June 12, 2025

Attn: Maggie Corbin
Puget Sound Clean Air Agency
1904 Third Ave, Suite 105
Seattle, Washington 98101

Subject: Notice of Construction (NOC) Application for the North Boeing Field / Plant 2 Site to Install Four (4) New Natural Gas-Fired Boilers

To Ms. Maggie Corbin:

The Boeing Company (Boeing) is pleased to submit the enclosed Notice of Construction (NOC) permit application to the Puget Sound Clean Air Agency. In the application, Boeing proposes to construct two (2) 30,000 pounds per hour (lb/hr) capacity natural gas-fired boilers with an input capacity of 36.5 million British thermal units per hour (MMBtu/hr) each and two (2) 80,000 lb/hr capacity natural gas-fired boilers with an input capacity of 96.9 MMBtu/hr each. All four boilers use ultra-low sulfur diesel as backup fuel.

The North Boeing Field/Plant 2 Site (Site) located in Seattle, Washington, operates under Puget Sound Clean Air Agency Permit 21147. Among the existing Site equipment are natural gas-fired boilers in Buildings 2-15 and 3-374. As a result of the project associated with this NOC application, the boilers in Building 3-374 will be removed and the building will be left as a shell. Boeing proposes to build a new boiler house building (Building 3-150) and install four (4) new boilers that will provide steam and comfort heating to the Site.

This NOC application covers the permitting of the four (4) new boilers and not the status adjustment of the boilers associated with Building 3-374.

Please feel free to contact me at (206) 303-7534 if you have questions or require additional information.

Sincerely,

Grant Peltier

Grant Peltier
Air Quality Engineer
The Boeing Company

(206) 303-7534
grant.r.peltier@boeing.com

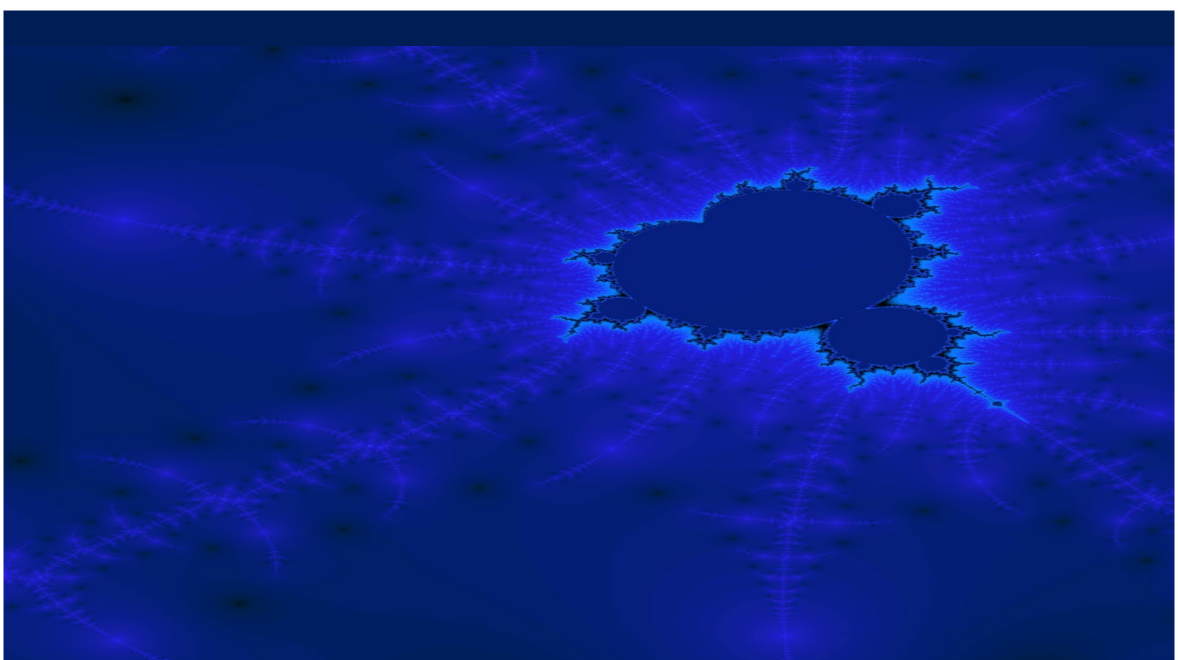
Notice of Construction Application for North Boeing Field/Plant 2 Site, Seattle, Washington

Version: Final

North Boeing Field/Plant 2 Site Boilers NOC
The Boeing Company

Document No: 250212085924_64af64c5

June 2025



Notice of Construction Application for North Boeing Field/Plant 2 Site, Seattle, Washington

Client Name:	The Boeing Company		
Project Name:	North Boeing Field/Plant 2 Site Boilers NOC		
Project No:	BONBFB24		
Document No:	250212085924_64af64c5	Project Manager:	Michelle Neumann/Jacobs
Version:	Final	Prepared By:	Jacobs Team
Date:	June 2025		

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Acronyms and Abbreviations

$\mu g/m^3$	microgram(s) per cubic meter
ASIL	acceptable source impact level
BACT	Best Available Control Technology
CAS	Chemical Abstracts Service
CFR	*Code of Federal Regulations*
CO	carbon monoxide
CO_2e	carbon dioxide equivalent
Ecology	Washington State Department of Ecology
GHG	greenhouse gas
HAP	hazardous air pollutant
lb/hr	pound(s) per hour
MMBtu	million British thermal units per hour
NO_2	nitrogen dioxide
NOC	Notice of Construction
NO_x	nitrogen oxide
NSPS	New Source Performance Standard
O_2	oxygen
PM	particulate matter
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
ppmv	parts per million by volume
PSCAA	Puget Sound Clean Air Agency
PTE	Potential to Emit
Site	Boeing Company North Boeing Field/Plant 2
SO_2	sulfur dioxide
SQER	small quantity emission rate
TAP	toxic air pollutant
tpy	ton(s) per year

ULSD	ultra-low sulfur diesel
VOC	volatile organic compound
WAC	Washington Administrative Code

1. Introduction

The Boeing Company North Boeing Field/Plant 2 site (Site) is an aircraft manufacturing and assembling facility located in Seattle, Washington, and operating under Puget Sound Clean Air Agency (PSCAA) Permit 21147. This project proposes to build a new boiler house building (Building 3-150) and install four new boilers providing steam and hot water to the Site.

Boeing has engaged Jacobs to prepare this Notice of Construction/Order of Approval (NOC) application. The purpose of the application is to obtain a NOC approval for four boilers with less than 100 million British thermal units per hour (MMBtu) of heat input. Required PSCAA forms and information for this application can be found within this text and the appendices. The proposed natural gas-fired boilers (with ultra-low sulfur diesel [ULSD] fuel as backup) will result in emissions of volatile organic compounds (VOCs), particulate matter (PM), particulate matter with an aerodynamic diameter of 10 microns or less (PM_{10}), particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$), hazardous air pollutants (HAPs), toxic air pollutants (TAPs), nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), and greenhouse gases. Application Appendix A-1 contains a process flow diagram. Application Appendix A-2 contains detailed emission estimates.

The Site is in King County, which is currently in attainment for all criteria pollutants. The Site is operating as major source for VOCs emitting greater than 100 tons per year (tpy) and for HAPs emitting more than 10 tpy of an individual HAP. To support the NOC application, the following documentation is included:

- Project description (Section 1.1)
- Emission estimates reflecting the maximum potential emission rates (Section 3, Appendix A-2)
- Additional information in support of the claims represented in this application, including maps and the required PSCAA forms and information

1.1 Project Description

Among its equipment, the facility includes a central plant heating water distribution system with boilers and other heating equipment used to provide steam, comfort heating, and hot water to the Site. The boilers on site are located in Buildings 2-15 and 3-374. As a result of this project, the existing boilers in Building 3-374 will be removed.

With this NOC application, Boeing proposes to install four (4) new boilers in Building 3-150 that will provide steam and comfort heating to the Site. The proposed boilers are:

- Two Cleaver Brooks boilers each with 30,000 pounds per hour (lb/hr) capacity at an approximate 36.5 MMBtu/hr heat input.
- Two Cleaver Brooks boilers each with 80,000 lb/hr capacity at an approximate 96.9 MMBtu/hr heat input.

The proposed boilers are natural gas-fired with ULSD used as a backup fuel during time periods of curtailment or emergencies while natural gas is not available. Based on the Manufacturer's Performance Guarantees for both the 30,000 lb/hr boiler and the 80,000 lb/hr boiler, the natural gas nitrogen oxide (NO_x) emissions for the burner (from 25 percent to 100 percent Maximum Continuous Rating) are 0.011 lb/MMBtu, corrected to 3 percent oxygen (O_2) on a dry basis. Similarly, the natural gas CO emissions are 0.036 lb/MMBtu, also corrected to 3 percent O_2 on a dry basis. Appendices B and C contain the manufacturer's emission guarantees for NO_x and CO.

1.2 Project Location

Figure 1-1 shows the industrial area where the North Boeing Field Site is located.

Figure 1-1. North Boeing Field Site Location

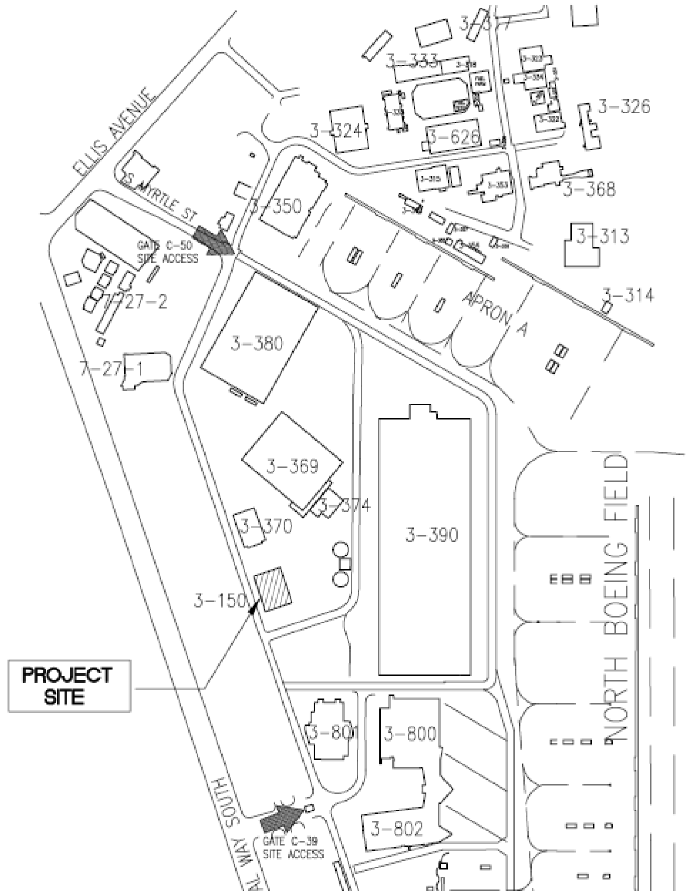
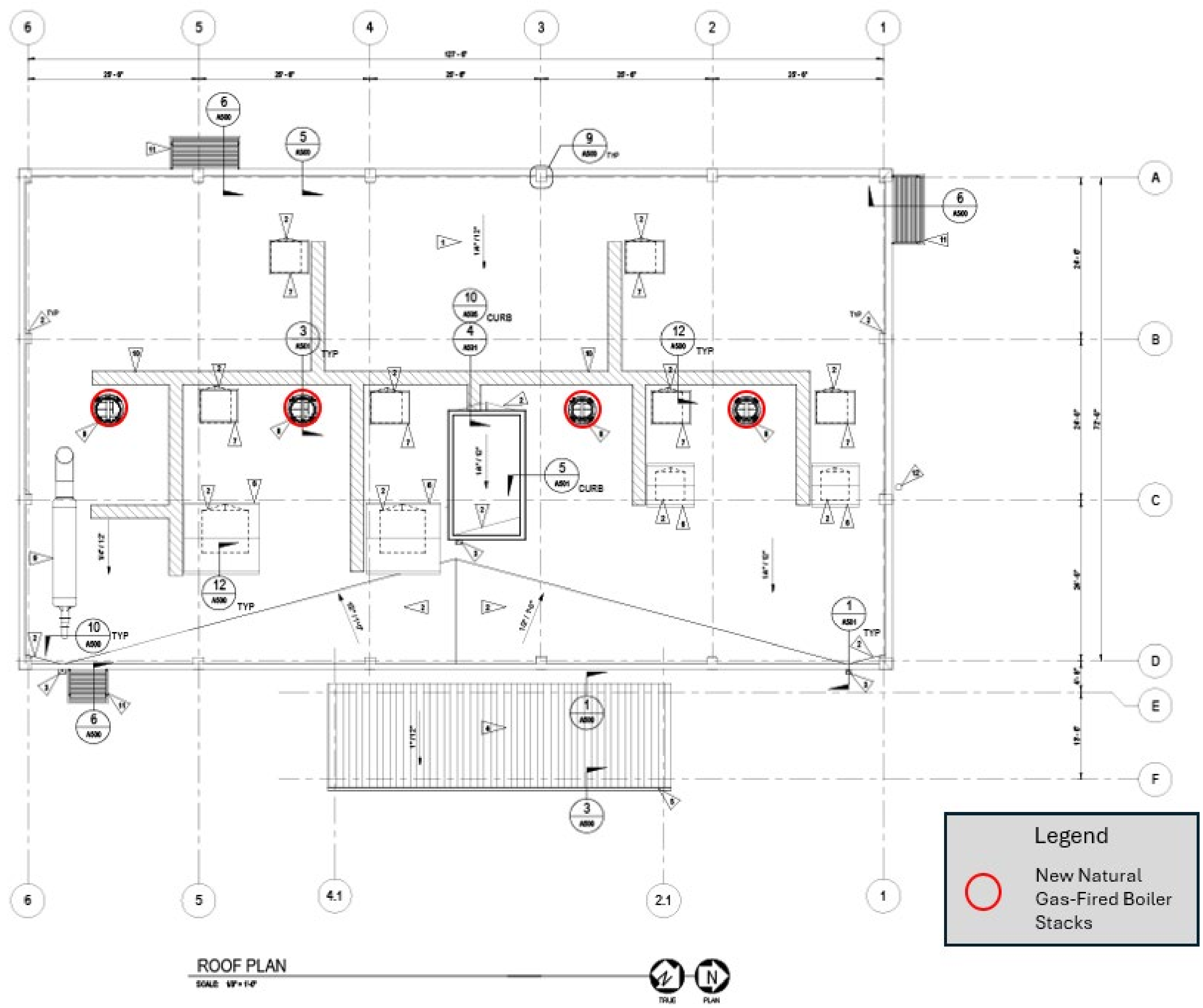


Figure 1-2 shows the site plan of the boilers to be located in Building 3-150.

Figure 1-2. Site Plan for Building 3-150



2. Boiler-specific Regulations

The following regulations are applicable to the project boilers:

- **Puget Sound Clean Air Agency Regulation I, Article 6, New Source Review**

  PSCAA Regulation I, Article 6, New Source Review adopts much of the Washington Administrative Code (WAC) 173-400 that relates to new source review. Specifically, PSCAA Regulation I, Article 6 requires that new or modified emission sources where emissions would increase as a result of a project, such as the new boilers, be reviewed and approved before modification. That review and approval includes the application of the Best Available Control Technology (BACT) for criteria pollutants such as particulate and for TAPs.

- **Puget Sound Clean Air Agency Regulation I, Article 7.09 (b), General Reporting Requirements for Operating Permits; Operation and Maintenance Plan**

  PSCAA Regulation I, Article 7.09(b), Operation and Maintenance Plan describes the requirements to develop and implement an operation and maintenance plan to assure continuous compliance with PSCAA Regulations I, II, and III. In the regulation describes that the plan is to reflect good industrial practice but does not define good industrial practice.

- **40 *Code of Federal Regulations* (CFR) Part 60 Subparts A (General Provisions) and Dc (Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units)**

  40 CFR Part 60 subparts A and Dc apply to this permit application as the four boilers are above 10 MMBtu/hr and below 100 MMBtu/hr. This regulation outlines emission standards for SO_2 and PM as well as additional requirements.

- **40 CFR Part 63 Subpart DDDDD (National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters)**

  40 CFR Part 63 subpart DDDDD applies to this permit application as the four boilers are part of a major source of HAP. This regulation outlines emission limits and work practice standards as well as additional requirements.

Appendix D contains the New Source Performance Standard (NSPS) applicability review.

3. State Environmental Policy Act Checklist

The proposed project involves the construction of a new boiler house building and the installation of two new 30,000 lb/hr boilers and two new 80,000 lb/hr boilers to provide steam and comfort heating to the site. Although not included as part of this project, the boilers in Building 3-374 will be removed and the building will be left as a shell. A State Environmental Policy Act checklist has been included in Appendix A. The PSCAA Environmental Checklist was filled out as a previous checklist or assessment has not been completed for another agency for the proposed project.

4. Emission Estimates and Ambient Analysis

Boeing has prepared Potential to Emit (PTE) emissions for four (4) new dual-fuel boilers. Appendix A-2 contains detailed emissions calculations and assumptions for the PTEs. The boilers will use ULSD as a backup fuel during time periods of curtailment or emergencies while natural gas is not available. A total of 48 hours per year of ULSD consumption is included in the PTE for maintenance and testing operations. Maintenance and testing operations for ULSD will take no more than 8 hours in a 24-hour period.

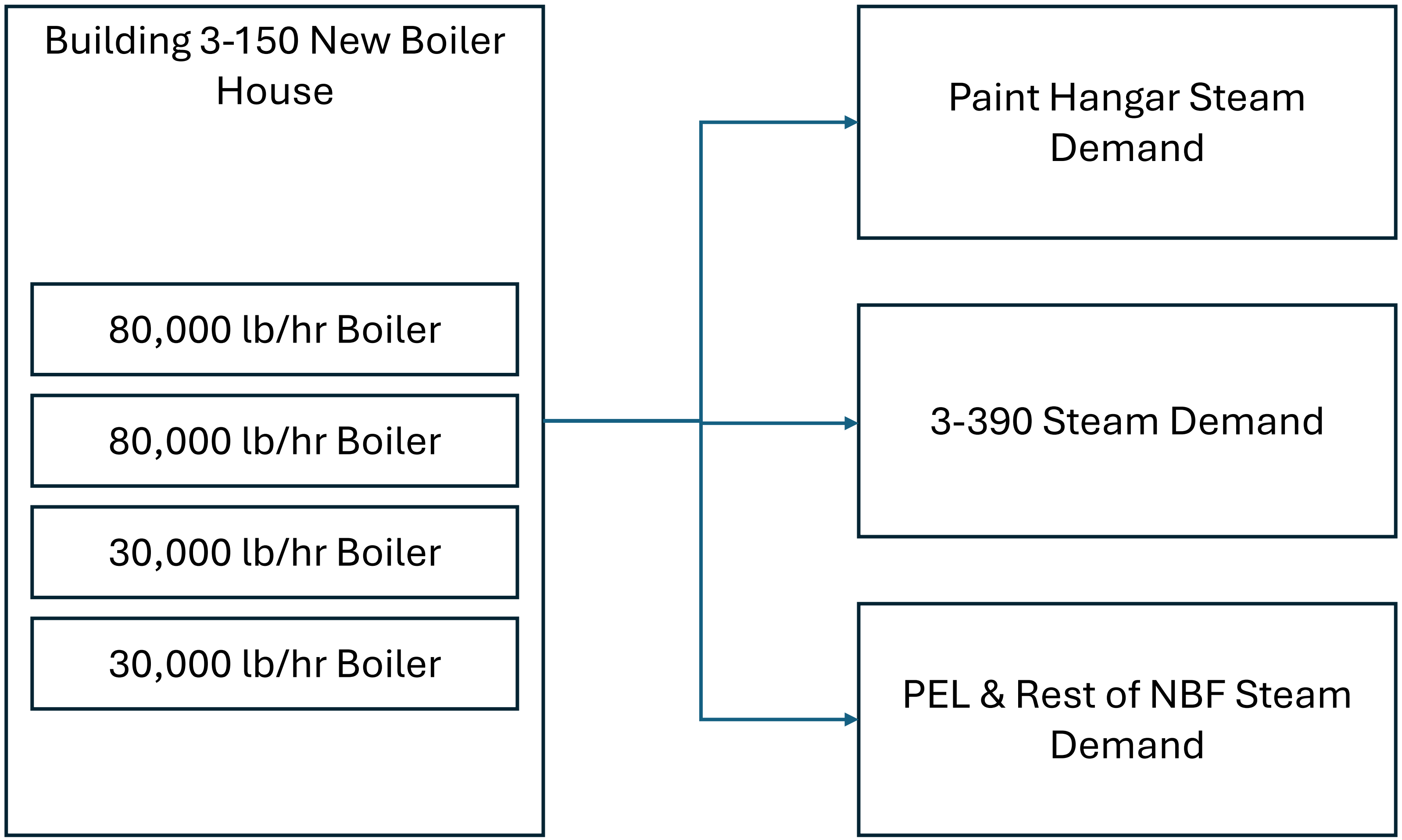
The NO_x and CO emission factors for the new boilers of both natural gas and ULSD were from Manufacturer's Specifications and typical emissions data. The PM_{10}, $PM_{2.5}$, and SO_2 emission factors for natural gas were from AP-42 Chapter 1.4, Table 1.4-2.[1] The manufacturer's typical emission data emission factor for the natural gas VOC emission factor is lower than BACT therefore included in this application the VOC emission factor was set to the assumed BACT. The ULSD PM_{10} and $PM_{2.5}$ emissions are based on the manufacture's typical emission data and speciation from AP-42 Chapter 1.3, Table 1.3-7[2]. The ULSD VOC emission factor is based on the manufacture's typical emissions data. The TAPs and greenhouse gas ULSD and natural gas combustion emissions factors for the boilers were taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing facility located in Kent, Washington.

The Site qualifies as a major source for VOC and HAPs due to the use of solvents and coatings used in support of aircraft manufacturing and testing operations. The project PTE for VOC are below the significant emissions rate of 40 tons/year based on the federal rule 40 CFR 52.21 (b) (23).

[1] U.S. Environmental Protection Agency. 1998. *AP-42: Compilation of Air Emissions Factors from Stationary Sources*. Fifth edition, Volume 1, Chapter 1.4. 1.4_natural_gas_combustion.pdf.

[2] U.S. Environmental Protection Agency. 2010. *AP-42: Compilation of Air Emissions Factors from Stationary Sources*. Fifth edition, Volume 1, Chapter 1.3. AP-42 VOL. I: 1.3: Fuel Oil Combustion.

Appendix A-1
Process Flow Diagram



Building 3-150 New Boiler House
80,000 lb/hr Boiler
80,000 lb/hr Boiler
30,000 lb/hr Boiler
30,000 lb/hr Boiler
Paint Hangar Steam Demand
3-390 Steam Demand
PEL & Rest of NBF Steam Demand

Appendix A-3
Environmental Checklist

pscleanair.org
Puget Sound Clean Air Agency

Puget Sound Clean Air Agency
1904 Third Avenue, Suite 105 | Seattle, WA 98101-3317
Phone 206-343-8800 | 206-343-7522 Fax

ENVIRONMENTAL CHECKLIST

Because of the State Environmental Policy Act, the action for which you are filing a Notice of Construction and Application for Approval to this Agency requires the completion of an environmental checklist.

BUT: If you can answer "yes" to either of the following statements with respect to the action being proposed, the attached checklist need not be completed:

1. I have obtained a State, City, or County Permit and filled out an environmental checklist.

   ☒ **Yes** ☐ **No**

   If yes, complete the following:

   State, City or County Department: ______________________________

   Date the checklist was completed: ______________________________

   Attach a copy of the checklist

2. An environmental checklist or assessment has previously been filled out for another agency.

   ☒ **Yes** ☐ **No**

   If yes, complete the following:

   Agency: ______________________________

   Date the checklist was completed: ______________________________

   Attach a copy of the checklist

If your answers are NO to both of the above statements, you must complete the attached environmental checklist.

Prepared by:

Signature *Grant Peltier*

Name Grant Peltier

Position Environmental Engineer

Agency/Organization The Boeing Company (Seattle Site)

Date Submitted 6/4/25

ENVIRONMENTAL CHECKLIST

Date: 6/4/25

Proponent: Puget Sound Clean Air Agency

Project, Brief Title: Bldg 3-150 Boiler House

Purpose of Checklist:

Governmental agencies use this checklist to help determine whether the environmental impacts of your proposal are significant. This information is also helpful to determine if available avoidance, minimization or compensatory mitigation measures will address the probable significant impacts or if an environmental impact statement will be prepared to further analyze the proposal.

