_{egg}), as published in the July 1999 Errata to the HHRAP, EPA assumed that the bioconcentration factors (BCFs) presented in the 1995 Stephens, Petreas, and Hayward paper were calculated as the ratio of the dioxin/furan concentration in tissue to the concentration in soil. However, the BCFs were actually calculated as the ratio of dioxin/furan concentration in tissue to the concentration in feed. Therefore, since the soil/feed mixture fed to the chickens was one part soil and nine parts feed (1:9), the bioaccumulation factors presented in the Errata would appear to be ten-fold too high. Therefore, EPA reduced the $Ba_{chicken}$ and BA_{egg} values provided in the Errata by a factor of 10 for those congeners evaluated ("Biotransfer and Bioaccumulation of Dioxins and Furans from Soil: Chickens as a Model for Foraging Animals"; Stephens, Petreas, and Hayward, 1995).

Additionally, since publication of the July 1999 Errata to the HHRAP, EPA's Office of Solid Waste has recommended use of the 1997 World Health Organization (WHO, 1997) Toxicity Equivalency Factors (TEFs) for dioxin/furan congeners. Therefore, EPA Region 6 changed appropriately those three congeners where TEFs specified in the HHRAP were different than the WHO values recommended for human health risk assessments (i.e., 1997 WHO TEFs for fish, mammals, and birds).

Bio-Transfer Factors

In completing the evaluation of risk estimates for the Georgia Gulf facility, EPA has noted that biotransfer factors are primarily responsible for artificially high risk estimates for certain compounds. Specifically, two polycyclic aromatic compounds (PAHs) were identified for further evaluation when resulting risk estimates

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seemed disproportionate for the low level emission rates (i.e., rates based upon non-detected levels) used in the Georgia Gulf risk assessment:

indeno(1,2,3-cd)pyrene and dibenz(a,h)anthracene

The farmer scenario uses beef and milk biotransfer factors based upon the *n*-octanol/water partition coefficient (Kow), as specified in the HHRAP. However, the HHRAP also provides discussion about the possibility of decreasing (rather than increasing) biotransfer values with increasing Kow values. The two PAH compounds in question fall within the range cited (log Kow between 6.5 and 8.0). The HHRAP suggests that this trend may be due to a greater rate of metabolism of higher Kow compounds (HHRAP, Volume 2, Appendix A pages A-3-25 thru A-3-26). In addition, other literature sources (Gorelova and Cherepanova, 1970; Gorelova et al., 1970) acknowledge that PAHs with large Kow values are readily metabolized by the mixed function oxidase metabolic pathway in mammals to water-soluble substances, which are then excreted. Therefore, the resulting risk estimates for these two PAHs may be biased high. In other words, EPA believes that the potential risk from exposure to these two compounds is not of concern since these two PAHs tend not to bioaccumulate in animal or human tissue, but rather to be metabolized and excreted.

Use of Non-Detected Compounds

Compounds which were quantified as not present at or above a laboratory specified reporting limit but could possibly be formed as products of incomplete combustion, were used in calculation of risk estimates. For example, PAHs are semi-volatile compounds typically associated with combustion sources. Therefore, EPA retained and considered these compounds in the risk assessment in accordance with the HHRAP even though they were not detected in any of the analyses conducted.

Additionally, EPA followed the HHRAP in determining the appropriate detection limits to use in estimating emission rates for non-detected compounds. However, since the HHRAP does not address the appropriate detection limit for waste feed samples, EPA used Sample Quantitation Limits (SQLs) to calculate emission rates for non-detected compounds, as reported by the laboratory. Conceptually, SQLs are the most appropriate detection limit to use for waste matrices where compounds are suspected to be present but interferences may occur to obscure the detection of certain compounds as presented in EPA's **Guidance for Data Useability in Risk Assessment** (Publication 9285.7-090A; April 1992).

Compounds Dropped from Quantitative Analysis

Of those compounds dropped from the risk analysis due to a lack of toxicity or transport and fate information, only the following chemicals were actually detected in the emissions data:

Phenanthrene, n-propylbenzene, 1,2,4-trimethylbenzene, sec-butylbenzene, p-Cymene, n-butylbenzene.

All of these compounds are volatile organic compounds which were detected only in a portion of the train for certain runs and only at extremely low values. Since these compounds do not have toxicity data and/or transport and fate information, they can not be quantitatively evaluated in the risk assessment. However, EPA did examine the data for each of these chemicals in relation to their corresponding Region 6 "Risk-Based Screening Level" benchmark values as available for Ambient Air, Residential Scenario (please see EPA's website http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm for more information on the benchmark values). All of the detected values were well below the corresponding screening level values,

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which would indicate that further evaluation of risk is unnecessary based upon the low levels emitted.

Unidentified Organic Compounds

Georgia Gulf conducted Total Organic Emissions (TOE) testing in accordance with the HHRAP. Permitting authorities need this information to address concerns about the unknown fraction of organic emissions from combustion units. Using the TOE test results, and the speciated data from the Risk Burn, EPA calculated a TOE factor which falls at the low end of the range anticipated in the HHRAP (2 -40). Based upon these results, and the process information available for the Georgia Gulf facility, EPA believes that unidentified organic compounds do not contribute significantly to those risk estimates calculated in this risk assessment.