Instructions for Applicants:

This environmental checklist asks you to describe some basic information about your proposal. Please answer each question accurately and carefully, to the best of your knowledge. You may need to consult with an agency specialist or private consultant for some questions. You may use "not applicable" or "does not apply" only when you can explain why it does not apply and not when the answer is unknown. You may also attach or incorporate by reference additional studies reports. Complete and accurate answers to these questions often avoid delays with the SEPA process as well as later in the decision-making process.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Instructions for Lead Agencies:

Please adjust the format of this template as needed. Additional information may be necessary to evaluate the existing environment, all interrelated aspects of the proposal and an analysis of adverse impacts. The checklist is considered the first but not necessarily the only source of information needed to make an adequate threshold determination. Once a threshold determination is made, the lead agency is responsible for the completeness and accuracy of the checklist and other supporting documents.

Use of Checklist for Nonproject Proposals:

For nonproject proposals (such as ordinances, regulations, plans and programs), complete the applicable parts of Sections A, B, and C plus section D: Supplemental Sheet for Nonproject Actions.

Please completely answer all questions that apply and note that the words "project," "applicant," and "property or site" should be read as "proposal," "proponent," and "affected geographic area," respectively. The lead agency may exclude (for non-projects) questions in Section B: Environmental Elements that do not contribute meaningfully to the analysis of the proposal.

ENVIRONMENTAL CHECKLIST

A. BACKGROUND

1. Name of proposed project, if applicable: 3-150 Natural Gas Boiler Plant Construction			
2. Name of Applicant The Boeing Company			
3. Applicant Address 7755 E. Marginal Way	City Seattle	State WA	Zip 98108
Applicant Phone (206)303-7534	Applicant Email grant.r.peltier@boeing.com		
Contact Person Grant Peltier	Title Environmental Engineer		
Company/Firm The Boeing Company			
4. Date Checklist Prepared 9/12/24	**5.** Agency Requesting Checklist Puget Sound Clean Air Agency (PSCAA)		
6. Proposed timing or schedule (including phasing, if applicable). Boiler House Construction scheduled to start 2025Q4.			
7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? ☐ Yes ☒ No. If yes, explain. Potential future Utility Corridor Upgrades between North Boeing Field and Plant 2. Decommission 3-374 boilers and remove boilers from site.			
8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal. A Notice of Construction application has been prepared and will be submitted to the Puget Sound Clean Air Agnecy concurently with this SEPA checklist.			
9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? ☒ Yes ☐ No. If yes, explain.			
10. List any government approvals or permits that will be needed for your proposal, if known. The following approvals or permits are believed to be needed for the proposed project: A notice of Consturction Order of Approval Building Permit King County Grading Permit FAA Review			

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. Construct a new roughly 9700 square foot steam boiler plan and supporting structures with four boilers at North Boeing Field. The new boiler house at North Boeing Field will have two 80,000 lb/hr and two 30,000 lb/hr boilers. We plan to demo and remove steam boilers in the 3-374.
12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist. Construction of the proposed project (Building 3-150) will be at North Boeing Field (7400 East Marginal Way South, Seattle WA. 98124-2207). Building 3-150 will be located south of building 3-374 and near building 3-370.

ENVIRONMENTAL CHECKLIST

B. ENVIRONMENTAL ELEMENTS

1. EARTH

a. General description of the site:

☐ flat ☐ rolling ☒ hilly ☐ steep slopes ☒ mountains

☐ other ____

b. What is the steepest slope on the site (approximate percent slope)?

<1%

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them, and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.

Generally found on site is silty sand. There are no known long-term commercial significant agricultural land.

d. Are there surface indications or history of unstable soils in the immediate vicinity? ☒ Yes ☐ No. If yes, describe.

The area is in a liquefaction zone

e. Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.

Approximately 490 cubic yards of fill will be imported to raise the grade at the proposed building location to slope the grade away from the new building footprint. The source of the fill will be from an approved off site location. The fill material will be clean soil appropriate for installation under driving surfaces and/or gravel subgrade material. The total area of the earthwork is approximately 0.55 acres.

f. Could erosion occur as a result of clearing, construction, or use? ☐ Yes ☐ No. If yes, generally describe.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

The existing project area is almost 100% impervious and most of the existing vegetation will be retained.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

Approved temporary erosion control measures will be implemented by the contractor.

ENVIRONMENTAL CHECKLIST

2. AIR
a. What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke, greenhouse gases) during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities, if known. During construction, vehicle and construction equipment and emissions and dust could be released. Upon completion of the project emissions that would result to the air are described in the NOC applicaiton.
b. Are there any off-site sources of emissions or odor that may affect your proposal? ☐ Yes ☒ No. If yes, generally describe.
c. Proposed measures to reduce or control emissions or other impacts to air, if any: Modern boiler design used to minimize emissions to the extent practicable. During the project mitigation measures will be implemented as required to meet or exceed all applicable standards as required by the Puget Sound Clean Air Agency. Additional potential mitigation measures to reduce emissions include ensuring that machines and equipment used during construction are well maintained. We plan to remove older boilers at the 3-374 as part of the scope of this project.

3. WATER
a. Surface
1. Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands) ? ☐ Yes ☒ No. If yes, describe type and provide names. If appropriate, state what stream or river it flows into.
2. Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? ☐ Yes ☒ No. If yes, please describe and attach available plans.
3. Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material. None
4. Will the proposal require surface water withdrawals or diversions? ☐ Yes ☒ No. Give general description, purpose, and approximate quantities if known.
5. Does the proposal lie within a 100-year floodplain? ☐ Yes ☒ No. If yes, note location on the site plan.

6. Does the proposal involve any discharges of waste materials to surface waters? ☐ Yes ☒ No. If yes, describe the type of waste and anticipated volume of discharge.
b. Ground Water
1. Will groundwater be withdrawn from a well for drinking water or other purposes? ☐ Yes ☒ No. If yes, give a general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? ☐ Yes ☒ No. If yes, give general description, purpose, and approximate quantities, if known.
2. Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: domestic sewage; industrial, containing the following chemicals...; agricultural; etc.). Describe the general size of the systems, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve. None
c. Water Runoff (including storm water)
1. Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? ☒ Yes ☐ No. If yes, describe. Stormwater runoff will be collected in the existing plant ' s stormwater control system. No additional impervious surface or runoff will be created by this project.
2. Could waste material enter ground or surface waters? ☐ Yes ☒ No. If yes, generally describe.
3. Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? ☐ Yes ☒ No. If yes, describe.
d. Proposed measures to reduce or control surface, ground, and runoff water, and drainage pattern impacts, impacts, if any: Utilize existing on-site stormwater system to mitigate potential runoff water impacts. Appropriate best managment practices will be implemented during construction to reduce and control surface water runoff impacts.

ENVIRONMENTAL CHECKLIST

4. PLANTS				
a. Check the types of vegetation found on the site:				
Deciduous Trees:	☐ Alder	☒ Maple	☐ Aspen	☒ other (specify): Oak, Willow, Varies
Evergreen Trees:	☒ Fir	☒ Cedar	☒ Pine	☒ other (specify): Magnolia
☒ Shrubs				
☒ Grass				
☐ Pasture				
☐ Crop or Grain				
☐ Orchards, Vineyards, or other permanent crops				
☐ Other types of Vegetation (specify):				
Wet Soil Plants:	☐ Cattail	☐ Buttercup		☐ other (specify):
	☐ Bulrush	☐ Skunk Cabbage		
Water Plants:	☐ Water Lily	☐ Eelgrass	☐ Milfoil	☐ other (specify):
b. What kind and amount of vegetation will be removed or altered? None				
c. List threatened or endangered species known to be on or near the site. None				
d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any: None				
e. List all noxious weeds and invasive species known to be on or near the site. None				

5. ANIMALS

a. Indicate birds and other animals that have been observed on or near the site or are known to be on or near the site.

Birds:	☒ Hawk	☒ Heron	☒ other (specify): Duck, Seagulls, Crows, Geese
	☒ Eagle	☒ Songbirds	
Mammals:	☐ Deer	☐ Bear	☐ other (specify):
	☐ Elk	☒ Beaver	
Fish:	☐ Bass	☒ Salmon	☒ Trout
	☒ Hearing	☒ Shellfish	☒ other (specify): In the Duwamish Waterway

b. List any threatened or endangered species known to be on or near the site.

None Known

c. Is the site part of a migration route? ☐ Yes ☒ No. If yes, explain.

d. Proposed measures to preserve or enhance wildlife, if any:

Utilize temporary erosion; long-term stormwater treatment and hazardous materials control systems and best management practices to prevent contaminated discharges.

e. List any invasive animal species known to be on or near the site.

None

6. ENERGY AND NATURAL RESOURCES

a. What kinds of energy (electric, natural gas, oil, woodstove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Natural gas and diesel (backup) for heating. Electricity will be used for lighting and building utility systems and to operate laboratory equipment. Steam will be used directly for process equipment heating requirements and is also used to generate hot water for building heating.

b. Would your project affect the potential use of solar energy by adjacent properties? ☐ Yes ☒ No. If yes, generally describe.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

Building envelope insulation levels, mechanical systems, and electrical systems meet or exceed those required by Washington State non-residential energy code.

ENVIRONMENTAL CHECKLIST

7. ENVIRONMENTAL HEALTH
a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste that could occur as a result of this proposal? ☐ Yes ☒ No. If yes, describe:
2. Describe any known or possible contamination at the site from present or past uses. None
3. Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity. None
4. Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project. None
5. Describe special emergency services that might be required. None
6. Proposed measures to reduce or control environmental health hazards, if any: None
b. Noise
1. What types of noise exist in the area that may affect your project (for example, traffic, equipment, operation, other)? Existing sources of noise in the area are road traffic, aircraft, trains, and industrial equipment. None of these are expected to affect the proposed project. All equipment noise at the site is below state-prescribed standards at the property boundary.
2. What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example, traffic, construction, operation, other)? Indicate what hours noise would come from the site. Temporary noise impacts during construction are anticipated. Construction Projects of this type typically produce noise levels that range from 68 to 98 dba at 50 feet from the specific equipment.
3. Proposed measures to reduce or control noise impacts, if any: None, No residential uses within 1,000 feet of the project vicinity. Residential areas are near the north gate.

ENVIRONMENTAL CHECKLIST

8. LAND AND SHORELINE USE
a. What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? ☐ Yes ☒ No. If yes, describe.
b. Has the project site been used as working farmlands or working forest lands? ☐ Yes ☒ No. If yes, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses as a result of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or nonforest use?
1. Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides, tilling, and harvesting? ☐ Yes ☒ No. If yes, how?
c. Describe any structures on the site. Industrial Structures
d. Will any structures be demolished? ☐ Yes ☒ No. If yes, what?
e. What is the current zoning classification of the site? MH Heavy Manufacturing
f. What is the current comprehensive plan designation of the site? MH Heavy Manufacturing
g. If applicable, what is the current shoreline master program designation of the site? Urban
h. Has any part of the site been classified as a critical area by the city or community? ☐ Yes ☒ No. If yes, specify.
i. Approximately how many people would reside or work in the completed project? 2-3

j. Approximately how many people would the completed project displace?
None

k. Proposed measures to avoid or reduce displacement impacts, if any:
None

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:
None

m. Proposed measures to ensure the proposal is compatible with nearby agricultural and forest lands of long-term commercial significance, if any:
None

9. HOUSING

a. Approximately how many units would be provided, if any? Indicate whether high- middle- or low-income housing.
None

b. Approximately how many units, if any, would be eliminated? Indicate whether high- middle- or low-income housing.
None

c. Proposed measures to reduce or control housing impacts, if any:
None

10. AESTHETICS

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?
39 Feet. Exterior Walls include Insul MTL Panel Over Steel structure and precast concrete panels.

b. What views in the immediate vicinity would be altered or obstructed?
None

c. Proposed measures to reduce or control aesthetic impacts, if any:
None

ENVIRONMENTAL CHECKLIST

11. LIGHT AND GLARE
a. What type of light or glare will the proposal produce? What time of day would it mainly occur? The proposed project is considered unlikely to objectionably alter any glare or light phenomenon that may currently exist. Any glare from the sun will be similar to what now occurs. Site lighting is provided to produce low-glare security lighting during low light conditions such as night.
b. Could light or glare from the finished project be a safety hazard or interfere with views? No
c. What existing off-site sources of light or glare may affect your proposal? None anticipated
d. Proposed measures to reduce or control light and glare impacts, if any: None

12. RECREATION
a. What designated and informal recreational opportunities are in the immediate vicinity? A small Boeing fitness center exists nearby and oppurunities for recreation exist on the Duwamish Waterway.
b. Would the proposed project displace any existing recreational uses? ☐ Yes ☒ No. If yes, describe.
c. Proposed measures to reduce or control impacts on recreation, including recreational opportunities to be provided by the project or applicant, if any: None

13. HISTORIC AND CULTURAL PRESERVATION
a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers located on or near the site? ☒ Yes ☐ No. If yes, specifically describe. The Geoergtown Steam Plant (1906) is located north of the site and is listed as a national historic landmark.
b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts, or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources. None

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc. None
d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required. Since previous excavation has disclosed no indications of archaeological significance, no impacts are anticipated. Should any in unknown archaeological artifacts/resources are uncovered during the project, work in that area will be halted pending notification and response from appropriate agencies.

14. TRANSPORTATION
a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on-site plans, if any. Site is served by East Marginal Way and no changes to surface streets are planned.
b. Is site or affected geographic area currently served by public transit? ☒ Yes ☐ No. If yes, generally describe. If not, what is the approximate distance to the nearest transit stop? There are multiple King County Metro bus stops nearby the site including on East Marginal Way South and Ellis Ave South.
c. How many parking spaces would the completed project or non-project proposal have? How many would the project or proposal eliminate? About 70 parking stalls will be eliminated and 15 stalls will be added, resulting in a net loss of about 55 parking stalls.
d. Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle or state transportation facilities, not including driveways? ☐ Yes ☒ No. If yes, generally describe (indicate whether public or private).
e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? ☒ Yes ☐ No. If yes, generally describe. King County Aiport is adjacent to the project.
f. How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and nonpassenger vehicles). What data or transportation models were used to make these estimates? None

g.	Will the proposal interfere with, affect or be affected by the movement of agricultural and forest products on roads or streets in the area? ☐ Yes ☒ No. If yes, generally describe.
h.	Proposed measures to reduce or control transportation impacts, if any: None

15. PUBLIC SERVICES	
a.	Would the project result in an increased need for public services (for example, fire protection, police protection, public transit, health care, schools, other)? ☐ Yes ☒ No. If yes, generally describe.
b.	Proposed measures to reduce or control direct impacts on public services, if any: None

16. UTILITIES			
a. Indicate utilities currently available at the site:			
☒ Electricity	☒ Natural gas	☒ Water	☒ Refuse Service
☒ Telephone	☒ Sanitary Sewer	☐ Septic System	☒ Other (specify): Storm Sewer
b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity that might be needed. No changes			

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.	
Signature	Grant Peltier
Name	Grant Peltier
Position	Environmental Engineer
Agency/Organization	The Boeing Company
Date Submitted	6/4/25

D. SUPPLEMENTAL SHEET FOR NON-PROJECT ACTIONS

(Do not use this sheet for project actions)

Because these questions are very general, it may be helpful to read them in conjunction with the list of the elements of the environment in section B of this checklist.

When answering these questions, be aware of how the extent the proposal, or the types of activities likely to result from the proposal, would affect the item at a greater intensity or at a faster rate than if the proposal were not implemented. Respond briefly and in general terms.

1. How would the proposal be likely to increase discharge to water; emissions to air; production, storage, or release of toxic or hazardous substance; or production of noise?
Proposed measures to avoid or reduce such increases are:
2. How would the proposal be likely to affect plants, animals, fish, or marine life?
Proposed measures to protect or conserve plants, animals, fish, or marine life are:
3. How would the proposal be likely to deplete energy or natural resources?
Proposed measures to protect or conserve energy and natural resources are:
4. How would the proposal be likely to use or affect environmentally sensitive areas or areas designated (or eligible or under study) for governmental protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?
Proposed measures to protect such resources or to avoid or reduce impacts are:
5. How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?

Proposed measures to avoid or reduce shoreline and land use impacts are:
6. How would the proposal be likely to increase demands on transportation or public services and utilities?
Proposed measures to reduce or respond to such demand(s) are:
7. Identify, if possible, whether the proposal may conflict with local, state, or federal laws or requirements for the protection of the environment.

Appendix B
NOC Application Supplemental Form – Form 50-169 (30,000 lb/hr Boiler)

PUGET SOUND
Clean Air Agency

1904 3rd Ave #105, Seattle, WA 98101
206-343-8800
pscleanair.gov

NOC APPLICATION SUPPLEMENTAL FORM

Boilers and Process Heaters

This application is for activities or equipment that is (check all that apply):

☒ New (including existing, unpermitted equipment)
☐ Physical or operational modification of existing equipment
☐ Relocation of existing equipment

Estimated date to begin construction: TBD   Estimated date to startup: TBD

Operating Data

Normal 24 hours/day 7 days/week 52 weeks/yr
Maximum 24 hours/day 7 days/week 52 weeks/yr

Boiler/Heater

Manufacturer: Cleaver Brooks   Model: CW-NB-100D-40

Max. Heat Input Rating: 36.5 MMBTU BTU per hour

Boiler Type: ☒ Water-Tube ☐ Fire-Tube

Turndown Ratio: 4:1   Percent Excess Air: 25%

Burner

Manufacturer(s): Cleaver Brooks   Model(s): TBD

Number of burners: 1   Rating of each burner: 36.5 MMBTU BTU per hour

Heat Transfer

Heat Transfer Medium: Water

Temperature (°F)	Pressure (psia)	Flow Rate (specify units):
Input: 235	Input: 135	Average: 30,000 lb/hr
Output: 358	Output: 135	Maximum: 30,000 lb/hr

Fuel Type (check all that apply)

☒ Natural Gas ☐ Liquefied Petroleum Gas ☐ Refinery Gas ☐ Digester Gas ☐ Landfill Gas

☐ Other____________________ ☒ Fuel Oil (specify grade) ULSD Fuel Oil No. 2

Emission Controls (check all that apply)

☒ Low NOx Burner

☒ Flue Gas Recirculation

☒ Oxygen Trim

☐ CO Catalyst

☐ Selective Catalytic Reduction (SCR)

☐ Selective Non-Catalytic Reduction (SNCR)

☐ Baghouse

☐ Electrostatic Precipitator

☐ Other, describe: ____________________

Exhaust Stack Parameters

☐ Stack information is specified on NOC Application Supplemental Form for proposed control device

☒ Stack information is specified below:

Stack diameter: 30 inches

Stack height above ground: 55 feet

Exhaust Flow Rate: 11,881 acfm

Exhaust Temperature: 317 °F

Building Dimensions of project location:

Building Height (highest point of roof) 39 ft

Building Width 72 ft

Building Length 127.5 ft

Fuel Information

If gas or oil fuel is used, attach the fuel specification sheet requested below. If wood fuel is used, provide the following:

Heat Value: N/A Btu/lb wood - Specify if on: ☐ Wet or ☐ Dry basis

% bark: N/A

% sander dust: N/A

% reinjected cinders: N/A

% moisture: N/A

Required Attachments

1. Manufacturer specification sheets for boiler, burner(s), and each identified control device (including guaranteed emission rates).
2. Supplier-provided fuel specification sheet.
3. Any applicable Agency specific control device form.
   See: www.pscleanair.org/180/Source-Specific-Applications-for-Permits
4. A copy of each applicable New Source Performance Standard (NSPS) with the applicable portions of each rule marked.
5. A copy of each applicable National Emissions Standard for Hazardous Air Pollutants (NESHAP) with the applicable portions of each rule marked.

Appendix B-1
30,000 lb/hr Boiler Manufacturer Specification Sheets

1.0 INTRODUCTION

Only **Cleaver-Brooks' Engineered Boiler Systems** offers single source responsibility for every aspect of your industrial steam system projects, from burner to stack, custom built to fulfill your exact needs. Our **NEBRASKA boilers** and **CLEAVER BROOKS burners** have long been the industry benchmarks for quality and engineering. When they're incorporated into a complete system, built and maintained by us, you are getting the best solution, the highest efficiency, and the lowest emissions possible.

For your unique application, we are offering a packaged system with the following design features:

1.1 OUTLET STEAM CONDITIONS:

Gross Steam Capacity:	Qty(2) 80,000 lb/hr and qty(2) 30,000 lb/hr
Operating Pressure:	135 psig (at exit of non-return valve)
Steam Temperature:	Saturated
Steam Quality:	99.5% dry steam

1.2 BOILER DESIGN:

Type:	D-Type Industrial Watertube
Model #1 (30,000 lb/hr):	NB-100D-40
Model #2 (80,000 lb/hr):	NB-300D-65
Vessel Design Pressure:	250 psig

1.3 BURNER DESIGN:

Type:	Cleaver Brooks Low NOx Burner
Main Fuel:	Natural Gas
Backup Fuel:	ULSD

1.4 ECONOMIZER DESIGN:

Type:	Rectangular Finned-Tube
Arrangement:	Vertical Gas Flow; Counter-Current Water Flow
Inlet Feedwater Temp:	235°F

1.5 STACK DESIGN:

Type:	Freestanding - Economizer Mounted
Diameter (at exit):	(#1) 30 inches and (#2) 42 inches
Height (from grade):	55 feet

In partnership with our authorized representative, **Cole Industrial Inc.** in Seattle, we offer your true single-source solution for boiler, burner, emissions reduction, controls, heat recovery, exhaust solutions & local support.

4.0 BOILER DESIGN DATA

Boiler Vessel Dimensions:	**NB-100D-40**	**NB-300D-65**	**Units**
Height to Main Steam Outlet	11 Ft 5 In	14 Ft 7 In	FT
Overall Width of Unit	10 Ft 2 In	11 Ft 4 In	FT
Overall Length of Unit*	18 Ft 6 In	26 Ft 10 In	FT
***Add approximately 6-8 ft length for burner.*			
Weight of Unit (Dry Shipping)	28,582	54,178	LBS
Weight of Unit (Wet Operating)	38,603	74,255	LBS
Surface Area / Volume:			**Units**
Furnace Volume	460	1,285	FT3
Furnace Projected Area	360	769	FT2
Evaporator Area	1,994	4,356	FT2
Total Area	2,354	5,125	FT2
Economizer Area	2,588	5,823	FT2
Tubing Data:			**Units**
Tube OD – Furnace Section	2.0	2.0	IN
Tube Wall Thickness – Furnace Section	0.105	0.105	IN
Tube OD – Evaporator Section	2.0	2.0	IN
Tube Wall Thickness – Evaporator Section	0.105	0.105	IN
Tube Material – Furnace & Evaporator Sections	SA-178 A	SA-178 A	
Extended (Finned) Surface Tubes Utilized in Evaporator Bank	Yes	Yes	
Steam Drum:			**Units**
Inside Drum Diameter:	36	42	IN
Drum Length	14 FT Seam/Seam	22.3 FT Seam/Seam	FT
Drum Material:	SA-516 Grade 70	SA-516 Grade 70	
Corrosion Allowance:	N/A	N/A	IN
Water Drum:			**Units**
Drum Diameter:	24	24	IN
Drum Length	14 FT Seam/Seam	22.3 FT Seam/Seam	FT
Drum Material:	SA-106 Grade B	SA-106 Grade B	
Corrosion Allowance:	N/A	N/A	IN

**The above information is preliminary and shall be confirmed at time of engineering submittal.*

5.0 BOILER PERFORMANCE DATA

Fuel: Natural Gas – NB-100D-40

Boiler load - %	100%	75%	50%	25%	16.7%	Units
Steam Flow - Gross Production	30,000	22,500	15,000	7,500	5,001	Lb/Hr
Net Steam Flow – To Process	30,000	22,500	15,000	7,500	5,001	Lb/Hr
Pegging Steam	-	-	-	-	-	Lb/Hr
Steam Pressure – Operating	135	135	135	135	135	PSIG
Steam Temperature	358	358	358	358	358	°F
Fuel Input (HHV)	36.5	27.2	18.1	9.1	6.2	MMBTU/Hr
Ambient Air Temperature	50	50	50	50	50	°F
Relative Humidity	60	60	60	60	60	%
Excess Air	25	25	25	25	30	%
Flue Gas Recirculation	25	25	25	25	25	%
Steam Output Duty	29.8	22.4	14.9	7.5	5.0	MMBTU/hr
Heat Release Rate	79,180	59,091	39,319	19,833	13,430	BTU/FT3-Hr
Heat Release Rate	101,394	75,669	50,350	25,397	17,198	BTU/FT2-Hr
Furnace Heat Flux	24,347					BTU/FT2-Hr
Feed Water Temperature	235	235	235	235	235	°F
Water Temp. Leaving Economizer	314	305	294	285	284	±10°F
Blow Down	3.0	3.0	3.0	3.0	3.0	%
Boiler Gas Exit Temperature	528	481	432	387	373	±10°F
Economizer Gas Exit Temp.	317	294	272	253	248	±10°F
Air Flow	33,047	24,663	16,411	8,278	5,829	Lb/Hr
Flue Gas to Stack	34,676	25,878	17,219	8,686	6,105	Lb/Hr
Flue Gas Including FGR	43,345	32,348	21,524	10,857	7,632	Lb/Hr
Fuel Flow	1,628	1,215	808	407	276	Lb/Hr
Flue Gas Losses/Efficiency-%						
Dry Gas Loss	5.5	5.0	4.6	4.2	4.2	%
Air Moisture Loss	0.0	0.0	0.0	0.0	0.0	%
Fuel Moisture Loss	11.1	11.0	10.9	10.8	10.8	%
Casing Loss	0.6	0.8	1.2	2.4	3.6	%
Margin	1.0	1.0	1.0	1.0	1.0	%
Efficiency - LHV	90.7	91.1	91.3	90.5	89.1	%
Efficiency – HHV	81.8	82.2	82.3	81.6	80.3	%
Total Pressure Drop Including Economizer	5.95	3.28	1.44	0.37	0.18	IN WC
Products of Combustion - CO_2	7.80	7.80	7.80	7.80	7.52	%
- H_2O	15.94	15.94	15.94	15.94	15.39	%
-N_2	72.42	72.42	72.42	72.42	72.64	%
-O_2	3.84	3.84	3.84	3.84	4.45	%
-SO_2	0.00	0.00	0.00	0.00	0.00	%
GAS- % volume	**NG**					
methane	95.0	% vol.				
ethane	2.0	% vol.				
carbon dioxide	1.0	% vol.				
nitrogen	2.0	% vol.				
hydrogen sulfide	1.0E-4	% vol.				
LHV	20,202	btu/lb				
HHV	22,404	btu/lb				

**The above information is preliminary and shall be confirmed at time of engineering submittal.*

Fuel: ULSD – NB-100D-40

Boiler load - %	100%	75%	50%	25%		Units
Steam Flow - Gross Production	30,000	22,500	15,000	7,500		Lb/Hr
Net Steam Flow – To Process	30,000	22,500	15,000	7,500		Lb/Hr
Pegging Steam	-	-	-	-		Lb/Hr
Steam Pressure – Operating	135	135	135	135		PSIG
Steam Temperature	358	358	358	358		°F
Fuel Input (HHV)	34.7	25.9	17.2	8.7		MMBTU/Hr
Ambient Air Temperature	50	50	50	50		°F
Relative Humidity	60	60	60	60		%
Excess Air	25	25	25	25		%
Flue Gas Recirculation	25	25	25	25		%
Steam Output Duty	29.8	22.4	14.9	7.5		MMBTU/hr
Heat Release Rate	75,197	56,185	37,423	18,882		BTU/FT3-Hr
Heat Release Rate	96,294	71,948	47,922	24,179		BTU/FT2-Hr
Furnace Heat Flux	32,025					BTU/FT2-Hr
Feed Water Temperature	235	235	235	235		°F
Water Temp. Leaving Economizer	306	298	289	281		±10°F
Blow Down	3.0	3.0	3.0	3.0		%
Boiler Gas Exit Temperature	510	467	424	384		±10°F
Economizer Gas Exit Temp.	308	287	268	251		±10°F
Air Flow	31,657	23,653	15,754	7,949		Lb/Hr
Flue Gas to Stack	33,408	24,961	16,626	8,388		Lb/Hr
Flue Gas Including FGR	41,760	31,202	20,782	10,486		Lb/Hr
Fuel Flow	1,756	1,312	874	441		Lb/Hr
Flue Gas Losses/Efficiency-%						
Dry Gas Loss	5.6	5.2	4.7	4.4		%
Air Moisture Loss	0.0	0.0	0.0	0.0		%
Fuel Moisture Loss	6.6	6.6	6.5	6.5		%
Casing Loss	0.6	0.8	1.2	2.4		%
Margin	1.0	1.0	1.0	1.0		%
Efficiency - LHV	91.8	92.1	92.2	91.3		%
Efficiency – HHV	86.1	86.4	86.5	85.7		%
Total Pressure Drop Including Economizer	5.52	3.06	1.36	0.35		IN WC
Products of Combustion - CO2	10.99	10.99	10.99	10.99		%
- H2O	10.11	10.11	10.11	10.11		%
-N2	74.99	74.99	74.99	74.99		%
-O2	3.92	3.92	3.92	3.92		%
-SO2	0.00	0.00	0.00	0.00		%
OIL- % weight	**#2**					
Carbon	86.9	% wt.				
Hydrogen	12.5	% wt.				
Sulfur	0.0	% wt.				
Oxygen	0.58	% wt.				
Nitrogen	0.0	% wt.				
°API	32.0					
LHV	18,511	btu/lb				
HHV	19,726	btu/lb				

**The above information is preliminary and shall be confirmed at time of engineering submittal.*

14.0 COMMENTS

14.1 TECHNICAL CLARIFICATIONS

Equipment is offered per Cleaver-Brooks Engineered Boiler System's standard design & construction, unless otherwise noted. Scope of supply shall be as outlined in this proposal.

This proposal is based on information from the specifications received and noted below.

NBF Boilers and associated equipment Specification 4.01.2019

Page	Section	Comments
235233 - 1	1.2.C	Plant Master not included
235233 – 4	1.2.D.13	This proposal includes a fully metered system. Jackshaft system is not included and not required.
235233 – 3	2.2	UPS is by others
235233 - 14	2.3.C	The burner main fuel gas train is designed for a minimum fuel supply pressure of 30 psig at the train inlet.
235233 - 14	2.3.C	With current pressure supply of 50 psig, the turndown is 4:1. The burner and fuel oil train have been designed for a minimum fuel supply pressure of 90 psig at the train inlet. Please ensure the oil pump-set (supplied by others) is sized accordingly
235233 - 14	2.3.C	The atomizing steam train has been designed for a supply pressure of 100 psig at the train inlet.
		CB has assumed fuel compositions for typical, pipeline quality Natural Gas. Please confirm actual fuel composition. Any required modifications to scope shall be charged at extra cost.

General Notes:

As an OEM, Cleaver-Brooks is providing equipment only. Any references in the specifications to field work (including erection, installation, etc…) are not currently included.

Since the Low NOx Burner utilizes Flue Gas Recirculation (FGR) to meet low emissions, we highly recommend that the inlet combustion air to be maintained above the dew point temperature to avoid condensation that accumulates inside the boiler, burner and air handling equipment. Large variations in combustion air temperature (maximum differential temperature is 50^0F) affect the combustion process. An inlet air preheater is required during cold temperature conditions when inlet combustion air is taken directly from outdoor ambient conditions. A preheater is/is not included in our scope at this time, but can be provided upon request.

The operational turndown is as listed in this proposal. Emissions guarantees are separate and valid from 25-100% unless stated otherwise.

We are offering our standard welding & NDE procedures at this time. Details can be provided upon request.

Boiler safety valves shall be set at the design pressure of the boiler. Lower set pressures can be provided for a price adder available upon request.

Please note that all the equipment of the scope of this contract could include some parts that are made of copper based material. If there are any specific reasons not to use copper based materials, please

15.0 PERFORMANCE GUARANTEES

Cleaver-Brooks offers the following performance guarantees specific to this project:

PROCESS GUARANTEES (FIRING NATURAL GAS ONLY)	VALUE	UNIT
Maximum Continuous Rating (MCR) Steam Flow (at exit of non-return valve)	30,000 / 80,000	lb/hr
Operating Steam Pressure (at exit of non-return valve)	135	psig
Operating Steam Temperature (at exit of non-return valve at 100% MCR)	Saturated	°F
Boiler Feedwater Inlet Temperature	235°F	°F
Inlet Combustion Air Temperature	50	°F
Inlet Combustion Air Relative Humidity	60	%
Boiler Thermal Efficiency (Based on HHV and ASME PTC 4 Input-Output Method)	81.8 / 82.1	%
Steam Purity (With ASME Quality Water per Attached)	99.5% dry steam	
Maximum Noise Rating (at 3 Ft in a free field)	85	dBA

BURNER EMISSIONS

Guaranteed Emissions; 25% to 100% MCR corrected to 3 %O_2 on a dry basis.		Natural Gas	ULSD
		25%-100% MCR	**25%-100% MCR**
NO_x	lb/MMBtu	0.011	0.130
CO	lb/MMBtu	0.036	0.080

Based on:
CB technician is required for start-up and adjustments.
EA (excess air) and FGR rates are expected only and not guaranteed. Please refer to boiler performance for guaranteed boiler efficiency.
PM is exclusive of any particulates in combustion air or other sources of residual particulates from material.

We are offering the above guarantees. All other data contained in this proposal is predicted only and will be finalized at time of engineering submittal after receipt of award. Guarantees are based on the unit being operated per the requirements of the operation and maintenance manual.

If performance testing is required, it is the Buyer's responsibility to provide steam load (or steam vent to atmosphere) and have the equipment tested by a third party during the stated warranty period. If equipment passes such tests, or the tests are not performed before the end of the warranty period, it will be assumed that the equipment is accepted. The cost of all tests is the responsibility of the Buyer.

The operational turndown is as listed above. Emissions guarantees are separate and valid from 25-100% unless stated otherwise.

The addition of any of the priced options listed above may impact the design, performance, and/or schedule as listed in this proposal and Seller provided datasheets (if applicable).

CleaverBrooks
6940 Cornhusker Highway
Lincoln, NE 68507
402.434.2000
cleaverbrooks.com

Typical emissions for industrial watertube boilers. Consult proposal for guarantees.

“Standard” Burner Emissions Values (in lb/mmbtu)

	Natural Gas	#2 Oil	#6 Oil
NOx	0.100	0.138	0.422
CO	0.037	0.057	0.076
SO_x	0.0006	0.051	2.19
VOC	0.004	0.006	0.008
PM_{total}	0.005	0.024	0.144

“Low-NOx” Burner Emissions Values (in lb/mmbtu)

	Natural Gas	#2 Oil	#6 Oil
NOx	0.036	0.088	0.373
CO	0.037	0.057	0.076
SO_x	0.0006	0.051	0.540
VOC	0.004	0.006	0.008
PM_{total}	0.005	0.024	0.144

“Ultra Low-NOx” Burner Emissions Values (in lb/mmbtu)

	Natural Gas	#2 Oil	#6 Oil
NOx	0.011	0.075	NA
CO	0.037	0.057	NA
SO_x	0.0006	0.051	NA
VOC	0.004	0.006	NA
PM_{total}	0.005	0.024	NA

Natural Gas
Pipeline quality, HHV of 1,040 BTU/SCF, 0.2 grain/100SCF total sulfur as sulfur.
#2 fuel oil
ASTM D975 S500, HHV of 140,000 BTU/gal, < 0.02 % wt fbn, < 0.05 % wt sulfur, < 0.01 % wt ash.
#6 fuel oil
HHV of 150,000 BTU/gal, < 0.3 % wt fbn, < 2.0 % wt sulfur, < 0.1 % wt ash.

PM total includes filterable and condensable. PM10 and 2.5 values are smaller or equal to PM total.

The above values are based on industry averages and may or may not represent requirements for any given region of the United States. Emissions regulations vary from state-to-state.

Appendix B-2
Natural Gas Specifications

NATURAL GAS SPECS SHEET

Fuel Providers and their large volume Customers (particularly Electric Utilities and possibly other End Users) are used to defining fuel requirements in the form of Spec Sheets. Attached, as an example, is a #6 Fuel Oil Quality Specifications table developed to conform to federal, state, and local regulations governing the generator (e.g., emissions compliance), operational requirements (e.g., type of generating and/or backend clean-up equipment), and/or any other constraints imposed on the generator. Other examples of Spec Sheets and standards lists are included. This document includes an excellent example of a Gas Quality Spec Sheet from Brazil (GasEnergia) and additionally, the regulatory standards behind it.

With other generation fuels, the quality of the delivered product is a result of an agreement between the provider and the customer (the transporter does not generally have a significant input, if any).

With Natural Gas, due to the nature of the product and the transportation mechanism, the quality of the delivered product is primarily determined by the pipeline.

Utility generators have a need to know the expected range of quality of the fuel being delivered to them and ideally to have some control over the variability of that fuel to assure compliance with regulations, to protect their investment in generating equipment, and to be able to meet the needs of their customers in the most economic manner.

Not only is there a potential for great variability in the quality of Natural Gas delivered to Customers, the standards and specs defined in pipeline tariffs tend to be vague, difficult to locate or extract from pipeline tariffs, and often difficult to comprehend. These difficulties are compounded when generators try to deal with the differences across pipelines as there is not even a standard format for describing the quality specifications.

Customers would benefit from having access to clearly defined statements of pipeline quality (even though it varies from pipeline to pipeline) in the form of Natural Gas Spec Sheets (comparable to what the folks in Brazil have) provided in screen and downloadable format under Informational Postings on U.S. pipeline websites.

APPENDIX D: NO. 6 FUEL OIL QUALITY SPECIFICATIONS *[Revised 11/06/03]*

QUALITY SPECIFICATIONS *(NOTE 1)*			DELIVERY LOCATIONS		
CHARACTERISTIC --OR-- PROPERTY	**UNITS / CONDITIONS**	**TEST METHOD *(NOTE 2)***	**MANATEE (TMT/PMT) PORT EVERGLADES (TPE/PPE) SANFORD (TJS/PSN)**	**MIAMI -FISHER ISLAND (TFI/PTF) CANAVERAL (TCC/PCC)**	**PALM BEACH (TMR/PMR/PRV)**
SULFUR	WEIGHT %	D-4294 *(NOTE 3)*	1.0 MAX	1.0 MAX	MAX As Ordered (.70% -OR- 1.0%)
HEATING VALUE	MMBTU/BBL	D-240	6.340 MIN *(NOTE 4)*	6.340 MIN *(NOTE 4)*	6.340 MIN *(NOTE 4)*
WATER & SEDIMENT (W&S)	VOLUME %	D-95 & D-473	1.0 MAX *(NOTE 5)*	1.0 MAX *(NOTE 5)*	1.0 MAX *(NOTE 5)*
SEDIMENT	WEIGHT %	D-473	0.20 MAX	0.20 MAX	0.20 MAX
FLASH POINT-PENSKY	°F	D-93	150 MIN	150 MIN	150 MIN
POUR POINT	°F	D-97	60 MAX	60 MAX	60 MAX
ASH	WEIGHT %	D-482	0.10 MAX	0.10 MAX	0.05 MAX for .70% S for PMR 0.07 MAX for 1.0% S for PMR 0.10 MAX for PRV
VISCOSITY	SSF@ 122°F	D-445 *(NOTE 6)*	25 MIN / 225 MAX	75 MIN / 225 MAX	25 MIN / 140 MAX for PMR 75 MIN / 225 MAX for PRV
GRAVITY	API	D-287 or D-4052	8.0 MIN for PPE & PMT 6.0 MIN for PSN	6.0 MIN	6.0 MIN
VANADIUM	PPM	D-5863 A or B/ D-5708 A or B	200 MAX	200 MAX	200 MAX
NITROGEN	WEIGHT %	D-5762	.40 MAX for PPE & PMT .50 MAX for PSN	.40 MAX for PTF .50 MAX for PCC	.30 MAX for .70% S for PMR .40 MAX for 1.0% S for PMR .50 MAX for 1.0% S for PRV
ALUMINUM + SILICON	PPM	D-5184	120 MAX	120 MAX	120 MAX
CALCIUM	PPM	D-5863 A or B/ D-5708 A or B	50 MAX	50 MAX	50 MAX
ASPHALTENES	WEIGHT %	BRITISH STANDARD BS-4676; IP-143.	8.0 MAX	8.0 MAX	8.0 MAX
DELIVERY TEMPERATURE	°F	N/A	105 MIN / 140 MAX	105 MIN / 140 MAX	105 MIN / 140 MAX

NOTES

1. **QUALITY WARRANTY:** PRODUCT SHALL MEET THE QUALITY SPECIFICATIONS DESCRIBED HEREIN AND, ADDITIONALLY, **(a)** SHALL NOT CONTAIN PETROCHEMICAL WASTES, RESIDUES, SPENT CHEMICALS, TAR BOTTOMS, HAZARDOUS WASTE, NOR ANY OTHER EXTRANEOUS MATERIALS OR MATTER FOREIGN TO NO. 6 FUEL OIL, **(b)** SHALL HAVE A CONSISTENT, MARKETABLE ODOR CHARACTERISTIC OF NO. 6 FUEL OIL, AND **(c)** SHALL BE FREE FROM EXCESSIVE AMOUNTS OF SOLID MATTER LIKELY TO MAKE CLEANING OF SUITABLE STRAINERS NECESSARY.
2. **TEST METHODS:** THE LATEST REVISION OF TEST METHODS SHALL APPLY. IN ADDITION TO ABOVE, THE FOLLOWING TESTS SHALL BE REPORTED AS PART OF THE AS-LOADED SPECIFICATION REQUIREMENTS FOR EACH CARGO: **(a)** DI-CYCLOPENTADIENE (DCPD) CONTENT USING CURRENTLY ACCEPTED TESTING METHODS, **(b)** ZINC AND MAGNESIUM (ASTM METHOD D-5863A OR B), AND **(c)** PHOPHOROUS (ASTM METHOD D-5708A OR B.
3. **SULFUR:** NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) NO. 6 FUEL OIL STANDARDS SHALL BE USED FOR CALIBRATION OF THE SULFUR EQUIPMENT.
4. **HEATING VALUE:** A QUALITY ADJUSTMENT SHALL BE MADE TO THE UNIT PRICE FOR CARGOS WITH HEATING VALUE BELOW THE MINIMUM SPECIFIED ABOVE, WITH THE REDUCTION IN UNIT PRICE CALCULATED IN ACCORDANCE WITH THE FOLLOWING FORMULA:

$$U_{BTU} = U \times (M - B) / M$$

WHERE: U_{BTU} IS THE AMOUNT OF THE PRICE REDUCTION ($/BBL), U IS THE UNIT PRICE CALCULATED PURSUANT TO THE CONTRACT ($/BBL), M IS THE MINIMUM HEATING VALUE (MMBTU/BBL) SPECIFIED ABOVE, AND B IS THE ACTUAL HEATING VALUE (MMBTU/BBL) OF THE CARGO AS DETERMINED BY THE DELIVERY INSPECTOR.

5. **WATER & SEDIMENT:** AN ADJUSTMENT SHALL BE MADE TO THE DELIVERY QUANTITY FOR CARGOS WITH GREATER THAN 0.30% WATER & SEDIMENT (W&S), WITH THE REDUCTION IN VOLUME CALCULATED IN ACCORDANCE WITH THE FOLLOWING FORMULA:

$$Q_{W\&S} = Q \times (A - 0.30\%)$$

WHERE: $Q_{W\&S}$ IS THE AMOUNT OF THE VOLUME REDUCTION (BBL), Q IS THE DELIVERY QUANTITY AS DETERMINED BY THE DELIVERY INSPECTOR (BBL), AND A IS THE ACTUAL W&S AS DETERMINED BY THE DELIVERY INSPECTOR (VOLUME %).

6. **VISCOSITY:** RUN VISCOSITY TEST BY ASTM D-445 AND CONVERT THE RESULTS TO UNITS OF SSF@122°F USING THE TABLE IN ASTM D-2161.

NATGAS QUALITY SPECIFICATIONS LIST

NATGAS PHYSICAL AND CHEMICAL PROPERTIES OR CHARACTERISTICS POTENTIALLY OF INTEREST TO NATGAS USER GROUPS THAT MAY BE MONITORED, TRACKED, OR CALCULATED BY THE INDUSTRY.

PROPERTY or CHARACTERISTIC	SYMBOL	MEASUREMENT UNIT(S) –or— CONDITION	ANALYTICAL TEST METHOD	MINIMUM VALUE	MAXIMUM VALUE
HIGH HEATING VALUE	HHV	Btu/scf			
LOW HEATING VALUE	LHV	Btu/scf			
SPECIFIC GRAVITY	ρ	---			
WOBBE INDEX	W	---			
TEMPERATURE	T	°F			
WATER	H_2O	lb/MMscf			
WATER DEWPOINT	D_{H2O}	°F			
HYDROCARBON DEWPOINT	D_{HC}	°F			
METHANE	C_1	%			
ETHANE	C_2	%			
PROPANE	C_3	%			
ISOBUTANE	iC_4	%			
NORMAL BUTANE	nC_4	%			
ISOPENTANE	Ic_5	%			
NORMAL PENTANE	nC_5	%			
HEXANES (and heavier)	C_6 (C_6+)	%			
HEPTANES	C_7	%			
OCTANES	C_8	%			
NONANES	C_9	%			
DECANES	C_{10}	%			
NITROGEN	N_2	%			
CARBON DIOXIDE	CO_2	%			
OXYGEN	O_2	%			
HYDROGEN	H_2	%			
HELIUM	He	%			
OTHER GASES	?	%			
TOTAL SULFUR	S_{TOT}	Note 1			
HYDROGEN SULFIDE	H_2S	Note 1			
CARBONYL SULFIDE	COS	Note 1			
SULFUR IN MERCAPTANS	SRSH	Note 1.			
IRON SULFIDE	FeS	lbs			
OTHER SULFUR COMPOUNDS	?	Note 1			
MERCURY	Hg	ppb			
PARTICULATES	?	microns			

NOTES
(1) Sulfur measurements given in grains/100scf or in ppm or both.

-- EXAMPLE OF STANDARDS LIST --
EGYPTIAN ORGANIZATION for STANDARDIZATION and QUALITY CONTROL
NATURAL GAS MEASUREMENT STANDARDS

75.060 Natural gas

ISO 6326-1:1989 Natural gas -- Determination of sulfur compounds -- Part 1: General introduction

ISO 6326-2:1981 Gas analysis -- Determination of sulphur compounds in natural gas -- Part 2: Gas chromatographic method using an electrochemical detector for the determination of odoriferous sulphur compounds

ISO 6326-3:1989 Natural gas -- Determination of sulfur compounds -- Part 3: Determination of hydrogen sulfide, mercaptan sulfur and carbonyl sulfide sulfur by potentiometry

ISO 6326-4:1994 Natural gas -- Determination of sulfur compounds -- Part 4: Gas chromatographic method using a flame photometric detector for the determination of hydrogen sulfide, carbonyl sulfide and sulfur-containing odorants

ISO 6326-5:1989 Natural gas -- Determination of sulfur compounds -- Part 5: Lingener combustion method

ISO 6327:1981 Gas analysis -- Determination of the water dew point of natural gas -- Cooled surface condensation hygrometers

ISO 6570-1:1983 Natural gas -- Determination of potential hydrocarbon liquid content -- Part 1: Principles and general requirements

ISO 6570-2:1984 Natural gas -- Determination of potential hydrocarbon liquid content -- Part 2: Weighing method

ISO 6974-1:2000 Natural gas -- Determination of composition with defined uncertainty by gas chromatography -- Part 1: Guidelines for tailored analysis

ISO 6974-2:2001 Natural gas -- Determination of composition with defined uncertainty by gas chromatography -- Part 2: Measuring-system characteristics and statistics for processing of data

ISO 6974-3:2000 Natural gas -- Determination of composition with defined uncertainty by gas chromatography -- Part 3: Determination of hydrogen, helium, oxygen, nitrogen, carbon dioxide and hydrocarbons up to C8 using two packed columns

ISO 6974-4:2000 Natural gas -- Determination of composition with defined uncertainty by gas chromatography -- Part 4: Determination of nitrogen, carbon dioxide and C1 to C5 and C6+ hydrocarbons for a laboratory and on-line measuring system using two columns

ISO 6974-5:2000 Natural gas -- Determination of composition with defined uncertainty by gas chromatography -- Part 5: Determination of nitrogen, carbon dioxide and C1 to C5 and C6+ hydrocarbons for a laboratory and on-line process application using three columns

ISO 6975:1997 Natural gas -- Extended analysis -- Gas-chromatographic method

ISO 6976:1995 Natural gas -- Calculation of calorific values, density, relative density and Wobbe index from composition

ISO 6976:1995/Cor 1:1997 (Applies to French version only)

ISO 6976:1995/Cor 2:1997 No title

ISO 6976:1995/Cor 3:1999 No title

ISO 6978:1992 Natural gas -- Determination of mercury

ISO 8943:1991 Refrigerated light hydrocarbon fluids -- Sampling of liquefied natural gas -- Continuous method

ISO 10101-1:1993 Natural gas -- Determination of water by the Karl Fischer method -- Part 1: Introduction

ISO 10101-2:1993 Natural gas -- Determination of water by the Karl Fischer method -- Part 2: Titration procedure

ISO 10101-3:1993 Natural gas -- Determination of water by the Karl Fischer method -- Part 3: Coulometric procedure

ISO 10715:1997 Natural gas -- Sampling guidelines

ISO 10723:1995 Natural gas -- Performance evaluation for on-line analytical systems

ISO 10723:1995/Cor 1:1998 No title

ISO 11541:1997 Natural gas -- Determination of water content at high pressure

ISO 12213-1:1997 Natural gas -- Calculation of compression factor -- Part 1: Introduction and guidelines

ISO 12213-2:1997 Natural gas -- Calculation of compression factor -- Part 2: Calculation using molar-composition analysis

ISO 12213-3:1997 Natural gas -- Calculation of compression factor -- Part 3: Calculation using physical properties

ISO 13443:1996 Natural gas -- Standard reference conditions

ISO 13443:1996/Cor 1:1997 (Applies to French version only)

ISO 13686:1998 Natural gas -- Quality designation

ISO 13734:1998 Natural gas -- Organic sulfur compounds used as odorants -- Requirements and test methods

ISO 13734:1998/Cor 1:1999 No title

ISO 14111:1997 Natural gas -- Guidelines to traceability in analysis

ISO 15403:2000 Natural gas -- Designation of the quality of natural gas for use as a compressed fuel for vehicles

Print

Chemical Composition of Natural Gas

Natural gas is a naturally occurring gas mixture, consisting mainly of methane. While most of the gas supplied to Union Gas is from western Canada, some gas is supplied from other sources, including the United States and Ontario producers. While the gas from these sources has a similar analysis, it is not entirely the same. The table below outlines the typical components of natural gas on the Union Gas system and the typical ranges for these values (allowing for the different sources).