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CONCLUSION & RECOMMENDATIONS

EPA's risk assessment shows that the appropriate regulatory maximum permit limits (Tier 1 Feed Rate Limits) for the Georgia Gulf hazardous waste combustion units should be supplemented with lower annual average limits (risk-based limits) for several metals in order for *the permit* to be protective of human health. Therefore, EPA recommends that LDEQ incorporate the annual average metal feed rate limits listed in the following tables into the RCRA permit.

Nebraska Boiler Waste Feed Rates
(g/s)

Metals of Concern	Regulatory Tier Permit Limit Maximum Allowable	Recommended Risk-Based [1] Permit Limit Annual Average	"Normal Operations" Demonstrated via the Risk Burn [1] (3 Runs Evaluated)
Antimony (Tier I)	**1.14E-1**	**1.14E-2**	**ND [2] = 2.43E-4**
Arsenic (Adj. Tier I)	**2.06E-4**	**2.06E-4**	**ND [2] = 1.22E-4**
Barium (Tier I)	**1.90E+1**	**1.90E-1**	**ND [2] = 3.89E-4**
Beryllium (Adj. Tier I)	**8.06E-5**	**8.06E-5**	**ND [2] = 4.87E-5**
Cadmium (Adj. Tier I)	**8.06E-5**	**8.06E-5**	**ND [2] = 4.87E-5**
Chromium, Total (Tier III)	**4.10E-3 [3]**	**8.20E-4 [3]**	**2.58E-2 [4]**
Lead (Tier I)	**3.83E-2**	**3.83E-2**	**ND [2] = 2.43E-4**
Mercury, Total (Tier I)	**1.14E-1**	**ND @ 9.73E-5 [5]**	**ND [2] = 9.73E-5**
Nickel	**N/A**	**8.76E-2**	**ND [2] = 8.76E-3**
Silver (Tier I)	**1.14E+0**	**1.14E-1**	**ND [2] = 4.87E-5**
Selenium	**N/A**	**1.46E-3**	**ND [2] = 1.46E-4**
Thallium (Tier I)	**1.14E-1**	**1.14E-3**	**ND [2] = 2.43E-4**

NOTES:

1. Recommended RCRA Permit Limits are based upon the average stack gas temperature of 498 K and an average stack gas flow rate of 26.4 m^3/s; both of these parameters were demonstrated during the risk burn.
2. **ND** means that the metal was ***not detected*** in the waste feed; the detection limit was used to calculate the emission rate shown.
3. Recommended RCRA Permit Limit for Total Chromium is actually based upon the assumption that Hexavalent Chromium is equal to 100% of the Total Chromium measured during the risk burn.
4. Detection of Total Chromium exceeds Regulatory Tier Permit Limit as well as Recommended RCRA Permit Limit (Annual Average).
5. Mercury is not believed to be present in the waste feed, but the analytical method used in the risk burn did not provide low enough detection limits for comparison with the Recommended RCRA Permit Limit.

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As the above comparison shows, Georgia Gulf demonstrated during the risk burn that feed rate limits during "normal operations" of the Nebraska Boiler should fall below the recommended permit feed rate limits, with exception of Total Chromium (see Footnote 4, above, and proceeding discussion). *Therefore, EPA used the calculated (or "recommended risk-based") permit limits in the final risk assessment model–along with actual emissions data for all the other COPCs being evaluated–in order to show permit protectiveness over the long term.*

The 1991 incinerator permit limits for the Industrial Furnace exceed risk levels, and reduction of these numbers for several metals (Antimony, Barium, Beryllium, Cadmium, Total Chromium, Total Mercury, Silver, and Thallium) was required to determine protective risk-based permit limits. These calculated limits were combined with the Nebraska Boiler limits in the final risk assessment model to show facility-wide permit protectiveness over the long term. Recommended RCRA Permit Limits will be developed upon review and use of December 2001 Trial Burn data.

Industrial Furnace Permit Limits
(g/s)

Metals of Concern	**1991 Incinerator Permit Limit [1]**	**Recommended Risk-Based Permit Limit Annual Average [2]**
Antimony	**3.02E-1**	**3.02E-3**
Arsenic	**2.27E-3**	**2.27E-3**
Barium	**5.04E-1**	**5.04E-3**
Beryllium	**4.16E-3**	**4.16E-4**
Cadmium	**5.54E-3**	**5.54E-4**
Chromium	**8.32E-4**	**4.16E-4**
Lead	**8.95E-2**	**8.95E-2**
Total Mercury	**3.03E-1**	**3.03E-7**
Silver	**3.02E+0**	**3.02E-2**
Thallium	**3.02E-1**	**3.02E-4**

NOTES:

1. Values taken from Georgia Gulf Corporation Final Permit, effective as of June 12, 1991. Treated as emission rates and evaluated in the risk model for the entire facility.
2. Recommended RCRA Permit Limits will be developed upon review and use of December 2001 Trial Burn data. Current evaluation of 1991 Permit Limits demonstrates risks associated with Antimony, Barium, Beryllium, Cadmium, Chromium (100% Hexavalent assumption), Total Mercury, Silver, and Thallium. Recommended Risk-Based Permit Limit (Annual Average) values were developed in order to provide protection to human health based upon facility source emissions (Nebraska Boiler, Industrial Furnace, and associated fugitive emissions).