Note that there is no guarantee of the following composition at your location or as an overall system average. Since the different gas supplies enter the Union Gas system at different locations, the exact composition at any site will vary among the different regions. The system average heating value will depend on the mix of gas supplies (which is increasingly controlled by our customers), and therefore can vary from the typical value listed below.

Component	Typical Analysis (mole %)	Range (mole %)
Methane	94.9	87.0 - 96.0
Ethane	2.5	1.8 - 5.1
Propane	0.2	0.1 - 1.5
iso - Butane	0.03	0.01 - 0.3
normal - Butane	0.03	0.01 - 0.3
iso - Pentane	0.01	trace - 0.14
normal - Pentane	0.01	trace - 0.04
Hexanes plus	0.01	trace - 0.06
Nitrogen	1.6	1.3 - 5.6
Carbon Dioxide	0.7	0.1 - 1.0
Oxygen	0.02	0.01 - 0.1
Hydrogen	trace	trace - 0.02
Specific Gravity	0.585	0.57 - 0.62
Gross Heating Value (MJ/m^3), dry basis *	37.8	36.0 - 40.2

* The gross heating value is the total heat obtained by complete combustion at constant pressure of a unit volume of gas in air, including the heat released by condensing the water vapour in the combustion products (gas, air, and combustion products taken at standard temperature and pressure).

Sulphur:

In the Union Gas system, the typical sulphur content is 5.5 mg/m^3. This includes the 4.9 mg/m^3 of sulphur in the odourant (mercaptan) added to gas for safety reasons.

Water:

The water vapour content of natural gas in the Union Gas system is less than 80 mg/m^3, and is typically 16 to 32 mg/m^3.

Typical Combustion Properties of Natural Gas

Note that there is no guarantee that the combustion properties at your location will be exactly as shown. The properties shown are an overall average on the Union Gas system.

Ignition Point:	593 ^{o}C *
Flammability Limits	4% - 16% (volume % in air) *
Theoretical Flame Temperature (stoichiometric air/fuel ratio)	1960 ^{o}C (3562 ^{o}F) †
Maximum Flame Velocity	0.3 m/s †
Relative density (specific gravity)	0.585 ‡
Wobbe Index (Btu/scf)	1328 ‡

† Information provided is from North American Combustion Handbook, Volume 1, 3rd edition, North American Mfg Co., 1986.
‡ Information provided is from the Chemical Composition of Natural Gas as shown on the chart above.
* Information provided is from the Union Gas Material Safety Data Sheet (WHMIS).

EXAMPLE - STATE OF WYOMING NATURAL GAS STANDARD

CHAPTER 9
STANDARDS FOR NATURAL GAS

40-9-101. Standard natural gas defined.

(a) For the purpose of this act [§§ 40-9-101 through 40-9-105] standard natural gas shall be considered to have an average standard of heating units of not less than one thousand (1,000) British thermal units per cubic foot of gas, ascertained and determined by the state chemist in accordance with standard conditions, to wit:

(i) At a temperature of sixty degrees Fahrenheit (60° F);

(ii) Under pressure of thirty (30) inches of mercury.

40-9-102. Factors to be considered in fixing rates.

The standard of heating units herein prescribed and any variations therefrom, in any gas distributed by any utility, or utilities, to users of natural gas, shall be taken into consideration by the public service commission as an additional factor to the factors provided for in W.S. 37-2-118, as a basis for fixing rates and rate schedules for the allowable charges the utility may make against the users of natural gas in any particular town, city or community, in which the question of such rates shall be presented to said commission, as provided for in W.S. 37-2-118.

40-9-103. Tests and report of state chemist upon complaint; use of results as evidence and in fixing rates.

Whenever any complaint is made, as provided for in W.S. 37-2-118, that the heat units of the natural gas supplied by any utility to the users thereof in any town or municipality are below the standard thereof theretofore used as a factor in the basis for rates to be charged by the utility in that particular town or municipality, the public service commission shall notify the state chemist to make proper tests of the heating units of the gas furnished by such utility to the complaining municipality. The state chemist shall certify to the public service commission and to the mayor of the complaining town or municipality the result of such test, which said certificate shall be used as competent evidence by the public service commission at the hearing of said complaint, and shall be used by the commission as one (1) of the factors as a basis for any change in the rates the commission may find necessary to make.

40-9-104. Municipality may require test every 3 months.

The mayor, or city council of any town or municipality, in which natural gas is furnished by any utility is hereby given the right to require the state chemist to make a test of such gas every three (3) months and to certify the results thereof to said mayor, or city council and public service commission.

40-9-105. Expense of tests charged to state university.

Any and all expenses incurred by the state chemist in carrying out the provisions of this act [§§ 40-9-101 through 40-9-105] shall be a charge against the University of Wyoming.

http://legisweb.state.wy.us/statutes/titles/title40/chapter09.htm

Natural Gas

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What it is?

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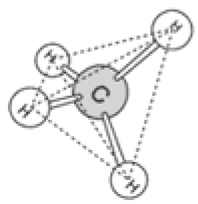
Typical Composition of Natural Gas



Its composition may vary, depending on whether the gas is associated or non-associated with oil, or has or has not been processed in industrial plants. The basic composition includes methane, ethane, propane and hydrocarbons with a heavier molecular weight (in smaller proportions). Normally it has low contaminant content, such as nitrogen, carbon dioxide, water and sulfides.

Check the composition and specifications of natural gas below.

Learn more:

» Composition of Natural Gas

» Composition of the Natural Gas in the Campos Basin (Cabiúnas Station - Macaé)

» Comparison Between Natural Gas and Other Gases

TYPICAL COMPOSITION OF NATURAL GAS

ELEMENTS	ASSOCIATED (1)	NON-ASSOCIATED (2)	PROCESSED (3)
METHANE	81,57	85,48	88,56
ETHANE	9,17	8,26	9,17
PROPANE	5,13	3,06	0,42
I-BUTANE	0,94	0,47	--
N-BUTANE	1,45	0,85	--
I-PENTANE	0,26	0,20	--
N-PENTANE	0,30	0,24	--
HEXANE	0,15	0,21	--
HEPTANE & SUPERIOR	0,12	0,06	--
NITROGEN	0,52	0,53	1,20
CARBON IOXIDE	0,39	0,64	0,65
TOTAL	100,0	100,0	100,0
DENSITY	0,71	0,69	0,61
RICHNESS (% WET C3+)	8,35	5,09	0,42
BASE CAL.VALUE (KCAL/M)	9.916	9.583	8.621
TOP CAL.VALUE (KCAL/M)	10.941	10.580	9.549

1- Gas from Garoupa field, Campos Basin

2- Gas from Miranga field in Bahia

3- Outlet from Candeias NGPU in Bahia

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NATURAL GAS SPECIFICATION (1) (2)*						
CHARACTERISTICS	UNIT	LIMIT			METHODO	
		NORTH (5)	NORTHEAST	SOUTH, SOUTHEAST, CENTRAL-WEST	ASTM	ISO
UPPER HEAT PRODUCING POWER (4)	KJ/M³	34.000 TO 38.400	35.000 TO 42.000		D 3588	6976
	KWH/M³	9,47 TO 10,67	9,72 TO 11,67			
WOBBE INDEX	KJ/M³ % VOL.	40.500 TO 45.000	46.500 A 52.500		-	6976
METHANE, MIN.	% VOL.	68,0	86,0		D 1945	6974
ETHANE, MAX.	% VOL.	12,0	10,0			
PROPANE, MAX.	% VOL.	3,0				
BUTANE AND HEAVIER, MAX.	% VOL.	1,5				
OXYGEN, MAX.	% VOL.	0,8	0,5			
HYDROGEN	% VOL.	NOTE				
INERT (N2 + CO2), MAX.	% VOL.	18,0	5,0	4,0		
NITROGEN, MAX.	% VOL.	NOTE	2,0			
TOTAL SULFUR, MAX.	MG/M³	70			D 5504	6326-2 6326-5
HYDRO-SULFURIC GAS (H2S), MAX.	MG/M³	10,0	15,0	10,0		
WATER DEW POINT AT 1 ATM, MÁX.	ºC	-39	-39	-45	D5454	-
LIQUID HYDROCARBONATES	MG/M³	NOTE			-	6570

Observations:

(1) Natural gas should be technically exempt, that is, there should be no visible traces of solid and liquid particles.

(2) Specification limits are values referred to as 293.15 K (20 ºC) and 101.325 kPa (1 atm) on a dry base, except at dew point.

(3) Limits for the North region are destined for different applications except vehicular, where for this purpose, limits equivalent to the Northeast region must be applied.

(4) Calorific energy of the pure reference substance used in this Technical Regulation is found under temperature and pressure conditions equivalent to 293.15 K, 101.325 kPa, respectively on a dry base.

(5) The Wobbe index is calculated by employing the Higher Calorific Energy on a dry base. When the ASTM D 3588 method is used to obtain the Higher Calorific Energy, the Wobbe index must be determined by the formula contained in the Technical Regulation.

(6) Odorized gas must not contain a sulfur content higher than70 mg/m³.

* The text was extracted from Administrative Rule #104, dated 8 July, 2002. **Click here** to see the administrative rule in its entirety.

Source: The National Petroleum Agency

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Natural Gas

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What it is?

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Composition of the Natural Gas in the Campos Basin

(Cabiúnas Station - Macaé) 5/31 October 2000

Non-processed Natural Gas | Processed Natural Gas

NON-PROCESSED NATURAL GAS

NON-PROCESSED GAS	AVERAGE	MAXIMUM	MINIMUM
O2	0.003	0.0540	0.000
N2	0.643	2.1120	0.4150
CO2	0.318	0.4100	0.2540
C1	84.266	87.2200	81.8040
C2	7.578	9.5860	5.4480
C3	4.427	5.4590	2.9480
IC4	0.663	0.7940	0.5470
NC4	1.283	1.4430	1.1170
NEO C5	0.000	0.0000	0.0000
IC5	0.238	0.3160	0.0000
NC5	0.298	0.4010	0.1860
C5+	0.281	0.5060	0.1210
RICHNESS (%)	7.189	8.1560	5.6000
P.C.S (KCAL/M3)	10502	10726	10282
DENSITY	0.687	0.7030	0.6690
H2S MG/M3	0.630	3.3961	0.0000
TOTAL SUFUR H2S MG/M3	0.746	4.1552	0.0000

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PROCESSED NATURAL GAS

PROCESSED GAS	AVERAGE	MAXIMUM	MINIMUM
O2	0.006	0.1130	0.000
N2	0.647	1.4590	0.4740
CO2	0.293	0.3630	0.1550
C1	88.974	90.9330	85.0040
C2	6.708	8.0490	4.9590
C3	2.636	4.0860	2.0780
IC4	0.248	0.5910	0.1370
NC4	0.394	1.0520	0.2470
NEO C5	0.000	0.0000	0.0000
IC5	0.040	0.1900	0.0180
NC5	0.038	0.2280	0.0100
C5+	0.016	0.0960	0.0010
RICHNESS (%)	3.370	6.2430	2.5520
P.C.S (KCAL/M3)	9738	10359	9538
DENSITY	0.630	0.6720	0.6160

Note:
. Consider the H2O content in the non-processed natural gas natural as saturated in H2O
. Consider the H2O content in processed natural gas as 5lb/MMft3 gas

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Learn more:
» Composition of Natural Gas
» Composition of the Natural Gas in the Campos Basin (Cabiúnas Station - Macaé)
» Comparison Between Natural Gas and Other Gases

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Natural Gas » What it is?

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Comparison between Natural Gas and other Gases

	NATURAL GAS	LPG	STREET GAS (MANUFACTURED)	REFINERY GAS
ORIGIN	UNASSOCIATED PETROLEUM AND GAS RESERVOIRS	PETROLEUM DISTILLATION AND GAS PROCESSING	THERMOCATALYTIC REFORM OF NATURAL GAS OR PETROCHEMICAL NAPHTHA	OIL REFINING PROCESSES (CATALYTIC CRACKING, DISTILLATION, REFORMING AND DELAYED COKING)
MOLECULAR WEIGHT	17 TO 21	44 TO 56	16	24
SUPERIOR HEATING POWER (KCAL/M3)	RICH: 10.900 PROCESSED: 9.300	24.000 TO 32.000	4.300	10.000
RELATIVE DENSITY	0.58 TO 0.72	1.50 TO 2.0	0.55	0.82
PRINCIPLE COMPONENTS	METHANE, ETHANE	PROPANE, BUTANE	HYDROGEN, METHANE, NITROGEN, CARBON MONOXIDE, CARBON DIOXIDE	HYDROGEN, NITROGEN, METHANE, ETHANEV
PRINCIPLE USES	RESIDENTIAL, COMMERCIAL, AUTOMOTIVE AND HERMOELECTRIC GENERATION: (FUEL) INDUSTRIAL: (FUEL, PETROCHEMICAL AND METALLURGICAL)	INDUSTRIAL, RESIDENTIAL AND COMMERCIAL (FUEL)	RESIDENTIAL AND COMMERCIAL (FUEL)	INDUSTRIAL (FUEL AND PETROCHEMICAL)
STORAGE PRESSURE	200 ATM	15 ATM	- - - -	- - - -

Comments :

Origin:
There is a fundamental difference between these gases in terms of origin: natural gas is found in nature in subterranean reservoirs, whereas all the other gases originate from industrial processes.

Molecular weight (and, in consequence, density):
LPG is the only one that is heavier than air. Therefore, in the event of a leak, it concentrates at ground level, whereas the others dissipate rapidly, or in enclosed environments, they concentrate at ceiling level. This difference is fundamental in directing actions in the event of gas leaks.

Heating power:
Street gas has the least heating power, therefore, larger quantities of this gas, in relation to others, are required to liberated the same quantity of energy from burning.

Principle components:
All of these are hydrocarbon-based, but street gas and refinery gas contain inorganic components in considerable proportions.

Principle uses:
Basically, refinery gas is for industrial use as a fuel and petrochemical raw materials; street gas is used as residential and commercial fuel; LPG, in addition to its residential and commercial use, is used as an industrial fuel, and there are applications for natural gas in all sectors, including the automotive sector. Note that the use of LPG in vehicles is prohibited by law. Moreover, this application is dangerous, due to improvisations and the lack of regulations regarding the equipment used for this purpose.

Storage pressure:
LPG is sold in 13 kg canisters and in 45 kg cylinders. In either case, when the containers are full, the pressure is approximately 15 atm. At this pressure and at room temperature, 85% of its volume is in the liquid state and 15 % is in the vaporous state. When natural gas is used in vehicles (VNG - vehicular natural gas), it is sold at service stations at 200 atm pressure, which is the final pressure in the vehicle's cylinder. Under these conditions, the quantity of natural gas in the cylinder is approximately 30 kg. It is distributed through the normal gas distribution networks for all other uses.

Source: Conpet

[top]

BACK

THE NATIONAL PETROLEUM AGENCY

ADMINISTRATIVE RULE # 104, DATED 8 JULY 2002

Establishes the specification for natural gas, whether national or imported, to be used commercially throughout national territory.

The DIRECTOR GENERAL of the NATIONAL PETROLEUM AGENCY – ANP in the exercise of its legal authority and functions, as provided for by Law #9.478, dated 06 August 1997 and Board of Director Resolution #455, dated 03 July 2002, hereby publishes the following act:

Art. 1º The specification of natural gas, whether of national origin or imported, to be used commercially throughout national territory, is hereby established in terms of this Administrative Rule, in accordance with the provisions contained in Technical Regulation ANP #3/2002, which forms an integral part of this Administrative Rule.

Art. 2º Importers, processors, carriers, transporters and distributors of natural gas that operate in the Country must obey the provision of the Technical Regulation attached to the stages of commercialization and transport.
Sole Paragraph. The sale and transport of natural gas not specified in the Technical Regulation are hereby authorized, provided the conditions of delivery by pipeline dedicated to the said product, the agreement among the parties involved and the limits of emission of combustible products established by the environmental organ having jurisdiction in the area, are respected.

Art. 3º For the purposes of this Administrative Rule, the following definitions are hereby established:

I. Carrier: a legal entity, duly registered as such, that contracts a transporter for the service of transporting natural gas;

II. Transporter: a legal entity, duly registered as such, and authorized by the ANP (The National Petroleum Agency) to operate transport installations;

III. Processador: pessoa jurídica autorizada pela ANP a processar o gás natural;

IV. Transport Installations: natural gas pipeline transport, compression stations, as well as storage facilities necessary for the operation of the system;

V. Reception Point: the point at which the natural gas is received by the transporter from the carrier or who authorizes such reception.

VI. Point of Delivery: at which the natural gas is delivered by the transporter to the carrier or who authorizes such delivery;

Art. 4 This Administrative Rule applies to processed natural gas to be used for industrial, residential, commercial, automotive and energy generation purposes.

Sole paragraph. The attached Technical Regulation does not apply to the use of natural gas as a raw material in chemical processes.

Art. 5 The carrier is obliged to carry out analyses of the natural gas at reception points, at intervals not exceeding 24 hours, as from the first supply and forward the result to the transporter by means of a Quality certificate, which must contain an analysis of all characteristics, specification limits and the methods employed, and proof that the product satisfies the specification contained in the attached Technical Regulation.

§ 1° The Certificate of Quality must contain the name of the technician in charge, together with his/her registration number with the competent professional organ.

§ 2° Any carrier who fails to carry out an analysis of natural gas, must complete the Certificate of Quality with the data supplied by the producer/importer that acquired the product, who shall then be considered responsible for its quality.

§ 3º The carrier must forward to the ANP (The National Petroleum Agency), by not later than the 15th (fifteenth) day of the following month, the document that refers to data sent, a statistical summary of the Certificates of Quality, issued by means of the electronic address carregadorgn@anp.gov.br, in the format of an electronic worksheet, which must contain:

I - ANP carrier code;

II – month and year relative to the data certificates;

III – total volume sold for the month;

IV - ANP code for the reception point at which the analysis was carried out;

V – table of results in accordance with the model below:

CHARACTERISTIC	UNIT	Test Method	Minimum	Maximum	Considered Average	Standard Deviation	Number of Analyses
Upper Heating Capacity kJ/m³	KJ/m^3						
Wobbe Index kJ/m³							
Methane % vol.	% vol.						
Ethane % vol.	% vol.						
Propane % vol.	% vol.						
Butane and heavier % vol.	% vol.						
Inerts (N2+ CO2) % vol.	% vol.						
Nitrogen % vol.	% vol.						
Oxygen % vol.	% vol.						
Hydrosulfuric Gas mg/m3	$mg/\ m^3$						
Dew Point of water, 1 atm (1) °C	ºC						

Note:
(1) Values referred to 20° C and 101,325 kPa except due point of water.
Where:

Minimum, Maximum – minimum and maximum value found in laboratory determinations for the month
Considered Average – considered average by volume of the object of the tests carried out during the month
Standard Deviation – standard deviation of average
Number of Analyses during the month.

Art. 6° The transporter is obliged to carry out an analysis of the product and issue a Conformity Report:

I – at all reception points after the homogenization of the mixture between gas entering and gas passing through, at maximum intervals of 24 hours from the first reception;

II – at all delivery points with an incidence of flow inversion in the transport pipeline and an outflow greater than 400 thousand m³/d during a maximum interval of 24 hours as from the first delivery.

§ 1° In cases where there is no mixture of distinct products, the transporter, who does not carry out an analysis, must complete the Conformity Report with the data contained in the Certificate of Quality sent by the carrier, who will then be held responsible for its quality.

§ 2º The transporter must send a copy of the Conformity Report, with the name of the technician in charge with his professional category number, to the carrier, proving the quality of the gas, by means of the presentation of the results, specification limits, and pertinent test methods relative to the analyses, containing the following characteristics:

I – upper heating capacity;

II- Wobbe Index;

III – contents of methane, ethane, propane, butane and heavier, inerts, nitrogen and oxygen.

§ 3º The transporter must, by not later than the 15th (fifteenth) day of the month following the data sent, a summary of Conformity Report statistics issued, via the electronic address transportadorgn@anp.gov.br, in the format of an electronic worksheet, containing the following:

I - ANP code for the transporter;

II – month and year of certified data;

III – total volume sold in the month;

IV - ANP code for analysis installation;

V – natural gas carrier code and

VI – table of results in accordance with the model below:

CHARACTERISTIC[1]	UNIT	Test Method	Minimum	Maximum	Considered Average	Standard Deviation	Number of Analyses
Upper Heating Capacity kJ/m³	kJ/m³						
Wobbe Index kJ/m³	kJ/m³						
Methane % vol.	% vol.						
Ethane % vol.	% vol.						
Propane % vol.	% vol.						
Butane and heavier % vol.	% vol.						
Inerts (N2+ CO2) % vol.	% vol.						
Nitrogen % vol.	% vol.						
Oxygen % vol.	% vol.						
Hydrosulfuric Gas mg/m3	mg/ m³						
Dew point of water, 1 atm (1) °C	ºC						

Note:
[1] The values referred to 20° C and 101,325 kPa.
Where:
Minimum, Maximum – minimum and maximum values found in laboratory determination during the month

Considered Average – considered average by volume of the object of analyses carried out during the month

Standard Deviation – standard deviation of average

Number of Analyses – total number of analyses during the month.

Art. 7º For the purposes of identifying the carrier, transporter, reception point and analysis installation. In accordance with the provisions of articles 5 and 6, the codes that will be permanently updated on the ANP page at the electronic address www.anp.gov.brmusst be used.

Art. 8º The ANP may at any time inspect the instruments used for the preparation of the Certificate of Quality and the Conformity Bulletin relative to natural gas specified in this Administrative Rule.

Art. 9º The Certificates of Quality issued by the carrier and the Conformity Bulletins issued by the transporter must be available to ANP whenever requested, for a minimum period of 2 (two) months as from that date of issue.

Art. 10º The natural gas must be odorized at transport in accordance with the requirements provided for during the environmental licensing process conducted by the environmental organ having jurisdiction over the area.

Art. 11º The natural gas must be odorized at distribution so that it can be detected by human smell in the event of a leak and when there is a concentration in the atmosphere that reaches 20% of the lower limit of inflammability.

Sole Paragraph: A request for the exemption of the use of odorization of natural gas in dedicated distribution pipelines whose destination does not recommend the use of odorization and such pipelines do not pass through urban areas must be addressed to the state organ having jurisdiction over the area in which analysis is performed and authorization is granted.

Art. 12º The periods established within which the agents referred to in article 2 hereof are to satisfy the specification limits contained in the Technical Regulation attached hereto, and the period within which the specifications contained in the ANP Administrative Rules #41 and #42, dated 15 April 1998, are to met, are set out below:

I – 180 days for the northeast region and

II –90 days for the north, central-west, south and southeast regions.

Art. 13º A period of 90 days as from the date of the publication of this Administrative Rule is hereby established in which carriers must present the first statistical summary of Quality Certificates in accordance with art 5 hereof.

Art. 14º A period of 180 days is hereby established in which transporter are to present the first statistical summary of Conformity Bulletins in accordance with article 6.

Art. 15º A failure to comply with the provisions of this Administrative Rule will subject the infractor to the penalties provided for in Law #9,847 dated 26 October 1999 and any other provisions that are applicable.

Art. 16º This Administrative Rule shall come into force and effects as from the date of its publication.

Art. 17º ANP Administrative Rule #128 dated 28 August 2001, and other provisions to the contrary, are hereby revoked, subject to the terms of article 12 of this Administrative Rule.

SEBASTIÃO DO REGO BARROS

Published in the Official Gazette on 9/7/2002

ATTACHMENT

ANP TECHNICAL REGULATION # 3/2002

1. Objective

This Technical Regulation applies to natural gas, whether national or imported, to be sold throughout national territory, and includes processed fuel gas that consists of a mixture of hydrocarbonates, mainly methane, ethane and heavier hydrocarbonates in smaller quantities.

1.1 Explicatory Note

Natural gas remains in a gaseous state under temperature and ambient pressures. It is produced by processing gas extracted from reservoirs and normally consists of inert gases, such as nitrogen and carbon dioxide, as well as traces of other elements.

The natural gas processing stage reduces concentrations of potentially corrosive components such as hydrogen sulfide, carbon dioxide, besides other components such as water and heavier hydrocarbonates, condensable when natural gas is transported and distributed.

2. System of Units

The system of units to be employed in this technical regulation is SI in accordance with Brazilian Standard NBR 12230.

Therefore, the unit of energy is J and its multiples or KWh, the unit of pressure is Pa and its multiples and the unit of temperature is K (Kelvin) or ºC (degrees Celsius).
The graph to be followed is determined by NBR 12230.

3. Characteristics

The tests contained in this specification referred to their respective meanings and performance properties, as well as other relevant definitions, are listed as follows.

The reference conditions employed in this Technical Regulation are temperature and pressure reference conditions equivalent to 293,15 K and 101,325 kPa on a dry basis.

3.1 Heating Capacity

3.1.1 Upper Heating Capacity

Quantity of energy released in the form of heat, on complete combustion of a defined quantity of gas with air, at a constant pressure and with all combustion products returning to the original temperature of the reagents. The water formed during combustion is in a liquid state.

3.1.2 Lower Heating Capacity

Quantity of heat released in the form of heat, on complete combustion of a defined quantity of gas with air, at a constant pressure and with all combustion products returning to the original temperature of the reagents. All products, including the water formed during combustion, are in a gaseous state.

Upper heating capacity differs from lower heating capacity because of thermal heat caused by condensation of water.

3.1.3 Reference State

The heating capacity reference values of the pure substances employed in this Technical Regulation were extracted from ISO 6976 under temperature and pressure conditions equivalent to 293,15 K, 101,325 kPa, respectively, on a dry basis.

3.2 Relative Density

The quotient between the mass of gas contained in an arbitrary volume and the mass of dry air having an ISSO 6976 standardized composition that must occupy the same volume under normal temperature and pressure conditions.

3.3 Wobbe Index

The quotient between heating capacity and the square root of relative density under the same reference temperature and pressure conditions.

INSERIR FIGURA3.EPS

Where:

IW – Wobbe Index

PCs – Upper heating capacity

r – relative density

The Wobbe index is the quantity of energy made available in a combustion system by means of an orifice injector. The quantity of energy made available is a linear function of the Wobbe index.

Two gases that present distinct compositions, but have the same Wobbe index, will make the same quantity of energy available by means of an orifice injector at the same pressure.

3.4 Methane Number

The methane number indicates the anti-knocking capacity of natural gas resulting from its application to vehicles, its limits being subject to a comparison with the octane rating of gasoline.

Anti-knocking power is the capacity of the fuel to resist knocking in vehicles at reigning temperature and pressure levels in the engine combustion chamber, caused by compression to which the air/fuel mixture is submitted.

The anti-knocking power of liquid fuels (gasoline) is measured by means of the octane rating (MON or RON). Typical octane rating values of natural gas is between 115 and 130, where methane is 140.

In order to obtain a better picture of the anti-knocking power of gas fuels, a new scale called octane number –NM (ON) that uses pure methane as a reference (NM (ON) = 100) and hydrogen (NM (ON) = 0) was developed. The procedure contained in ISO 15403 is used to calculate the methane number based on the composition of the gas.

3.5 Composition

Mass fractions or percentages, whether volumetric or molars of the principal components, associated components, traces and other components determined by means of an analysis of natural gas. For ideal gases the volumetric fraction equals the molar fraction.

Propane and heavier hydrocarbonates have a heating capacity, on a volumetric basis that is higher than that of methane. Although adequate for combustion engines, they are undesirable when used with an elevated content for vehicles because they have a very much lower anti-knocking capacity than methane, thus reducing the methane number. In regard to the use of natural gas processed in gas turbines or industrially, these present problems in regard to the quality of combustion.

3.6 Total Sulfur

Is the sum total of sulfur compounds present in natural gas.

Some sulfur compounds when in the presence of water cause the corrosion of steel and aluminum alloys. Sulfuric gas (H_2S) is the most critical compound in respect to corrosion and will be dealt with separately.

3.7 Hydrosulfuric Gas

Its presence depends on origin as well as the process employed in the treatment of the gas and can cause problems in piping and the end use of natural gas.

Hydrosulfuric gas in the presence of oxygen can cause corrosion when under pressure, especially in respect to copper, and can also be harmful to transport systems and the use of natural gas.

3.8 Dew Point

Dew point is the temperature at which the first drop of liquid occurs when gas undergoes cooling or compression. Liquids normally found are water, hydrocarbonates or glycol, which have distinct dew points. The most important safety requirement in respect to natural gas is the temperature of dew point in order to avoid the formation of liquid. Water in a liquid state is the precursor of the formation of corrosive compounds by means of the combination of natural gas components, specifically CO_2 and H_2S. The combination of corrosive agents and variable pressure during transport of the fuel may result in cracks in the metal and cause obstructions in the gas system.

Hydrates, formed when free water reacts with hydrocarbonates can obstruct instrumentation lines, control valves and filters.

3.9 Inert Gases

The principal inert components present in natural gas are carbon dioxide (CO_2) and nitrogen (N_2). Their presence in gaseous mixtures reduce heating capacity, besides increasing the resistance to knocking in the case of vehicles, and, consequently, the methane number

The presence of carbon dioxide is due to the natural gas extraction technique employed or because of the natural occurrence of this element in the origin of the product. Carbon dioxide has a corrosive action when in the presence of water.

3.10 Oxygen

Is present in low concentrations. Under these conditions it dilutes the fuel and is critical in the presence of water, even in low concentrations, because it could cause corrosion of metallic surfaces.

3.11 Solid particles

Causes contamination, obstruction and erosion of vehicle feed systems and industrial burner injector openings. When natural gas is destined for use as a turbine fuel, the solid particles can cause erosion of the parts that circulate the hot gas.

3.12 Liquid particles

Cause sharp alterations to flame temperature and in the gas turbine load, drawback of flame from pre-mixed flames and can nuclear the condensation of heavier natural gas fractions. When the presence of liquid is identified in the gas to be employed in gas turbines, separators are used and the flow is heated in order to vaporize the liquid phase.

4. Applicable standards

The definition of product characteristics is obtained by means of the use of American Society for Testing and Materials standards (ASTM), issued by the International Organization for Standardization" (ISO) and the Brazilian Association of Technical Standards (Associação Brasileira de Normas Técnicas) (ABNT).

Uncertainty, repetitivity and reproducibility data supplied within the methods related to this regulation, must only be used as guidelines for the acceptance of duplicate test results and must not be considered as a tolerance applied to the limits specified in this Regulation.

Product analysis must be conducted on a representative sample of the product obtained in accordance with the ISO 10715 method – Natural Gas: Sampling Guidelines.

Test Standards and Methods:

The characteristics contained in Table I, attached hereto, must be determined according to the most recent publication of the following test methods:

4.1 ABNT Standard

METHOD	TITLE
NBR 12230	SI – Prescriptions for its application

4.2 ASTM Standards

METHOD	TITLE
ASTM D 1945	Standard Test Method for Analysis of Natural Gas by Gas Chromatography
ASTM D 3588	Standard Practice for Calculating Heat Value, Compressibility Factor, and Relative Density (Specific Gravity) of Gaseous Fuels
ASTM D 5454	Standard Test Method for Water Vapor Content of Gaseous Fuels Using Electronic Moisture Analyzers
ASTM D 5504	Standard Test Method for Determination of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Chemiluminescence

4.3 ISSO Standards

METHOD	TITLE
ISSO 6326	Natural Gas – Determination of Sulfur Compounds, Parts 1 to 5
ISO 6570	Natural Gas – Determination of Potential Hydrocarbon Liquid Content, Parts 1 to 2
ISO 6974	Natural Gas – Determination of composition with defined uncertainty by gas chromatography, Parts 1 to 5
ISO 6976	Natural Gas – Calculation of calorific values, density, relative density and Wobbe index from composition
ISO 10715	Natural Gas – Sampling Guidelines
ISO 13686	Natural Gas – Quality Designation
ISO 15403	Natural Gas – Designation of the quality of natural gas for use as a compressed fuel for vehicles

Table I: Specification of Natural Gas [1]

CHARACTERISTIC	UNIT	LIMIT			METHOD	
Upper heating capacity(4)	kJ/m3 kWh/m3	North	Northeast	South, Southeast, Central-West	ASTM	ISO
Wobbe Index (5)	kJ/m3	34.000 a 38.400 9,47 a 10,67	35.000 a 42.000 9,72 a 11,67		D3588	6976
Methane, min	% vol.	40.500 a 45.000	46.500 a 52.500		-	6976

<table>
<tr><td>Ethane, max</td><td>% vol.</td><td colspan="2">68,0</td><td>86,0</td><td>D1945</td><td>6974</td></tr>
<tr><td>Propane, max.</td><td>% vol.</td><td colspan="2">12,0</td><td>10,0</td><td></td><td></td></tr>
<tr><td>Butane and heavier, max</td><td>% vol.</td><td colspan="3">3,0</td><td></td><td></td></tr>
<tr><td>Oxygen, max.</td><td>% vol.</td><td colspan="3">1,5</td><td></td><td></td></tr>
<tr><td>Inerts (N2+CO2), max.</td><td>% vol.</td><td>0,8</td><td>5,0</td><td>4,0</td><td></td><td></td></tr>
<tr><td>Nitrogen</td><td>% vol.</td><td>anotar</td><td colspan="2">2,0</td><td></td><td></td></tr>
<tr><td>Total Sulfur, max.</td><td>mg/m3</td><td colspan="3">70</td><td>D5504</td><td>6326-2
6326-5</td></tr>
<tr><td>Hydrosulfuric Gas (H2S), max.</td><td>mg/m3</td><td>10,0</td><td>15,0</td><td>10,0</td><td>D5504</td><td>6326-2
6326-5</td></tr>
<tr><td>Dew point of water at 1atm, max.</td><td>ºC</td><td>-39</td><td>-39</td><td>-45</td><td>D5454</td><td>-</td></tr>
</table>

Comments:
(1) O gás natural deve estar tecnicamente isento, ou seja, não deve haver traços visíveis de partículas sólidas e partículas líquidas.

(2) Specified limits are values referred to 293,15 K (20 ºC) and 101,325 kPa (1 atm) on a dry basis, except for dew point.

(3) Limits related to the North region are destined for a variety of uses except for use in vehicles, and for this specific use, must meet the limits equivalent to those set for the Northeast region.

(4) The heating capacity reference of pure substance employed in this Technical Regulation is found under temperature and pressure conditions equal to 293,15 K, 101,325 kPa, respectively on a dry basis.

(5) The Wobbe index is calculated by employing Upper Heating Capacity on a dry basis. When the ASTM D 3588 method is employed in order to obtain Upper Heating Capacity, the Wobbe index must be determined by means of the formula contained in the Technical Regulation.

(6) Odorized gas must not have a total sulfur content that exceeds70 mg/m³.

Appendix B-3
ULSD Fuel Specification Sheet

U. S. Oil & Refining Co.

3001 Marshall Avenue, Tacoma, Washington, 98421 (253) 383-1651

ULTRA LOW SULFUR DIESEL
Certificate of Analysis
Tank Number: TK80005
Batch Number:24-D-045
Volume in Bbl:
Contract Number: N/A
Barge, Ship or Tug Name: N/A

Property	ASTM Method	Specifications		
		Min.	2BMax	3BTest Result
Sulfur, ppm	D 7039		15	12.2
Distillation – 90% recovered, °C	D 86	282	338	329.4
Flash Point, °C	D 93	52		62
Gravity, API	D4052			34.6
Density, Kg/m^3	D 4052		876	851
Cloud Point - Summer[1]/Winter[2], °C	D 5771		-4/-10	-14.0
Viscosity @ 40°C,mm^2/S (cSt)	D7042	1.9	4.1	3.11
Cetane Index	D976	41		49.1
Corrosion, Copper Strip – 3h @ 50°C	D 130		1B	1A
Carbon – Residue on 10% dist, % mass	D 4530		0.35	0.027
Ash, mass %	D 482		0.01	<0.001
Water & Sediment, Volume %	D 2709		0.05	<0.05
Conductivity, pS/m	D2624	50		223
Lubricity, High Frequency Recip Rig (HFRR), µm@60°C	D 6079		520	500.0

This volume of neat or blended renewable diesel is designated and intended for the use as transportation fuel, heating oil, or jet fuel in the 48 U.S. contiguous states and Hawaii. Any person exporting this fuel is subject to the requirements of 40 CFR 80.1430. This volume of neat or blended renewable diesel may contain up to 5% renewable content.
15 ppm sulfur (maximum) Undyed Ultra-Low Sulfur Diesel Fuel. For use in all diesel vehicles and engines.
This product conforms to ASTM D 975 No.2-D S15 specification.

1) Summer: March 1 – October 31
2) Winter: November 1 – February 29
3) Clear and bright @ambient temperature

COA Created By:

KL Skrivan
U. S. Oil & Refining Co.
LABORATORY
Date: 8/13/2024

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Appendix C
NOC Application Supplemental Form – Form 50-169 (80,000 lb/hr Boiler)

PUGET SOUND
Clean Air Agency

1904 3rd Ave #105, Seattle, WA 98101
206-343-8800
pscleanair.gov

NOC APPLICATION SUPPLEMENTAL FORM

Boilers and Process Heaters

This application is for activities or equipment that is (check all that apply):

☒ New (including existing, unpermitted equipment)
☐ Physical or operational modification of existing equipment
☐ Relocation of existing equipment

Estimated date to begin construction: TBD   Estimated date to startup: TBD

Operating Data

Normal 24 hours/day 7 days/week 52 weeks/yr
Maximum 24 hours/day 7 days/week 52 weeks/yr

Boiler/Heater

Manufacturer: Cleaver Brooks   Model: CW-NB-300D-65
Max. Heat Input Rating: 96.9 MMBTU BTU per hour
Boiler Type: ☒ Water-Tube ☐ Fire-Tube
Turndown Ratio: 4:1   Percent Excess Air: 25%

Burner

Manufacturer(s): Cleaver Brooks   Model(s): TBD
Number of burners: 1   Rating of each burner: 96.9 MMBTU BTU per hour

Heat Transfer		
Heat Transfer Medium: Water		
Temperature (°F) Input: 235 Output: 358	Pressure (psia) Input: 135 Output: 135	Flow Rate (specify units): Average: 80,000 lb/hr Maximum: 80,000 lb/hr

Fuel Type (check all that apply)
☒ Natural Gas ☐ Liquefied Petroleum Gas ☐ Refinery Gas ☐ Digester Gas ☐ Landfill Gas ☐ Other ______ ☒ Fuel Oil (specify grade) ULSD Fuel Oil No. 2

Emission Controls (check all that apply)	**Exhaust Stack Parameters**
☒ Low NOx Burner ☒ Flue Gas Recirculation ☒ Oxygen Trim ☐ CO Catalyst ☐ Selective Catalytic Reduction (SCR) ☐ Selective Non-Catalytic Reduction (SNCR) ☐ Baghouse ☐ Electrostatic Precipitator ☐ Other, describe: ______	☐ Stack information is specified on NOC Application Supplemental Form for proposed control device ☒ Stack information is specified below: Stack diameter: 42 inches Stack height above ground: 55 feet Exhaust Flow Rate: 232,072 acfm Exhaust Temperature: 511 °F Building Dimensions of project location: Building Height (highest point of roof) 39 ft Building Width 72 ft Building Length 127.5 ft

Fuel Information

If gas or oil fuel is used, attach the fuel specification sheet requested below. If wood fuel is used, provide the following:

Heat Value: N/A Btu/lb wood - Specify if on: ☐ Wet or ☐ Dry basis

% bark: N/A

% sander dust: N/A

% reinjected cinders: N/A

% moisture: N/A

Required Attachments

1. Manufacturer specification sheets for boiler, burner(s), and each identified control device (including guaranteed emission rates).
2. Supplier-provided fuel specification sheet.
3. Any applicable Agency specific control device form.
   See: www.pscleanair.org/180/Source-Specific-Applications-for-Permits
4. A copy of each applicable New Source Performance Standard (NSPS) with the applicable portions of each rule marked.
5. A copy of each applicable National Emissions Standard for Hazardous Air Pollutants (NESHAP) with the applicable portions of each rule marked.

Appendix C-1
80,000 lb/hr Boiler Manufacturer Specification Sheets

1.0 INTRODUCTION

Only **Cleaver-Brooks' Engineered Boiler Systems** offers single source responsibility for every aspect of your industrial steam system projects, from burner to stack, custom built to fulfill your exact needs. Our **NEBRASKA boilers** and **CLEAVER BROOKS burners** have long been the industry benchmarks for quality and engineering. When they're incorporated into a complete system, built and maintained by us, you are getting the best solution, the highest efficiency, and the lowest emissions possible.

For your unique application, we are offering a packaged system with the following design features:

1.1 OUTLET STEAM CONDITIONS:

Gross Steam Capacity:	Qty(2) 80,000 lb/hr and qty(2) 30,000 lb/hr
Operating Pressure:	135 psig (at exit of non-return valve)
Steam Temperature:	Saturated
Steam Quality:	99.5% dry steam

1.2 BOILER DESIGN:

Type:	D-Type Industrial Watertube
Model #1 (30,000 lb/hr):	NB-100D-40
Model #2 (80,000 lb/hr):	NB-300D-65
Vessel Design Pressure:	250 psig

1.3 BURNER DESIGN:

Type:	Cleaver Brooks Low NOx Burner
Main Fuel:	Natural Gas
Backup Fuel:	ULSD

1.4 ECONOMIZER DESIGN:

Type:	Rectangular Finned-Tube
Arrangement:	Vertical Gas Flow; Counter-Current Water Flow
Inlet Feedwater Temp:	235°F

1.5 STACK DESIGN:

Type:	Freestanding - Economizer Mounted
Diameter (at exit):	(#1) 30 inches and (#2) 42 inches
Height (from grade):	55 feet

In partnership with our authorized representative, **Cole Industrial Inc.** in Seattle, we offer your true single-source solution for boiler, burner, emissions reduction, controls, heat recovery, exhaust solutions & local support.

4.0 BOILER DESIGN DATA

Boiler Vessel Dimensions:	**NB-100D-40**	**NB-300D-65**	**Units**
Height to Main Steam Outlet	11 Ft 5 In	14 Ft 7 In	FT
Overall Width of Unit	10 Ft 2 In	11 Ft 4 In	FT
Overall Length of Unit*	18 Ft 6 In	26 Ft 10 In	FT
***Add approximately 6-8 ft length for burner.*			
Weight of Unit (Dry Shipping)	28,582	54,178	LBS
Weight of Unit (Wet Operating)	38,603	74,255	LBS
Surface Area / Volume:			**Units**
Furnace Volume	460	1,285	FT3
Furnace Projected Area	360	769	FT2
Evaporator Area	1,994	4,356	FT2
Total Area	2,354	5,125	FT2
Economizer Area	2,588	5,823	FT2
Tubing Data:			**Units**
Tube OD – Furnace Section	2.0	2.0	IN
Tube Wall Thickness – Furnace Section	0.105	0.105	IN
Tube OD – Evaporator Section	2.0	2.0	IN
Tube Wall Thickness – Evaporator Section	0.105	0.105	IN
Tube Material – Furnace & Evaporator Sections	SA-178 A	SA-178 A	
Extended (Finned) Surface Tubes Utilized in Evaporator Bank	Yes	Yes	
Steam Drum:			**Units**
Inside Drum Diameter:	36	42	IN
Drum Length	14 FT Seam/Seam	22.3 FT Seam/Seam	FT
Drum Material:	SA-516 Grade 70	SA-516 Grade 70	
Corrosion Allowance:	N/A	N/A	IN
Water Drum:			**Units**
Drum Diameter:	24	24	IN
Drum Length	14 FT Seam/Seam	22.3 FT Seam/Seam	FT
Drum Material:	SA-106 Grade B	SA-106 Grade B	
Corrosion Allowance:	N/A	N/A	IN

**The above information is preliminary and shall be confirmed at time of engineering submittal.*

Fuel: Natural Gas – NB-300D-65

Boiler load - %	**100%**	**75%**	**50%**	**25%**	**16.7%**	**Units**
Steam Flow - Gross Production	80,000	60,000	40,000	20,000	13,336	Lb/Hr
Net Steam Flow – To Process	80,000	60,000	40,000	20,000	13,336	Lb/Hr
Pegging Steam	-	-	-	-	-	Lb/Hr
Steam Pressure – Operating	135	135	135	135	135	PSIG
Steam Temperature	358	358	358	358	358	°F
Fuel Input (HHV)	96.9	72.2	47.9	24.0	16.1	MMBTU/Hr
Ambient Air Temperature	50	50	50	50	50	°F
Relative Humidity	60	60	60	60	60	%
Excess Air	25	25	25	25	30	%
Flue Gas Recirculation	25	25	25	25	25	%
Steam Output Duty	79.6	59.7	39.8	19.9	13.3	MMBTU/hr
Heat Release Rate	75,379	56,186	37,298	18,679	12,554	BTU/FT3-Hr
Heat Release Rate	125,946	93,877	62,320	31,210	20,977	BTU/FT2-Hr
Furnace Heat Flux	26,668					BTU/FT2-Hr
Feed Water Temperature	235	235	235	235	235	°F
Water Temp. Leaving Economizer	308	299	290	281	281	±10°F
Blow Down	3.0	3.0	3.0	3.0	3.0	%
Boiler Gas Exit Temperature	511	466	419	378	368	±10°F
Economizer Gas Exit Temp.	316	292	271	252	248	±10°F
Air Flow	87,767	65,420	43,428	21,749	15,202	Lb/Hr
Flue Gas to Stack	92,092	68,643	45,568	22,821	15,923	Lb/Hr
Flue Gas Including FGR	115,116	85,804	56,961	28,526	19,904	Lb/Hr
Fuel Flow	4,325	3,223	2,140	1,071	720	Lb/Hr
Flue Gas Losses/Efficiency-%						
Dry Gas Loss	5.5	5.0	4.5	4.2	4.2	%
Air Moisture Loss	0.0	0.0	0.0	0.0	0.0	%
Fuel Moisture Loss	11.1	11.0	10.9	10.8	10.8	%
Casing Loss	0.3	0.4	0.6	1.2	1.8	%
Margin	1.0	1.0	1.0	1.0	1.0	%
Efficiency - LHV	91.1	91.6	92.0	91.8	91.1	%
Efficiency – HHV	82.1	82.6	82.9	82.8	82.1	%
Total Pressure Drop Including Economizer	12.20	6.72	2.92	0.74	0.36	IN WC
Products of Combustion - CO2	7.80	7.80	7.80	7.80	7.52	%
- H2O	15.94	15.94	15.94	15.94	15.39	%
-N2	72.42	72.42	72.42	72.42	72.64	%
-O2	3.84	3.84	3.84	3.84	4.45	%
-SO2	0.00	0.00	0.00	0.00	0.00	%
GAS- % volume	**NG**					
methane	95.0	% vol.				
ethane	2.0	% vol.				
carbon dioxide	1.0	% vol.				
nitrogen	2.0	% vol.				
hydrogen sulfide	1.0E-4	% vol.				
LHV	20,202	btu/lb				
HHV	22,404	btu/lb				

**The above information is preliminary and shall be confirmed at time of engineering submittal.*

Fuel: ULSD – NB-300D-65

Boiler load - %	**100%**	**75%**	**50%**	**25%**		**Units**
Steam Flow - Gross Production	80,000	60,000	40,000	20,000		Lb/Hr
Net Steam Flow – To Process	80,000	60,000	40,000	20,000		Lb/Hr
Pegging Steam	-	-	-	-		Lb/Hr
Steam Pressure – Operating	135	135	135	135		PSIG
Steam Temperature	358	358	358	358		°F
Fuel Input (HHV)	92.0	68.7	45.7	22.9		MMBTU/Hr
Ambient Air Temperature	50	50	50	50		°F
Relative Humidity	60	60	60	60		%
Excess Air	25	25	25	25		%
Flue Gas Recirculation	25	25	25	25		%
Steam Output Duty	79.6	59.7	39.8	19.9		MMBTU/hr
Heat Release Rate	71,600	53,438	35,512	17,796		BTU/FT3-Hr
Heat Release Rate	119,632	89,287	59,335	29,734		BTU/FT2-Hr
Furnace Heat Flux	36,389					BTU/FT2-Hr
Feed Water Temperature	235	235	235	235		°F
Water Temp. Leaving Economizer	301	293	285	278		±10°F
Blow Down	3.0	3.0	3.0	3.0		%
Boiler Gas Exit Temperature	493	453	411	376		±10°F
Economizer Gas Exit Temp.	306	286	267	251		±10°F
Air Flow	84,089	62,759	41,707	20,900		Lb/Hr
Flue Gas to Stack	88,740	66,230	44,013	22,056		Lb/Hr
Flue Gas Including FGR	110,925	82,788	55,017	27,570		Lb/Hr
Fuel Flow	4,666	3,482	2,314	1,159		Lb/Hr
Flue Gas Losses/Efficiency-%						
Dry Gas Loss	5.6	5.1	4.7	4.4		%
Air Moisture Loss	0.0	0.0	0.0	0.0		%
Fuel Moisture Loss	6.6	6.6	6.5	6.5		%
Casing Loss	0.3	0.4	0.6	1.2		%
Margin	1.0	1.0	1.0	1.0		%
Efficiency - LHV	92.1	92.6	92.8	92.6		%
Efficiency – HHV	86.5	86.9	87.1	86.9		%
Total Pressure Drop Including Economizer	10.93	6.05	2.66	0.68		IN WC
Products of Combustion - CO_2	10.99	10.99	10.99	10.99		%
- H_2O	10.11	10.11	10.11	10.11		%
- N_2	74.99	74.99	74.99	74.99		%
- O_2	3.92	3.92	3.92	3.92		%
- SO_2	0.00	0.00	0.00	0.00		%
OIL- % weight	**#2**					
Carbon	86.9	% wt.				
Hydrogen	12.5	% wt.				
Sulfur	0.0	% wt.				
Oxygen	0.58	% wt.				
Nitrogen	0.0	% wt.				
°API	32.0					
LHV	18,511	btu/lb				
HHV	19,726	btu/lb				

**The above information is preliminary and shall be confirmed at time of engineering submittal.*

14.0 COMMENTS

14.1 TECHNICAL CLARIFICATIONS

Equipment is offered per Cleaver-Brooks Engineered Boiler System's standard design & construction, unless otherwise noted. Scope of supply shall be as outlined in this proposal.