EPA evaluated the most current information available to estimate potential impacts to human health, both directly via inhalation, incidental soil ingestion, and ingestion of drinking water (via surface water intakes),

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and indirectly via modeled deposition and uptake through the food chain. Emissions data collected as part of the risk burn, operational data specific to the Georgia Gulf facility, and site-specific information based upon the facility's location, were evaluated and considered in making assumptions and in predicting risks associated with long term operations. The risk estimates provided in this risk assessment are conservative in nature and represent possible future risks, based upon those operating conditions evaluated for issuance of a final RCRA combustion permit. If operations change significantly, or land use changes occur which would result in more frequent potential exposure to receptors, risks from facility operations may need to be reevaluated.

EPA did consider the potential emissions from the IF unit in the overall risk evaluation. Permit limits and conditions for the IF unit were modeled and considered prior to recommending the protective limits for the NB unit. However, additional limits for the IF unit may also be appropriate once data from that unit are evaluated and accepted by the associated regulatory agencies. In addition, EPA has received a copy of the 3/20/2002 letter from Georgia Gulf to LDEQ, stating the intent to replace the Nebraska Boiler with a new unit. Since testing of this new unit will occur, risk-based permit limits can be reevaluated if the replacement unit results in different operating parameters and/or increased emissions.

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REFERENCES

1. **Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Peer Review Draft** (EPA530-D-98-001 A, B, and C; July 1998); **Errata to the HHRAP** (EPA, July 1999).

2. **Guidance on Collection of Emissions Data to Support Site-Specific Risk Assessments at Hazardous Waste Combustion Facilities, Peer Review Draft** (EPA530-D-98-002; August 1998).

3. **Risk Burn Report for Georgia Gulf Corporation, Plaquemine Complex** (December 1997).

4. **"Fugitive Emissions Data for Georgia Gulf's Nebraska Boiler"** memo from Georgia Gulf (August 1998).

5. **"Notification of Intent to Amend Hazardous Waste Permit Application"** letter from Georgia Gulf (March 2002).

6. **Nebraska Boiler Metals Burn Report, Georgia Gulf Chemicals & Vinyls LLC. Plaquemine, LA Facility - Revision 0** (September 2002).

7. **Louisiana Chemical Association (LCA)** *Letter Report on Upset Factors* (October 27, 1999).

8. **Recertification Of Compliance** for the Georgia Gulf facility (1999).

9. **Final Incinerator Permit LAD057117434** Georgia Gulf Incorporated, effective 6/12/91.

10. ***External Peer Review Meeting, HHRAP and Errata***. (TechLaw, Inc.; Dallas, Texas; May 2000).

11. **Region 6 Risk Management Addendum - *Draft Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*** (EPA-R6-98-002, July 1998).

12. **Biotransfer and Bioaccumulation of Dioxins and Furans from Soil: Chickens as a Model for Foraging Animals** (Stephens, Petreas, and Hayward, 1995).

13. **World Health Organization (WHO)** *Meeting on the Derivation of Toxicity Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs, and other Dioxin-like Compounds for Human Health & Wildlife, June 15 - 18, 1997.* Institute of Environmental Medicene, Karolinska Institute, Stockholm, Sweden. Draft Report dated July 30, 1997.

14. **Federal Register, 40 CFR Parts 148, 261, 266, etc. Hazardous Waste Management System; Identification and Listing of Hazardous Waste; et al.; Final Rule and Proposed Rule; Thursday, August 6, 1998** (Bioavailability and Bioaccumulation, pages 42148 - 42149).

15. **Waste Technologies Industries Screening Human Health Risk Assessment (SHHRA): Evaluation of Potential Risk from Exposure to Routine Operating Emissions** (EPA, Volume V. External Review Draft. EPA Region 5, Chicago, Illinois; 1995).

16. **EPA Region 6 Human Health Medium Specific Screening Levels** (EPA November 2000)

17. **Guidance for Data Useability in Risk Assessment (Part A) Final** (EPA 9285.7-09A, April 1992).

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18. **On the Possibility of Accumulation of 3,4-Benzopyrene in Tissues and Organs of Cows and Calves, As Well as in Milk in Case of Presence of This Carcinogen in Fodder** (Gorelova and Cherepanova; The N. N. Petrov Research Institute of Oncology of the USSR Ministry of Public Health, Leningrad; 1970).

19. **Correlation Between The Content of Polycyclic Carcinogens in Animal Food Products and In Fodder for Farm Animals** (Gorelova, Dikun, Dmitrochenko, Krasnitskaya, Cherepanova, and Shendrikova; The N. N. Petrov Research Institute of Oncology of the USSR Ministry of Public Health, Leningrad; 1970).

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