This proposal is based on information from the specifications received and noted below.

NBF Boilers and associated equipment Specification 4.01.2019

Page	Section	Comments
235233 - 1	1.2.C	Plant Master not included
235233 – 4	1.2.D.13	This proposal includes a fully metered system. Jackshaft system is not included and not required.
235233 – 3	2.2	UPS is by others
235233 - 14	2.3.C	The burner main fuel gas train is designed for a minimum fuel supply pressure of 30 psig at the train inlet.
235233 - 14	2.3.C	With current pressure supply of 50 psig, the turndown is 4:1. The burner and fuel oil train have been designed for a minimum fuel supply pressure of 90 psig at the train inlet. Please ensure the oil pump-set (supplied by others) is sized accordingly
235233 - 14	2.3.C	The atomizing steam train has been designed for a supply pressure of 100 psig at the train inlet.
		CB has assumed fuel compositions for typical, pipeline quality Natural Gas. Please confirm actual fuel composition. Any required modifications to scope shall be charged at extra cost.

General Notes:

As an OEM, Cleaver-Brooks is providing equipment only. Any references in the specifications to field work (including erection, installation, etc…) are not currently included.

Since the Low NOx Burner utilizes Flue Gas Recirculation (FGR) to meet low emissions, we highly recommend that the inlet combustion air to be maintained above the dew point temperature to avoid condensation that accumulates inside the boiler, burner and air handling equipment. Large variations in combustion air temperature (maximum differential temperature is 50^0F) affect the combustion process. An inlet air preheater is required during cold temperature conditions when inlet combustion air is taken directly from outdoor ambient conditions. A preheater is/is not included in our scope at this time, but can be provided upon request.

The operational turndown is as listed in this proposal. Emissions guarantees are separate and valid from 25-100% unless stated otherwise.

We are offering our standard welding & NDE procedures at this time. Details can be provided upon request.

Boiler safety valves shall be set at the design pressure of the boiler. Lower set pressures can be provided for a price adder available upon request.

Please note that all the equipment of the scope of this contract could include some parts that are made of copper based material. If there are any specific reasons not to use copper based materials, please

15.0 PERFORMANCE GUARANTEES

Cleaver-Brooks offers the following performance guarantees specific to this project:

PROCESS GUARANTEES (FIRING NATURAL GAS ONLY)	VALUE	UNIT
Maximum Continuous Rating (MCR) Steam Flow (at exit of non-return valve)	30,000 / 80,000	lb/hr
Operating Steam Pressure (at exit of non-return valve)	135	psig
Operating Steam Temperature (at exit of non-return valve at 100% MCR)	Saturated	°F
Boiler Feedwater Inlet Temperature	235°F	°F
Inlet Combustion Air Temperature	50	°F
Inlet Combustion Air Relative Humidity	60	%
Boiler Thermal Efficiency (Based on HHV and ASME PTC 4 Input-Output Method)	81.8 / 82.1	%
Steam Purity (With ASME Quality Water per Attached)	99.5% dry steam	
Maximum Noise Rating (at 3 Ft in a free field)	85	dBA

BURNER EMISSIONS

Guaranteed Emissions; 25% to 100% MCR corrected to 3 %O_2 on a dry basis.		**Natural Gas**	**ULSD**
		25%-100% MCR	**25%-100% MCR**
NO_x	lb/MMBtu	0.011	0.130
CO	lb/MMBtu	0.036	0.080

Based on:
CB technician is required for start-up and adjustments.
EA (excess air) and FGR rates are expected only and not guaranteed. Please refer to boiler performance for guaranteed boiler efficiency.
PM is exclusive of any particulates in combustion air or other sources of residual particulates from material.

We are offering the above guarantees. All other data contained in this proposal is predicted only and will be finalized at time of engineering submittal after receipt of award. Guarantees are based on the unit being operated per the requirements of the operation and maintenance manual.

If performance testing is required, it is the Buyer's responsibility to provide steam load (or steam vent to atmosphere) and have the equipment tested by a third party during the stated warranty period. If equipment passes such tests, or the tests are not performed before the end of the warranty period, it will be assumed that the equipment is accepted. The cost of all tests is the responsibility of the Buyer.

The operational turndown is as listed above. Emissions guarantees are separate and valid from 25-100% unless stated otherwise.

The addition of any of the priced options listed above may impact the design, performance, and/or schedule as listed in this proposal and Seller provided datasheets (if applicable).

6940 Cornhusker Highway
Lincoln, NE 68507
402.434.2000
cleaverbrooks.com

Typical emissions for industrial watertube boilers. Consult proposal for guarantees.

"Standard" Burner Emissions Values (in lb/mmbtu)

	Natural Gas	#2 Oil	#6 Oil
NOx	0.100	0.138	0.422
CO	0.037	0.057	0.076
SO_x	0.0006	0.051	2.19
VOC	0.004	0.006	0.008
PM_{total}	0.005	0.024	0.144

"Low-NOx" Burner Emissions Values (in lb/mmbtu)

	Natural Gas	#2 Oil	#6 Oil
NOx	0.036	0.088	0.373
CO	0.037	0.057	0.076
SO_x	0.0006	0.051	0.540
VOC	0.004	0.006	0.008
PM_{total}	0.005	0.024	0.144

"Ultra Low-NOx" Burner Emissions Values (in lb/mmbtu)

	Natural Gas	#2 Oil	#6 Oil
NOx	0.011	0.075	NA
CO	0.037	0.057	NA
SO_x	0.0006	0.051	NA
VOC	0.004	0.006	NA
PM_{total}	0.005	0.024	NA

Natural Gas
Pipeline quality, HHV of 1,040 BTU/SCF, 0.2 grain/100SCF total sulfur as sulfur.
#2 fuel oil
ASTM D975 S500, HHV of 140,000 BTU/gal, < 0.02 % wt fbn, < 0.05 % wt sulfur, < 0.01 % wt ash.
#6 fuel oil
HHV of 150,000 BTU/gal, < 0.3 % wt fbn, < 2.0 % wt sulfur, < 0.1 % wt ash.

PM total includes filterable and condensable. PM10 and 2.5 values are smaller or equal to PM total.

The above values are based on industry averages and may or may not represent requirements for any given region of the United States. Emissions regulations vary from state-to-state.

Appendix D
New Source Performance Standard (NSPS) Applicability Review

New Source Performance Standard (NSPS) Regulation Applicability

40 *Code of Federal Regulations* (CFR) Part 60, Subparts A and Dc applies because the two (2) new 30,000 pounds per hour (lb/hr) (36.5 million British thermal units per hour [MMBtu/hr]) boilers and the two (2) new 80,000 lb/hr (96.9 MMBtu/hr) boilers do not meet the definition of a temporary boiler for this NSPS. Key applicable requirements for the four boilers, each of which will be fired on natural gas and ultra-low sulfur diesel as a backup fuel, are summarized as follows:

40 CFR part 60 Subpart Dc Section 60.48c: Reporting and Recordkeeping Requirements

(a) The owner or operator of each affected facility shall submit notification of the date of construction or reconstruction and actual startup, as provided by 40 CFR Section 60.7 of Part 60. This notification shall include:

(1) The design heat input capacity of the affected facility and identification of fuels to be combusted in the affected facility.

(3) The annual capacity factor at which the owner or operator anticipates operating the affected facility based on all fuels fired and based on each individual fuel fired.

(g)

(1) Except as provided under paragraphs (g)(2) and (g)(3) of Section 60.48c, the owner or operator of each affected facility shall record and maintain records of the amount of each fuel combusted during each operating day.

(2) As an alternative to meeting the requirements of paragraph (g)(1) of Section 60.48c, the owner or operator of an affected facility that combusts only natural gas, wood, fuels using fuel certification in §60.48c(f) to demonstrate compliance with the SO_2 standard, fuels not subject to an emissions standard (excluding opacity), or a mixture of these fuels may elect to record and maintain records of the amount of each fuel combusted during each calendar month.

(3) As an alternative to meeting the requirements of paragraph (g)(1) of this section, the owner or operator of an affected facility or multiple affected facilities located on a contiguous property unit where the only fuels combusted in any steam generating unit (including steam generating units not subject to this subpart) at that property are natural gas, wood, distillate oil meeting the most current requirements in 40 CFR Section 60.42c to use fuel certification to demonstrate compliance with the SO_2 standard, and/or fuels, excluding coal and residual oil, not subject to an emissions standard (excluding opacity) may elect to record and maintain records of the total amount of each steam generating unit fuel delivered to that property during each calendar month.

(i) All records required under this section shall be maintained by the owner or operator of the affected facility for a period of two years following the date of such record.

(j) The reporting period for the reports required under this subpart is each six-month period. All reports shall be submitted to the Administrator and shall be postmarked by the 30th day following the end of the reporting period.

Appendix E
Air Dispersion Modeling Report

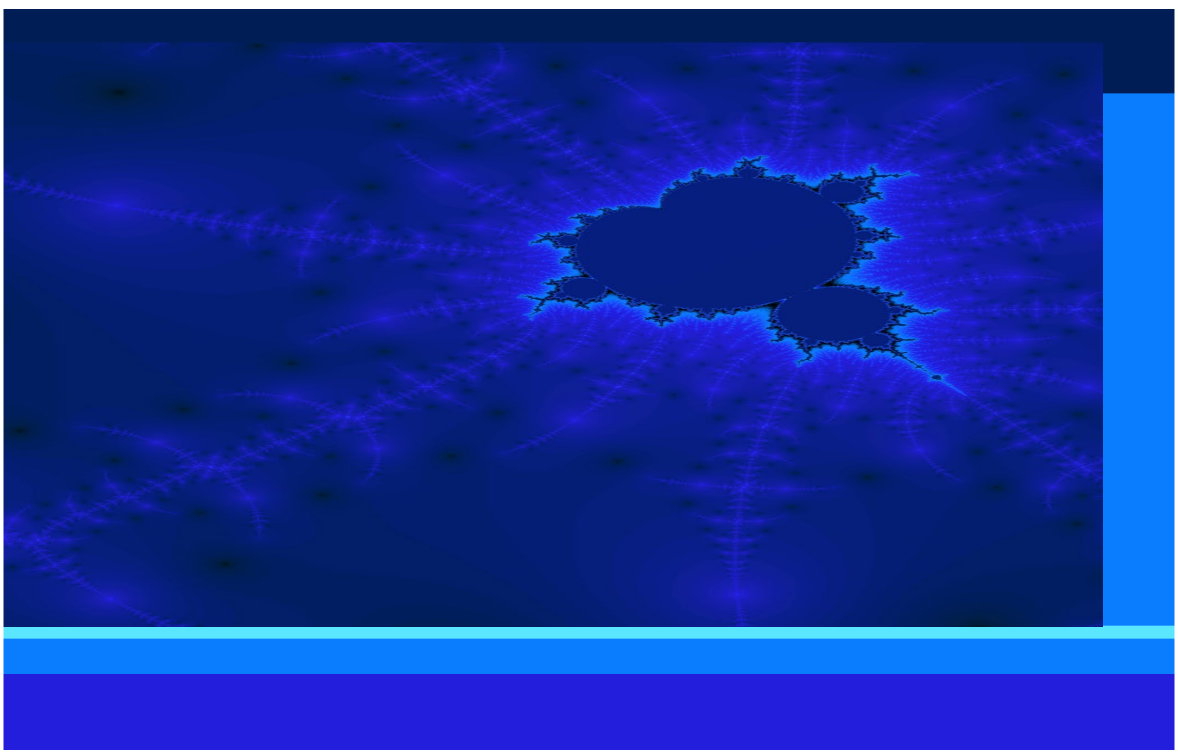
Dispersion Modeling Report

Version: Final

North Boeing Field/Plant 2 Site Boilers
The Boeing Company

Document No: 250528213830_bc8ac5fe

June 2025



Dispersion Modeling Report

Client Name:	The Boeing Company		
Project Name:	North Boeing Field/Plant 2 Site Boilers		
Project No.:	Michelle Neumann/Jacobs		
Document No:	250528213830_bc8ac5fe	Project Manager:	Michelle Neumann/Jacobs
Version:	Final	Prepared by:	Jacobs Team
Date:	June 2025		

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Contents

Attachment

Tables

Figures

Acronyms and Abbreviations

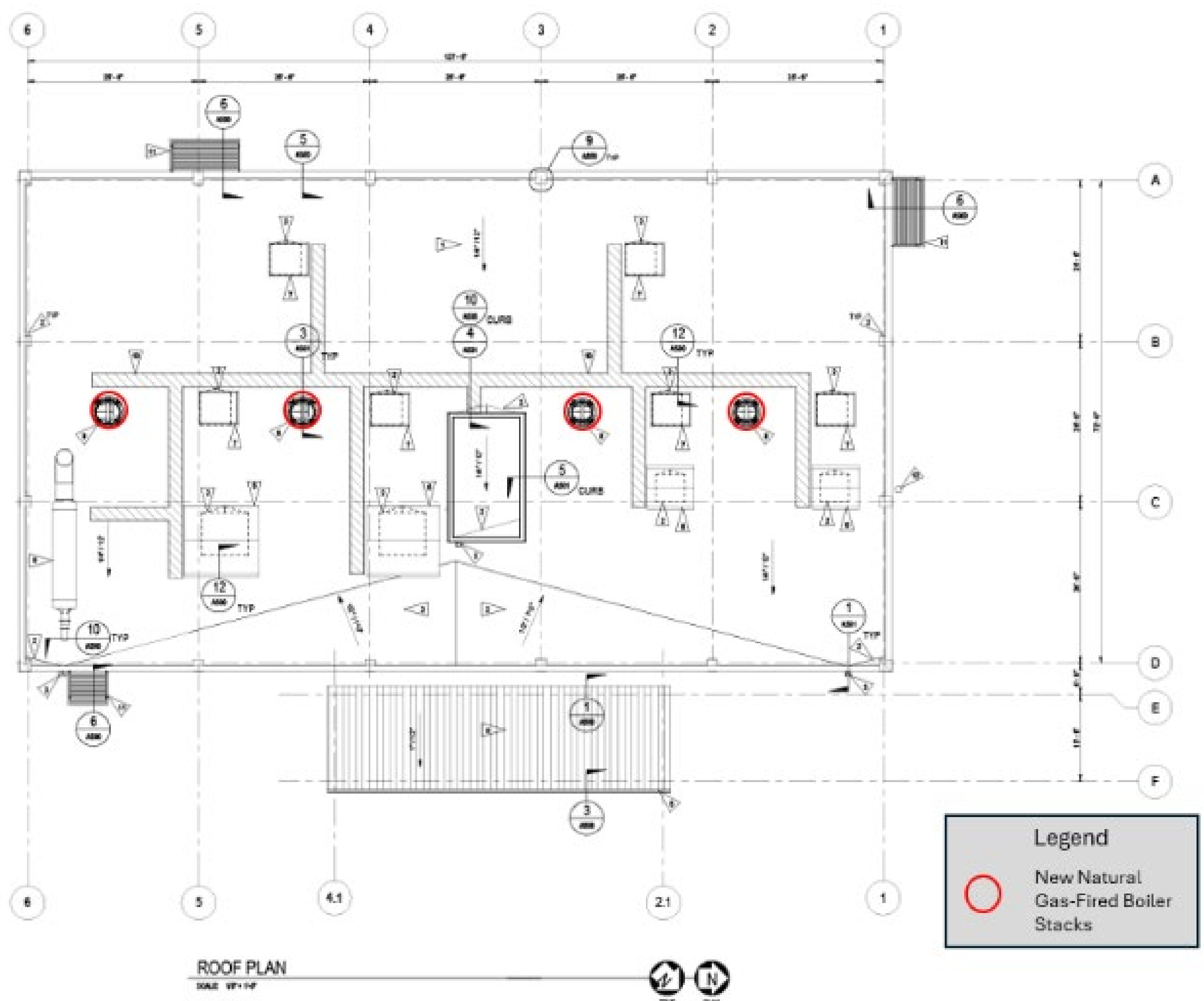
μg/m^3	microgram(s) per cubic meter
ASIL	acceptable source impact level
CAS	Chemical Abstracts Service
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ID	Identification
K	Kelvin
km	kilometer(s)
lb/24-hr	pound(s) per 24-hours
lbs/hr	pound(s) per hour
lb/yr	pound(s) per year
m	meter(s)
m/s	meter(s) per second
MET	meteorological
MMBtu/hr	million British thermal units per hour
NOC	Notice of Construction
PRIME	Plume Rise Model Enhancement
PTE	Potential to Emit
Site	North Boeing Field/Plant 2 Site
SQER	small quantity emission rate
TAP	toxic air pollutant
tpy	ton(s) per year
ULSD	ultra-low sulfur diesel
WAC	Washington Administrative Code

1. Introduction

This report summarizes the toxic air pollutant (TAP) dispersion modeling methodology and analysis results for the North Boeing Field/Plant 2 Site (site) boiler house operation in Seattle, Washington. This analysis is a first tier review as part of Boeing's 2025 Notice of Construction (NOC) permit application for the new TAP sources at the Site. Jacobs completed this analysis on behalf of Boeing in accordance with the Washington State Department of Ecology's *Guidance Document for First, Second and Third Tier Review of Toxic Air Pollution Sources* (Ecology 2015) and the U.S. Environmental Protection Agency's *Guideline on Air Quality Models* (EPA 2024).

Figure 1-1 shows the site plan of the boilers to be located in Building 3-150.

Figure 1-1. Site Plan for Building 3-150



1.1 Estimated Emissions

A detailed TAP emissions summary is included in Table 3-2 of the NOC application. Table 1-1 summarizes the project TAP emissions that exceed Ecology's small quantity emission rate (SQER) thresholds, which triggered a Tier 1 TAP refined air dispersion modeling analysis.

Table 1-1. Toxic Air Pollutant Emission Summary for Modeling

Pollutant	CAS Number	Total Project Emissions (Natural Gas + ULSD)			SQER Thresholds		
		lb/hr	lb/24-hr	lb/yr	lb/hr	lb/24-hr	lb/yr
Acrolein	107-02-8	0.34	1.01	9.82	-	0.026	-
Arsenic	7440-38-2	0.01	0.02	0.46	-	-	0.049
Cadmium	7440-43-9	0.00	0.01	2.47	-	-	0.039
Formaldehyde	50-00-0	0.32	1.24	130.02	-	-	27
Hexavalent chromium	--	2.78E-04	8.08E-04	4.85E-03	-	-	6.50E-04
Hydrogen chloride	7647-01-0	0.35	1.03	6.18	-	0.67	-
Hydrogen fluoride	7664-39-3	0.35	1.03	6.18	-	1.00	-
Hydrogen sulfide	7783-06-4	0.35	1.03	6.18	-	0.15	-
Mercury	7439-97-6	4.10E-03	0.01	0.58	-	2.20E-03	-
Nitrogen dioxide	10102-44-0	3.47	16.27	2,570.88	0.87	-	-

Notes:

- = not applicable

CAS = Chemical Abstracts Service

lbs/hr = pound(s) per hour

lb/24-hr = pound(s) per 24-hours

lb/yr = pound(s) per year

ULSD = ultra-low sulfur diesel

1.2 Acceptable Source Impact Level

Table 1-2 summarizes applicable acceptable source impact level (ASIL) TAP modeling standards for this project in Washington.

Table 1-2. Acceptable Source Impact Levels

Pollutant	Washington Pollutant Common Name	CAS Number	Averaging Period	Applicable ASIL (µg/m^3)
Acrolein	Acrolein	107-02-8	24-Hour	0.35
Arsenic	Arsenic & inorganic arsenic compounds, NOS	7440-38-2	Annual	0.0003
Cadmium	Cadmium & compounds, NOS	7440-43-9	Annual	0.00024
Formaldehyde	Formaldehyde	50-00-0	Annual	0.17
Hexavalent chromium	Chromium (VI) & compounds, NOS	--	Annual	0.000004
Hydrogen chloride	Hydrogen chloride	7647-01-0	24-Hour	9
Hydrogen fluoride	Hydrogen fluoride	7664-39-3	24-Hour	14
Hydrogen sulfide	Hydrogen sulfide	7783-06-4	24-Hour	2
Mercury	Mercury, elemental	7439-97-6	24-Hour	0.03
Nitrogen dioxide	Nitrogen dioxide	10102-44-0	1-Hour	470

Source: Washington Administrative Code (WAC) 173-460-150.

µg/m^3 = microgram(s) per cubic meter

2. Tier 1 TAP Modeling Methodology

This section presents the Tier 1 TAP modeling methodology utilized for dispersion model setup, source characterization, building downwash, and receptors.

2.1 Dispersion Modeling

The American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) (Version 24142) was used with regulatory default options as recommended in EPA's *Guideline on Air Quality Models* (EPA 2024). The following supporting preprocessing programs for AERMOD were used:

- BPIP-Prime (Version 04274)
- AERMET (Version 24142)
- AERMAP (Version 24142)

AERMOD is a steady-state plume model that simulates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. This model is recommended for short-range (less than 50 kilometers [km]) dispersion from the source. The model incorporates the Plume Rise Model Enhancement (PRIME) algorithm for modeling building downwash. AERMOD is designed to accept input data prepared by two specific preprocessor programs, AERMET and AERMAP. AERMOD was run with the following options:

- Regulatory default options
- Direction-specific building downwash
- Actual receptor elevations and hill height scales obtained from AERMAP

2.2 Source Characterization

The proposed sources have been modeled as point sources. Modeling reflects approximate locations and may be updated as the design progresses. Tables 2-1 and 2-2 contain source parameter information and emission rates, respectively, for all sources included in the modeling. Figure 2-1 shows the source layout.

Table 2-1. Proposed New Boiler Stack Source Parameters

Source ID	Source Description	Base Elevation (m)[a]	Stack Height (m)	Temp. (K)	Exit Velocity (m/s)	Stack Diameter (m)
BOIL_1	36.5 MMBtu/hr Dual Fuel	3.00	16.76	548.71	62.80	0.91
BOIL_2	36.5 MMBtu/hr Dual Fuel	3.00	16.76	548.71	62.80	0.91
BOIL_3	96.9 MMBtu/hr Dual Fuel	3.00	16.76	539.26	122.54	1.07
BOIL_4	96.9 MMBtu/hr Dual Fuel	3.00	16.76	539.26	122.54	1.07

[a] Base elevation of the sources determined using AERMAP.

ID = Identification

K = Kelvin

m = meter(s)

m/s = meters per second

MMBtu/hr = million British thermal units per hour

For the 1-hour emissions, the Potential to Emit (PTE) was calculated by taking the maximum of all four boilers emitting natural gas or all four boilers emitting ULSD. For the 24-hour emissions, the PTE was calculated by taking the maximum of all four boilers emitting natural gas or three boilers (two 36.5 MMBtu/hr and one 96.9 MMBtu/hr) emitting natural gas for 24 hours and one 96.9 MMBtu/hr boiler emitting natural gas for 16 hours and ULSD for 8 hours. For annual emissions, the PTE was calculated for three boilers (two 36.5 MMBtu/hr and one 96.9 MMBtu/hr) emitting natural gas for 8,760 hours and one 96.9 MMBtu/hr boiler emitting natural gas for 8,712 hours and ULSD for 48 hours.

Table 2-2. Modeled Source Emission Rates

Pollutant	CAS Number	Averaging Period	Units	BOIL_1	BOIL_2	BOIL_3	BOIL_4
Acrolein	107-02-8	24-Hour	lb/hr	9.45E-05	9.45E-05	2.51E-04	4.17E-02
Arsenic	7440-38-2	Annual	tpy	3.13E-05	3.13E-05	8.30E-05	1.38E-04
Cadmium	7440-43-9	Annual	tpy	1.69E-04	1.69E-04	4.48E-04	4.68E-04
Formaldehyde	50-00-0	Annual	tpy	8.89E-03	8.89E-03	2.36E-02	2.63E-02
Hexavalent chromium	--	Annual	tpy	0.00E+00	0.00E+00	0.00E+00	2.43E-06
Hydrogen chloride	7647-01-0	24-Hour	lb/hr	0.00E+00	0.00E+00	0.00E+00	4.29E-02
Hydrogen fluoride	7664-39-3	24-Hour	lb/hr	0.00E+00	0.00E+00	0.00E+00	4.29E-02
Hydrogen sulfide	7783-06-4	24-Hour	lb/hr	0.00E+00	0.00E+00	0.00E+00	4.29E-02
Mercury	7439-97-6	24-Hour	lb/hr	9.10E-06	9.10E-06	2.42E-05	5.12E-04
Nitrogen dioxide	10102-44-0	1-Hour	lb/hr	4.75E-01	4.75E-01	1.26E+00	1.26E+00

tpy = ton(s) per year

Figure 2-1. Model Layout

2.3 Building Downwash

Building influences on stacks were calculated by incorporating the updated EPA BPIP-PRIME algorithm. The stack heights used in the dispersion modeling are the proposed stack heights. The proposed building associated with the boiler house was included in this modeling analysis. The attachment to this report contains the building coordinates and heights used in the model.

2.4 Receptors

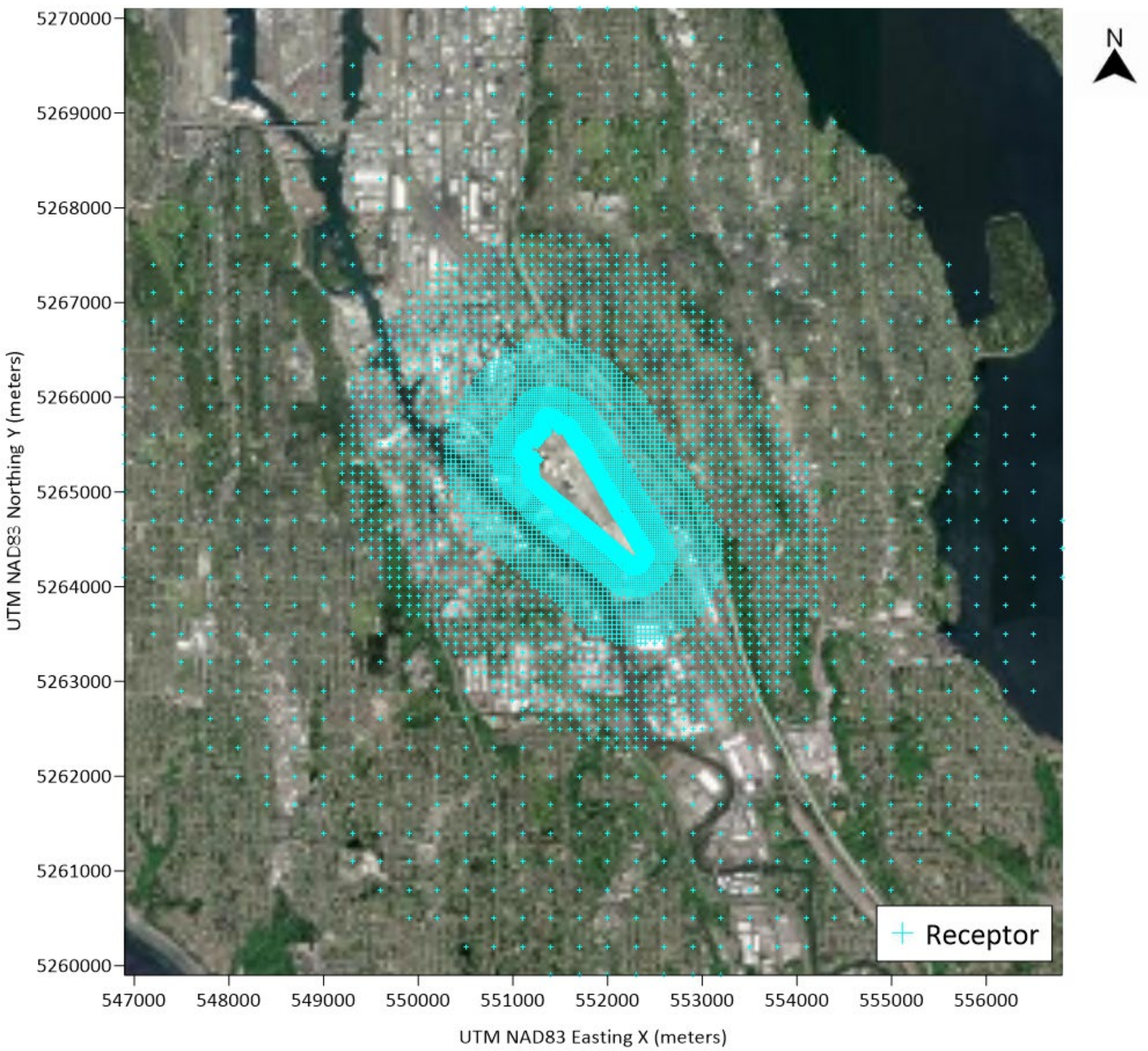
The ambient air boundary was defined by the fenceline surrounding the Site. The AERMOD receptors were selected based on Ecology's *Guidance on First, Second, and Third Tier Review of Air Toxics* (Ecology 2015) and are as follows:

- 12.5-meter (m) spacing along the fenceline
- 12.5-m spacing from the fenceline to 150 m from grid origin (centered at the approximate midpoint of the modeled sources)

- 25-m spacing from beyond 150 m to 400 m from the grid origin
- 50-m spacing from beyond 400 m to 900 m from the grid origin
- 100-m spacing from beyond 900 m to 2 km from the grid origin
- 300-m spacing from beyond 2 km to 4.5 km from the grid origin

AERMAP (Version 24142) was used to process terrain elevation data for all sources and receptors using National Elevation Dataset files with a 10-m resolution prepared by the U.S. Geological Survey. AERMAP first determined the base elevation at each building and receptor. AERMAP created hill height scale by searching for the terrain height and location that has the greatest influence on dispersion for each individual receptor. Both the base elevation and hill-height scale data were produced for each receptor by AERMAP as a file or files that were directly accessed by AERMOD. All receptors and source locations were expressed in the Universal Transverse Mercator North American Datum 1983 (NAD83), Zone 10 coordinate system. The receptor grid is shown in Figure 2-2.

Figure 2-2. Receptor Grid

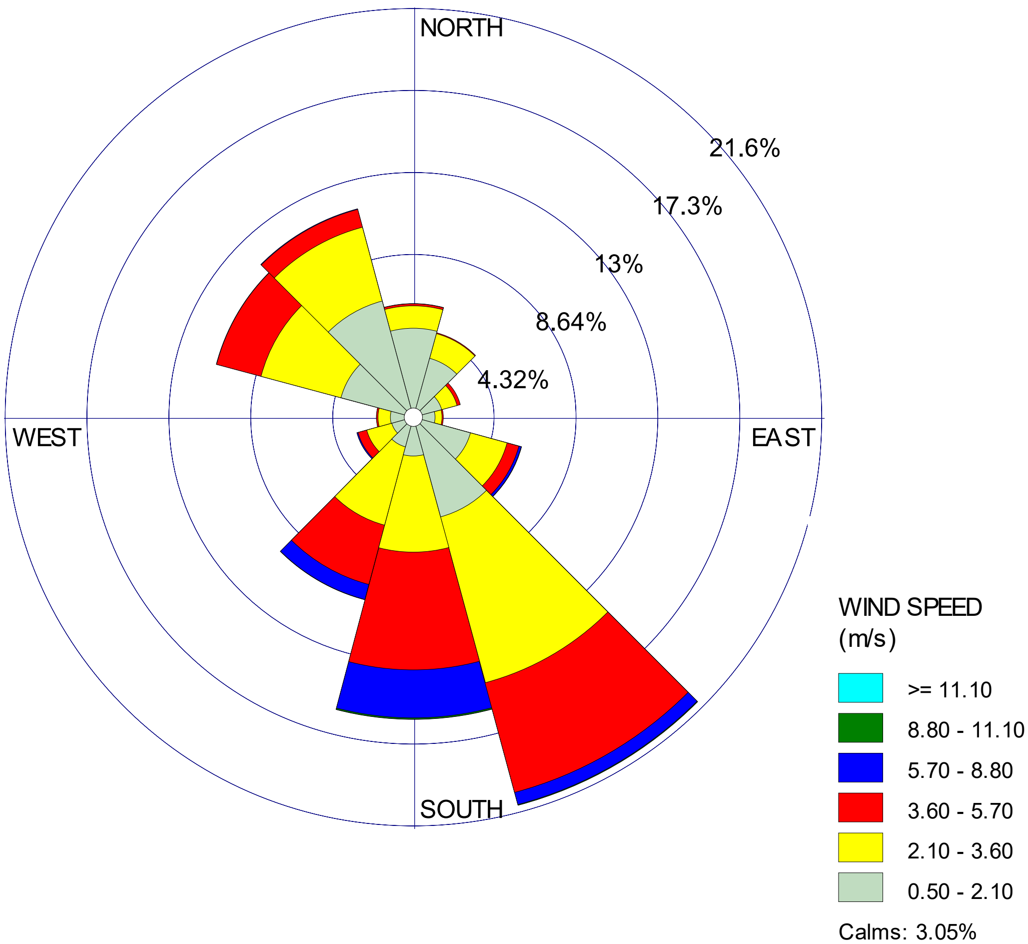


2.5 Meteorological Data

AERMOD used 5 years of meteorological (MET) data collected at two stations. Surface observation data were obtained from the Boeing Field/King County International Airport (AWS: 24234) and the upper air data are from the National Weather Service in Quillayute, Washington, for the years 2020 through 2024. Jacobs processed the 2020 through 2024 MET data for input into AERMOD.

The predominant wind directions for this meteorological dataset are winds blowing from the south-southeast to north-northwest. The average wind speed for the 5-year meteorological period (2020-2024) is 5.37 meters per second. The airport meteorological tower is approximately 1 km north of the Site. A wind rose for this meteorological dataset is depicted in Figure 2-3.

Figure 2-3. Boeing Field/King County International Airport, Washington, Wind Rose



3. Tier 1 TAP Modeling Results

The worst-case emission estimates for each emission unit have been modeled in AERMOD. These maximum modeled concentrations are summarized in Table 3-1. Results from the analysis were compared to the ASILs. Modeled impacts are below the ASILs. Table 3-1 summarizes the modeled TAP concentrations from all four dual-fueled boilers (BOIL_1 through BOIL_4).

Table 3-1. Acceptable Source Impact Level Modeling

Pollutant	Averaging Period	Maximum Modeled Concentration (μg/m^3)[a]	ASIL(μg/m^3)	Exceeds ASIL
Acrolein	24-Hour	0.030	0.35	No
Arsenic	Annual	0.00001	0.0003	No
Cadmium	Annual	0.00003	0.00024	No
Formaldehyde	Annual	0.002	0.17	No
Hexavalent chromium	Annual	0.000000055	0.000004	No
Hydrogen chloride	24-Hour	0.031	9	No
Hydrogen fluoride	24-Hour	0.031	14	No
Hydrogen sulfide	24-Hour	0.031	2	No
Mercury	24-Hour	0.0004	0.03	No
Nitrogen dioxide	1-Hour	13.18	470	No

[a] The modeled concentration is the maximum value of the five individual modeled years (2020-2024) from all four boilers.

< = less than

The modeled TAP concentrations do not exceed the ASILs; therefore, no additional modeling analysis for primary impacts is required.

4. References

Washington State Department of Ecology (Ecology). 2015. *Guidance on First, Second, and Third Tier Review of Toxics (Chapter 173-460 WAC)*. Revised. August. https://apps.ecology.wa.gov/publications/documents/0802025.pdf#:~:text=This%20publication%20is%20to%20help%20toxic%20air%20pollution,found%20in%20Chapter%20173-460%20Washington%20Administrative%20Code%20%28WAC%29.

U.S. Environmental Protection Agency (EPA). 2000. *Meteorological Monitoring Guidance for Regulatory Modeling Applications*. February. https://www.epa.gov/sites/default/files/2020-10/documents/mmgrma_0.pdf.

U.S. Environmental Protection Agency (EPA). 2024. *Appendix W of 40 CFR Part 51—Guideline on Air Quality Models (Revised)*. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. November. https://www.epa.gov/system/files/documents/2024-11/appendix_w-2024.pdf.

Attachment
Modeled Buildings

Modeling Building & Tank Information

Building Name	Number of Tiers	Tier Number	Base Elevation (m)	Tier Height (m)	Number of Corners	Corner 1 East (X) (m)	Corner 1 North (Y) (m)	Corner 2 East (X) (m)	Corner 2 North (Y) (m)	Corner 3 East (X) (m)	Corner 3 North (Y) (m)	Corner 4 East (X) (m)	Corner 4 North (Y) (m)	Corner 5 East (X) (m)	Corner 5 North (Y) (m)	Corner 6 East (X) (m)	Corner 6 North (Y) (m)	Corner 7 East (X) (m)	Corner 7 North (Y) (m)	Corner 8 East (X) (m)	Corner 8 North (Y) (m)	Corner 9 East (X) (m)	Corner 9 North (Y) (m)	Corner 10 East (X) (m)	Corner 10 North (Y) (m)	Corner 11 East (X) (m)	Corner 11 North (Y) (m)
Bldg_1	1	1	3	25.84	4	551,319.85	5,265,231.02	551,388.12	5,265,232.26	551,386.75	5,265,339.64	551,319.11	5,265,338.84														
Bldg_2	1	1	2	17.68	9	551,269.88	5,265,177.22	551,278.32	5,265,181.50	551,276.44	5,265,185.55	551,280.69	5,265,192.73	551,299.24	5,265,205.49	551,299.81	5,265,213.74	551,290.28	5,265,227.29	551,284.30	5,265,227.53	551,252.86	5,265,206.26				
Bldg_3	3	1	3	22.25	4	551,400.26	5,265,198.13	551,472.62	5,265,186.14	551,479.18	5,265,225.36	551,406.88	5,265,237.94														
Bldg_3	*	2	*	19.51	4	551,397.07	5,265,180.09	551,469.68	5,265,167.41	551,472.62	5,265,186.14	551,400.26	5,265,198.13														
Bldg_3	*	3	*	14.27	4	551,397.07	5,265,180.09	551,396.52	5,265,176.83	551,468.95	5,265,164.68	551,469.68	5,265,167.41														
Bldg_4	1	1	3	10.67	4	551,476.07	5,265,174.84	551,494.53	5,265,171.47	551,498.87	5,265,193.10	551,479.42	5,265,196.20														
Bldg_5	2	1	2	6.61	4	551,431.16	5,265,116.85	551,444.39	5,265,131.84	551,429.51	5,265,145.10	551,416.28	5,265,129.27														
Bldg_5	*	2	*	8.99	8	551,431.16	5,265,116.85	551,440.32	5,265,107.42	551,442.41	5,265,109.96	551,443.90	5,265,109.09	551,452.92	5,265,119.70	551,451.57	5,265,121.44	551,453.30	5,265,123.69	551,444.39	5,265,131.84						
Bldg_6	3	1	4	28.14	4	551,628.29	5,265,083.78	551,682.64	5,265,114.87	551,561.61	5,265,322.16	551,507.62	5,265,290.28														
Bldg_6	*	2	*	27.66	4	551,607.52	5,265,072.84	551,628.29	5,265,083.78	551,507.62	5,265,290.28	551,484.64	5,265,278.70														
Bldg_6	*	3	*	4.82	4	551,506.71	5,265,302.08	551,511.36	5,265,292.56	551,527.65	5,265,302.15	551,522.96	5,265,310.19														
Bldg_7	3	1	3	23.49	4	551,596.99	5,264,973.33	551,621.07	5,264,986.92	551,593.67	5,265,033.46	551,570.40	5,265,019.34														
Bldg_7	*	2	*	27.97	8	551,573.12	5,264,996.28	551,574.99	5,264,992.37	551,585.64	5,264,983.26	551,616.39	5,265,005.02	551,615.28	5,265,007.24	551,617.34	5,265,008.05	551,615.15	5,265,014.05	551,607.86	5,265,020.47						
Bldg_7	*	3	*	30.56	6	551,575.29	5,264,997.69	551,577.18	5,264,993.79	551,582.76	5,264,989.28	551,607.26	5,265,003.75	551,605.57	5,265,008.39	551,599.41	5,265,014.46										
Bldg_8	2	1	3	26.65	11	551,663.54	5,265,004.41	551,686.11	5,265,017.20	551,704.42	5,264,983.41	551,660.89	5,264,948.75	551,681.96	5,264,922.11	551,735.39	5,264,963.97	551,720.20	5,264,994.90	551,722.80	5,265,013.18	551,705.11	5,265,018.59	551,668.55	5,265,079.98	551,631.52	5,265,059.46
Bldg_8	*	2	*	29.31	4	551,649.41	5,265,006.66	551,680.92	5,265,025.40	551,657.32	5,265,063.95	551,625.53	5,265,046.06														
Bldg_10	1	1	3	3.66	6	551,522.80	5,265,138.11	551,524.51	5,265,139.00	551,527.48	5,265,133.80	551,536.83	5,265,139.05	551,531.05	5,265,148.40	551,520.76	5,265,142.76										
Boiler	1	1	3	11.89	4	551,504.54	5,265,077.15	551,473.86	5,265,100.85	551,460.60	5,265,084.50	551,491.57	5,265,060.45														

Tank Name	Base Elevation (m)	Center East (X) (m)	Center North (Y) (m)	Tank Height (m)	Tank Diameter (m)
Tank_9	3	551,517.00	5,265,154.00	6.97	15.24
Tank_10	3	551,533.00	5,265,126.00	6.97	15.24

The Boeing Company
Seattle, WA
2025 North Boeing Field site (NBF) Potential to Emit

Table 1. Project Criteria Emissions Summary

Source	Quantity	Potential to Emit (tons/year)								
		NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	VOC	HAPs	WAC TAPs	CO_2e
30,000 lb/hr (36.5 MMBtu/hr) Dual Fuel (Natural Gas and ULSD) Boiler	2	3.7	11.6	2.3	2.3	0.19	1.6	1.0	13.0	36,951
80,000 lb/hr (96.9 MMBtu/hr) Dual-Fuel (Natural Gas and ULSD) Boiler	2	9.9	30.9	6.2	6.2	0.50	4.3	2.7	34.5	98,097
Total Emissions (tpy)		**13.6**	**42.5**	**8.6**	**8.6**	**0.7**	**5.9**	**3.8**	**47.5**	**135,048**
Prevention of significant deterioration Significant Emission Rate (SER)		40	100	15	10	40	(40 for Ozone)	N/A	N/A	N/A
Above the SER?		**No**	**No**	**No**	**No**	**No**	**N/A**	**N/A**	**N/A**	**N/A**

Notes:
N/A - not applicable
PTE based on 8,712 hours of operation run on natural gas and 48 hours on ultra-low sulfur diesel (ULSD) for all boilers.
SER based on 40 CFR 52.21 (23) (i)

The Boeing Company
Seattle, WA
2025 North Boeing Field site (NBF) Potential to Emit

Table 2. Project TAP Emissions Summary

TAP Emissions from Dual-Fuel (Natural Gas and Ultra-Low Sulfur Diesel) Boilers

Pollutant	CAS #	Washington Administrative Code Toxic Air Pollutant (WAC TAP)	Hazardous Air Pollutant (HAP)	Natural Gas Emissions									Diesel Fuel (ULSD) Emissions[1]						Total Project Emissions[2] (Natural Gas + ULSD)			SQER Thresholds[3]			Do emissions exceed the SQER thresholds?		
				36.5 MMBtu/hr Boilers (Qty 2) Max Emissions			96.9 MMBtu/hr Boilers (Qty 2) Max Emissions			Natural Gas Total (Qty 4)			36.5 MMBtu/hr Boilers (Qty 2) Max Emissions			96.9 MMBtu/hr Boilers (Qty 2) Max Emissions											
				(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lbs/24-hr)	(lbs/yr)	(lbs/hr)	(lbs/24-hr)	(lbs/yr)
1,3-butadiene	106-99-0	X	X	0	0	0	0	0	0	0	0	0	7.82E-03	0.06	0.38	0.02	0.17	1.00	0.01	0.08	0.50	--	--	5.4	No	No	No
Acetaldehyde	75-07-0	X	X	4.05E-04	9.73E-03	3.55	1.08E-03	0.03	9.43	1.48E-03	0.04	12.98	0.18	1.46	8.79	0.49	3.89	23.32	0.24	1.97	24.61	-	-	60	No	No	No
Acrolein	107-02-8	X	X	1.89E-04	4.54E-03	1.66	5.02E-04	0.01	4.40	6.91E-04	0.02	6.05	0.09	0.75	4.51	0.25	1.99	11.96	0.13	1.01	12.02	-	0.026	-	No	Yes	No
Ammonia	7664-41-7	X	X	0.08	1.96	716.09	0.22	5.21	1,901.07	0.30	7.17	2,617.15	0	0	0	0	0	0	0.30	7.17	2,617.15	-	37	-	No	No	No
Arsenic	7440-38-2	X	X	1.43E-05	3.43E-04	0.13	3.79E-05	9.10E-04	0.33	5.22E-05	1.25E-03	0.46	1.74E-03	0.01	0.08	4.61E-03	0.04	0.22	2.34E-03	0.02	0.57	-	-	0.049	No	No	Yes
Benzene	71-43-2	X	X	2.13E-04	5.11E-03	1.86	5.65E-04	0.01	4.95	7.78E-04	0.02	6.81	1.83E-03	0.01	0.09	4.86E-03	0.04	0.23	2.92E-03	0.04	6.91	-	-	21	No	No	No
Cadmium	7440-43-9	X	X	7.70E-05	1.85E-03	0.67	2.04E-04	4.91E-03	1.79	2.81E-04	6.76E-03	2.47	7.04E-04	5.63E-03	0.03	1.87E-03	0.01	0.09	1.11E-03	0.01	2.51	-	-	0.039	No	No	Yes
Carbon Monoxide	630-08-0	X		2.63	63.07	23,021.28	6.98	167.44	61,116.77	9.60	230.52	84,138.05	5.84	46.72	280.32	15.50	124.03	744.19	13.87	264.62	84,342.70	43	-	-	No	No	No
Chlorobenzene	108-90-7	X	X	0	0	0	0	0	0	0	0	0	1.04E-04	8.34E-04	5.01E-03	2.77E-04	2.21E-03	0.01	1.38E-04	1.11E-03	6.64E-03	-	74	-	No	No	No
Copper	--	X		0	0	0	0	0	0	0	0	0	2.01E-03	0.02	0.10	5.33E-03	0.04	0.26	2.66E-03	0.02	0.13	0.19	-	-	No	No	No
Dichlorobenzene	--		X	8.40E-05	2.02E-03	0.74	2.23E-04	5.35E-03	1.95	3.07E-04	7.37E-03	2.69	0	0	0	0	0	0	3.07E-04	7.37E-03	2.69	N/A	N/A	N/A	No	No	No
Ethylbenzene	100-41-4	X	X	4.83E-04	0.01	4.23	1.28E-03	0.03	11.24	1.77E-03	0.04	15.47	4.56E-04	3.65E-03	0.02	1.21E-03	9.69E-03	0.06	1.77E-03	0.04	15.47	-	-	65	No	No	No
Formaldehyde	50-00-0	X	X	4.06E-03	0.10	35.57	0.01	0.26	94.44	0.01	0.36	130.02	0.09	0.70	4.18	0.23	1.85	11.10	0.13	1.24	135.31	-	-	27	No	No	Yes
Hexane	110-54-3	X	X	0.06	1.52	553.24	0.17	4.02	1,468.75	0.23	5.54	2,021.99	6.41E-03	0.05	0.31	0.02	0.14	0.82	0.23	5.54	2,021.99	-	52	-	No	No	No
Hexavalent chromium	--	X	X	0	0	0	0	0	0	0	0	0	7.61E-05	6.09E-04	3.65E-03	2.02E-04	1.62E-03	9.70E-03	1.01E-04	8.08E-04	4.85E-03	-	-	6.50E-04	No	No	Yes
Hydrogen chloride	7647-01-0	X	X	0	0	0	0	0	0	0	0	0	0.10	0.78	4.66	0.26	2.06	12.36	0.13	1.03	6.18	-	0.67	-	No	Yes	No
Hydrogen fluoride	7664-39-3	X	X	0	0	0	0	0	0	0	0	0	0.10	0.78	4.66	0.26	2.06	12.36	0.13	1.03	6.18	-	1.00	-	No	Yes	No
Hydrogen sulfide	7783-06-4	X	X	0	0	0	0	0	0	0	0	0	0.10	0.78	4.66	0.26	2.06	12.36	0.13	1.03	6.18	-	0.15	-	No	Yes	No
Lead	--	X	X	0	0	0	0	0	0	0	0	0	2.35E-03	0.02	0.11	6.24E-03	0.05	0.30	3.12E-03	0.02	0.15	-	-	14	No	No	No
Manganese	--	X	X	0	0	0	0	0	0	0	0	0	7.98E-04	6.38E-03	0.04	2.12E-03	0.02	0.10	1.06E-03	8.47E-03	0.05	-	0.022	-	No	No	No
Mercury	7439-97-6	X	X	1.82E-05	4.37E-04	0.16	4.83E-05	1.16E-03	0.42	6.65E-05	1.60E-03	0.58	1.12E-03	8.97E-03	0.05	2.98E-03	0.02	0.14	1.53E-03	0.01	0.65	-	2.20E-03	-	No	Yes	No
Naphthalene	91-20-3	X	X	3.19E-05	7.65E-04	0.28	8.46E-05	2.03E-03	0.74	1.16E-04	2.79E-03	1.02	1.64E-03	0.01	0.08	4.35E-03	0.03	0.21	2.25E-03	0.02	1.12	-	-	4.8	No	No	No
Nickel	--	X	X	0	0	0	0	0	0	0	0	0	1.30E-03	0.01	0.06	3.45E-03	0.03	0.17	1.72E-03	0.01	0.08	-	-	0.62	No	No	No
Nitrogen dioxide (NO2)	10102-44-0	X		0.08	1.93	703.43	0.21	5.12	1,867.46	0.29	7.04	2,570.88	0.95	7.59	45.55	2.52	20.16	120.93	1.45	16.27	2,626.23	0.87	-	-	Yes	No	No
Propylene	115-07-1	X	X	0.04	0.89	325.08	0.10	2.36	863.01	0.14	3.26	1,188.09	0.03	0.25	1.48	0.08	0.65	3.92	0.14	3.26	1,188.09	-	220	-	No	No	No
Selenium	--	X	X	0	0	0	0	0	0	0	0	0	3.13E-03	0.03	0.15	8.31E-03	0.07	0.40	4.15E-03	0.03	0.20	-	1.5	-	No	No	No
Sulfur dioxide (SO2)	7446-09-5	X	X	0.04	1.01	368.01	0.11	2.68	976.99	0.15	3.68	1,345.00	0.11	0.89	5.33	0.29	2.36	14.15	0.25	4.42	1,349.40	1.2	-	-	No	No	No
Toluene	108-88-3	X	X	7.70E-04	0.02	6.75	2.04E-03	0.05	17.91	2.81E-03	0.07	24.66	2.29E-03	0.02	0.11	6.09E-03	0.05	0.29	4.84E-03	0.08	24.76	-	370	-	No	No	No
Xylenes	1330-20-7	X	X	1.40E-03	0.03	12.27	3.72E-03	0.09	32.57	5.12E-03	0.12	44.83	8.34E-04	6.67E-03	0.04	2.21E-03	0.02	0.11	5.12E-03	0.12	44.83	-	1.6	-	No	No	No
			Total TAP Emissions	**2.94**	**70.56**	**25,754.25**	**7.81**	**187.32**	**68,372.25**	**10.75**	**257.88**	**94,126.51**	**7.62**	**60.96**	**365.78**	**20.23**	**161.84**	**971.06**	**17.15**	**309.13**	**94,433.99**						
			Total HAP Emissions	**0.23**	**5.56**	**2,030.28**	**0.62**	**14.77**	**5,389.98**	**0.85**	**20.33**	**7,420.27**	**0.83**	**6.63**	**39.81**	**2.20**	**17.61**	**105.68**	**1.83**	**28.22**	**7,467.61**						

Notes:

1.) "Diesel Fuel" refers to ultra-low sulfur diesel (ULSD), which will be used as a backup fuel for the boilers. 24-hour emissions are based on 8 hours per day and annual emissions are based on 48 hours per year.

2.) Totals the proposed two 36.5 MMBtu/hr and two 96.9 MMBtu/hr dual-fuel boilers that run on natural gas and ULSD. For the 1-hour emissionsemissions are calculated by taking the maximum of all four boilers operating on natural gas or three boilers (two 36.5 MMBtu/hr and one 96.9 MMBtu/hr) operating on natural gas and one 96.9 MMBtu/hr boiler operating on ULSD. The 24-hour emissions are calculated by taking the maximum of all four boilers operating on natural gas or three boilers (two 36.5 MMBtu/hr and one 96.9 MMBtu/hr) operating on natural gas for 24 hours and one 96.9 MMBtu/hr boiler operating on natural gas for 16 hours and on ULSD for 8 hours. Annual emissions are calculated for three boilers (two 36.5 MMBtu/hr and one 96.9 MMBtu/hr) operating on natural gas for 8,760 hours and one 96.9 MMBtu/hr boiler operating on natural gas for 8,712 hours and on ULSD for 48 hours per year.

3.) Small Quantity Emission Rate (SQER)

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Table 3. 36.5 MMBtu/hr Boiler Emissions Summary

Number of Units	2
Unit Maximum Rating (MMBtu/hr)	36.5

Boiler Information	Natural Gas	Diesel Fuel[1]
Annual Operating Hours (hrs/yr)	8,760	48
Daily Operating Hours (hrs/day)	24	8

Notes:
1.) "Diesel Fuel" refers to ultra-low sulfur diesel (ULSD), which will be used as a backup fuel for the boilers.

Criteria Pollutant Emissions from Dual-Fuel (Natural Gas and Diesel) Boilers

Pollutant	Natural Gas				Diesel Fuel		
	Boiler Emission Factor [1] (lb/MMBtu)	Single Boiler Max Hourly Emissions [2] (lbs/hr)	Single Boiler Max Annual Emissions (8760 usage) [3] (tpy)	Single Boiler Max Annual Emissions (8712 usage) [3] (tpy)	Boiler Emission Factor [4] (lb/MMBtu)	Single Boiler Max Hourly Emissions [2] (lbs/hr)	Single Boiler Max Annual Emissions [3] (tpy)
NO_X	0.011	0.40	1.76	1.75	0.130	4.75	0.11
CO	0.036	1.31	5.76	5.72	0.080	2.92	0.07
PM_{10}	0.007	0.27	1.17	1.16	0.013	0.48	0.01
$PM_{2.5}$	0.007	0.27	1.17	1.16	0.010	0.37	0.01
SO_2	5.75E-04	0.02	0.09	0.09	1.52E-03	0.06	0.00
VOC	0.005	0.18	0.80	0.79	0.006	0.22	0.01

Notes:

1.) NO_x and CO emission factors from Manufacturer's Specifications and Expected Emissions Data. PM_{10}, $PM_{2.5}$, and SO_2, emission factors from AP-42 Ch 1.4 Table 1.4-2. VOC emission factor from Boeing's NOC Worksheet #12383 BACT recommendation for natural gas-fired boilers under 100 MMBtu.

2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Maximum Firing Rate (MMBtu/hr)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)

4.) NO_x and CO emission factors from Manufacturer's Specifications and Expected Emissions Data. PM_{10}, $PM_{2.5}$, and VOC emission factors from the typical emissions summary from the Manufacturer. Per AP-42 Chapter 1.3 Table 1.3-7, PM10 is 55% cumulative mass % stated size and PM2.5 is 42%. SO_2 derived based on 15 ppm sulfur content.

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Table 3. 36.5 MMBtu/hr Boiler Emissions Summary
TAP Emissions from Dual-Fuel (Natural Gas and Diesel) Boilers

Pollutant	CAS #	Washington Administrative Code Toxic Air Pollutant (WAC TAP)	Hazardous Air Pollutant (HAP)	Emission Factor Source Natural Gas [1]	Emission Factor Source Diesel [4]	Natural Gas				Diesel Fuel		
						Boiler Emission Factor [1]	Single Boiler Max Hourly Emissions [2]	Single Boiler Max Annual Emissions (8760 usage) [3]	Single Boiler Max Annual Emissions (8712 usage) [3]	Boiler Emission Factor [4]	Single Boiler Max Hourly Emissions [5]	Single Boiler Max Annual Emissions [3]
						(lb/MMscf)	(lbs/hr)	(tpy)	(tpy)	(lb/MMBtu)	(lbs/hr)	(tpy)
1,3-butadiene	106-99-0	X	X	--	AB2588	--	0	0	0	1.07E-04	3.91E-03	9.39E-05
Acetaldehyde	75-07-0	X	X	Average of CATEF (median value) and AB2588	AB2588	5.79E-03	2.03E-04	8.88E-04	8.83E-04	2.51E-03	0.09	2.20E-03
Acrolein	107-02-8	X	X	AB2588	Average of AB2588 and Hot Spots 1999 (median value)	2.70E-03	9.45E-05	4.14E-04	4.12E-04	1.29E-03	0.05	1.13E-03
Ammonia	7664-41-7	X	X	Average of WebFIRE and AB2588	--	1.17	0.04	0.18	0.18	--	0	0
Arsenic	7440-38-2	X	X	WebFIRE	Average of AB2588, SDAPCD and Hot Spots 1999 (median value)	2.04E-04	7.14E-06	3.13E-05	3.11E-05	2.38E-05	8.68E-04	2.08E-05
Benzene	71-43-2	X	X	Average of WebFIRE, CATEF (median value), AB2588 and SDAPCD	Average of AB2588 and CATEF (median value)	3.04E-03	1.06E-04	4.66E-04	4.63E-04	2.51E-05	9.15E-04	2.20E-05
Cadmium	7440-43-9	X	X	AP-42, Section 1.4, Table 1.4-3	Average of AB2588 and SDAPCD	1.10E-03	3.85E-05	1.69E-04	1.68E-04	9.64E-06	3.52E-04	8.45E-06
Carbon Monoxide	630-08-0	X		Manufacturer's Specifications Data	Manufacturer's Specifications Data	37.53	1.31	5.76	5.72	0.08	2.92	7.01E-02
Chlorobenzene	108-90-7	X	X	--	AB2588	--	0	0	0	1.43E-06	5.21E-05	1.25E-06
Copper	--	X		--	Average of AB2588 and SDAPCD	--	0	0	0	2.75E-05	1.00E-03	2.41E-05
Dichlorobenzene	--		X	SDAPCD	--	1.20E-03	4.20E-05	1.84E-04	1.83E-04	--	0	0
Ethylbenzene	100-41-4	X	X	AB2588	Average of AB2588 and CATEF (median value)	6.90E-03	2.42E-04	1.06E-03	1.05E-03	6.25E-06	2.28E-04	5.48E-06
Formaldehyde	50-00-0	X	X	Average of WebFIRE, CATEF (median value), AB2588 and SDAPCD	Average of AB2588, SDAPCD and CATEF (median value)	5.80E-02	2.03E-03	8.89E-03	8.84E-03	1.19E-03	0.04	1.04E-03
Hexane	110-54-3	X	X	Average of AB2588 and SDAPCD	Average of AB2588, SDAPCD and CATEF (median value)	0.90	0.03	0.14	0.14	8.79E-05	3.21E-03	7.70E-05
Hexavalent chromium	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (5% of Cr max)	--	0	0	0	1.04E-06	3.81E-05	9.14E-07
Hydrogen chloride	7647-01-0	X	X	--	AB2588	--	0	0	0	1.33E-03	0.05	1.16E-03
Hydrogen fluoride	7664-39-3	X	X	--	AB2588	--	0	0	0	1.33E-03	0.05	1.16E-03
Hydrogen sulfide	7783-06-4	X	X	--	AB2588	--	0	0	0	1.33E-03	0.05	1.16E-03
Lead	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	3.22E-05	1.18E-03	2.82E-05
Manganese	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	1.09E-05	3.99E-04	9.57E-06
Mercury	7439-97-6	X	X	WebFIRE	Average of AB2588, SDAPCD and Siemens Survey (max)	2.60E-04	9.10E-06	3.99E-05	3.96E-05	1.54E-05	5.61E-04	1.35E-05
Naphthalene	91-20-3	X	X	Average of AB2588 and SDAPCD	Average of AB2588 and CATEF (median value)	4.55E-04	1.59E-05	6.98E-05	6.94E-05	2.24E-05	8.19E-04	1.96E-05
Nickel	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	1.78E-05	6.49E-04	1.56E-05
Nitrogen dioxide (NO2)	10102-44-0	X		Manufacturer's Specification Data for 10% of NOx emission factor	Manufacturer's Specification Data for 10% of NOx emission factor	1.15	0.04	0.18	0.17	0.01	0.47	1.14E-02
Propylene	115-07-1	X	X	AB2588	Average of AB2588 and CATEF (median value)	0.53	0.02	0.08	0.08	4.21E-04	0.02	3.69E-04
Selenium	--	X	X	--	Average of AB2588 and SDAPCD	--	0	0	0	4.29E-05	1.56E-03	3.75E-05
Sulfur dioxide (SO2)	7446-09-5	X	X	AP-42 Table 1.4-2	100% of fuel sulfur	0.60	0.02	0.09	0.09	1.52E-03	0.06	1.33E-03
Toluene	108-88-3	X	X	Average of WebFIRE, AB2588 and SDAPCD	AB2588	0.01	3.85E-04	1.69E-03	1.68E-03	3.14E-05	1.15E-03	2.75E-05
Xylenes	1330-20-7	X	X	AB2588	AB2588	0.02	7.00E-04	3.07E-03	3.05E-03	1.14E-05	4.17E-04	1.00E-05
					Total TAP Emissions	**--**	**1.47**	**6.44**	**6.40**	**--**	**3.81**	**0.09**
					Total HAP Emissions	**--**	**0.12**	**0.51**	**0.50**	**--**	**0.41**	**0.01**

Notes:
1.) The natural gas combustion emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in Kent, WA.
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMscf) x Maximum Firing Rate (MMBtu/MMscf) / 1,020 (MMBTU/MMscf)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) The diesel fuel emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in Kent, WA.
5.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Unit Maximum Rating (MMBtu/hr)

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Table 3. 36.5 MMBtu/hr Boiler Emissions Summary

GHG Emissions

Pollutant	Emission Factor Source for Natural Gas [1]	Emission Factor Source Diesel [4]	Natural Gas				Diesel Fuel		
			Boiler Emission Factor [1]	Single Boiler Max Hourly Emissions [2]	Single Boiler Max Annual Emissions (8760 usage) [3]	Single Boiler Max Annual Emissions (8712 usage) [3]	Boiler Emission Factor [4]	Single Boiler Max Hourly Emissions [5]	Single Boiler Max Annual Emissions [6]
			(lb/MMscf)	(lbs/hr)	(tpy)	(tpy)	(lb/MMBtu)	(lbs/hr)	(tpy)
CO_2	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-12	120,000	4,201	18,401	18,300	159.29	5,814	139.53
CH_4	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-3	2.3	0.08	0.35	0.35	1.54E-03	0.06	1.35E-03
N_2O	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-8	0.64	0.02	0.10	0.10	1.86E-03	0.07	1.63E-03
		Total CO_2e	**4,209**	**18,436**	**18,335**	--	**5,833**	**140.00**	

Notes:
1.) The natural gas combustion emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in Kent, WA.
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMscf) x Maximum Firing Rate (MMBtu/MMscf) / 1,020 (MMBTU/MMscf)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) The diesel fuel emissions for CH4, N_2O, and CO_2 emission factors are from AP-42 Chapter 1.3 Table 1.3-8 and Table 1.3-12 respectively.

Dual Fuel Property Information			Source
Natural Gas Heating Value	1042.6	BTU/cft	PSCAA NOC Worksheet #12383
Diesel Heating Value	0.14	MMBtu/gal	PSCAA NOC Worksheet #12383

Global Warming Potentials		Source
GWP CO_2 =	1	40 CFR 98 Subpart A, Table A-1
GWP CH_4 =	28	40 CFR 98 Subpart A, Table A-1
GWP N_2O =	265	40 CFR 98 Subpart A, Table A-1

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Table 4. 96.9 MMBtu/hr Boiler Emissions Summary

Number of Units	2
Unit Maximum Rating (MMBtu/hr)	96.9

Boiler Information	Natural Gas	Diesel Fuel[1]
Annual Operating Hours (hrs/yr)	8,760	48
Daily Operating Hours (hrs/day)	24	8

Notes:
1.) "Diesel Fuel" refers to ultra-low sulfur diesel (ULSD), which will be used as a backup fuel for the boilers.

Criteria Pollutant Emissions from Dual-Fuel (Natural Gas and Diesel) Boilers

Pollutant	Natural Gas				Diesel Fuel		
	Boiler Emission Factor [1] (lb/MMBtu)	Single Boiler Max Hourly Emissions [2] (lbs/hr)	Single Boiler Max Annual Emissions (8760 usage) [3] (tpy)	Single Boiler Max Annual Emissions (8712 usage) [3] (tpy)	Boiler Emission Factor [4] (lb/MMBtu)	Single Boiler Max Hourly Emissions [2] (lbs/hr)	Single Boiler Max Annual Emissions [3] (tpy)
NO_X	0.011	1.07	4.67	4.64	0.130	12.60	0.30
CO	0.036	3.49	15.28	15.27	0.080	7.75	0.19
PM_{10}	0.007	0.71	3.09	3.09	0.013	1.28	0.03
$PM_{2.5}$	0.007	0.71	3.09	3.09	0.010	0.98	0.02
SO_2	0.001	0.06	0.24	0.24	0.0015	0.15	0.0035
VOC	0.005	0.48	2.12	2.12	0.006	0.58	0.01

Notes:
1.) NO_x and CO emission factors from Manufacturer's Specifications and Expected Emissions Data. PM_{10}, $PM_{2.5}$, and SO_2, emission factors from AP-42 Ch 1.4 Table 1.4-
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Maximum Firing Rate (MMBtu/hr)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) NO_x and CO emission factors from Manufacturer's Specifications and Expected Emissions Data. PM_{10}, $PM_{2.5}$, and VOC emission factors from the typical emissions summary from the Manufacturer. Per AP-42 Chapter 1.3 Table 1.3-7, PM10 is 55% cumulative mass % stated size and PM2.5 is 42%. SO_2 derived based on 15 ppm sulfur content.

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Table 4. 96.9 MMBtu/hr Boiler Emissions Summary

TAP Emissions from Dual-Fuel (Natural Gas and Diesel) Boilers

Pollutant	CAS #	Washington Administrative Code Toxic Air Pollutant (WAC TAP)	Hazardous Air Pollutant (HAP)	Emission Factor Source Natural Gas [1]	Emission Factor Source Diesel [4]	Natural Gas				Diesel Fuel		
						Boiler Emission Factor [1]	Single Boiler Max Hourly Emissions [2]	Single Boiler Max Annual Emissions (8760 usage) [3]	Single Boiler Max Annual Emissions (8712 usage) [3]	Boiler Emission Factor [4]	Single Boiler Max Hourly Emissions [5]	Single Boiler Max Annual Emissions [3]
						(lb/MMscf)	(lbs/hr)	(tpy)	(tpy)	(lb/MMBtu)	(lbs/hr)	(tpy)
1,3-butadiene	106-99-0	X	X	--	AB2588	--	0	0	0	1.07E-04	0.01	2.49E-04
Acetaldehyde	75-07-0	X	X	Average of CATEF (median value) and AB2588	AB2588	5.79E-03	5.38E-04	2.36E-03	2.34E-03	2.51E-03	0.24	5.83E-03
Acrolein	107-02-8	X	X	AB2588	Average of AB2588 and Hot Spots 1999 (median value)	2.70E-03	2.51E-04	1.10E-03	1.09E-03	1.29E-03	0.12	2.99E-03
Ammonia	7664-41-7	X	X	Average of WebFIRE and AB2588	--	1.17	0.11	0.48	0.47	--	0	0
Arsenic	7440-38-2	X	X	WebFIRE	Average of AB2588, SDAPCD and Hot Spots 1999 (median value)	2.04E-04	1.90E-05	8.30E-05	8.26E-05	2.38E-05	2.30E-03	5.53E-05
Benzene	71-43-2	X	X	Average of WebFIRE, CATEF (median value), AB2588 and SDAPCD	Average of AB2588 and CATEF (median value)	3.04E-03	2.82E-04	1.24E-03	1.23E-03	2.51E-05	2.43E-03	5.83E-05
Cadmium	7440-43-9	X	X	AP-42, Section 1.4, Table 1.4-3	Average of AB2588 and SDAPCD	1.10E-03	1.02E-04	4.48E-04	4.45E-04	9.64E-06	9.34E-04	2.24E-05
Carbon Monoxide	630-08-0	X		Manufacturer's Specifications Data	Manufacturer's Specifications Data	37.53	3.49	15.28	15.20	0.08	7.75	1.86E-01
Chlorobenzene	108-90-7	X	X	--	AB2588	--	0	0	0	1.43E-06	1.38E-04	3.32E-06
Copper	--	X		--	Average of AB2588 and SDAPCD	--	0	0	0	2.75E-05	2.66E-03	6.40E-05
Dichlorobenzene	--		X	SDAPCD	--	1.20E-03	1.12E-04	4.88E-04	4.86E-04	--	0	0
Ethylbenzene	100-41-4	X	X	AB2588	Average of AB2588 and CATEF (median value)	6.90E-03	6.41E-04	2.81E-03	2.79E-03	6.25E-06	6.06E-04	1.45E-05
Formaldehyde	50-00-0	X	X	Average of WebFIRE, CATEF (median value), AB2588 and SDAPCD	Average of AB2588, SDAPCD and CATEF (median value)	5.80E-02	5.39E-03	0.02	0.02	1.19E-03	0.12	2.77E-03
Hexane	110-54-3	X	X	Average of AB2588 and SDAPCD	Average of AB2588, SDAPCD and CATEF (median value)	0.90	0.08	0.37	0.37	8.79E-05	8.51E-03	2.04E-04
Hexavalent chromium	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (5% of Cr max)	--	0	0	0	1.04E-06	1.01E-04	2.43E-06
Hydrogen chloride	7647-01-0	X	X	--	AB2588	--	0	0	0	1.33E-03	0.13	3.09E-03
Hydrogen fluoride	7664-39-3	X	X	--	AB2588	--	0	0	0	1.33E-03	0.13	3.09E-03
Hydrogen sulfide	7783-06-4	X	X	--	AB2588	--	0	0	0	1.33E-03	0.13	3.09E-03
Lead	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	3.22E-05	3.12E-03	7.49E-05
Manganese	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	1.09E-05	1.06E-03	2.54E-05
Mercury	7439-97-6	X	X	WebFIRE	Average of AB2588, SDAPCD and Siemens Survey (max)	2.60E-04	2.42E-05	1.06E-04	1.05E-04	1.54E-05	1.49E-03	3.57E-05
Naphthalene	91-20-3	X	X	Average of AB2588 and SDAPCD	Average of AB2588 and CATEF (median value)	4.55E-04	4.23E-05	1.85E-04	1.84E-04	2.24E-05	2.17E-03	5.22E-05
Nickel	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	1.78E-05	1.72E-03	4.14E-05
Nitrogen dioxide (NO2)	10102-44-0	X		Manufacturer's Specification Data for 10% of NOx emission factor	Manufacturer's Specification Data for 10% of NOx emission factor	1.15	0.11	0.47	0.46	0.01	1.26	3.02E-02
Propylene	115-07-1	X	X	AB2588	Average of AB2588 and CATEF (median value)	0.53	0.05	0.22	0.21	4.21E-04	0.04	9.80E-04
Selenium	--	X	X	--	Average of AB2588 and SDAPCD	--	0	0	0	4.29E-05	4.15E-03	9.97E-05
Sulfur dioxide (SO2)	7446-09-5	X	X	100% of fuel sulfur - AP-42[7]	100% of fuel sulfur - AP-42[1]	0.60	0.06	0.24	0.24	1.52E-03	0.15	3.54E-03
Toluene	108-88-3	X	X	Average of WebFIRE, AB2588 and SDAPCD	AB2588	0.01	1.02E-03	4.48E-03	4.45E-03	3.14E-05	3.05E-03	7.31E-05
Xylenes	1330-20-7	X	X	AB2588	AB2588	0.02	1.86E-03	8.14E-03	8.10E-03	1.14E-05	1.11E-03	2.66E-05
					Total TAP Emissions	--	**3.90**	**17.09**	**17.00**	--	**10.12**	**0.24**
					Total HAP Emissions	--	**0.31**	**1.35**	**1.34**	--	**1.10**	**0.03**

Notes:
1.) The natural gas combustion emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMscf) x Maximum Firing Rate (MMBtu/MMscf) / 1,020 (MMBTU/MMscf)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) The diesel fuel emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in
5.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Unit Maximum Rating (MMBtu/hr)

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Table 4. 96.9 MMBtu/hr Boiler Emissions Summary

GHG Emissions

Pollutant	Emission Factor Source for Natural Gas [1]	Emission Factor Source Diesel [4]	Natural Gas				Diesel Fuel		
			Boiler Emission Factor [1]	Single Boiler Max Hourly Emissions [2]	Single Boiler Max Annual Emissions (8760 usage) [3]	Single Boiler Max Annual Emissions (8712 usage) [3]	Boiler Emission Factor [4]	Single Boiler Max Hourly Emissions [5]	Single Boiler Max Annual Emissions [6]
			(lb/MMscf)	(lbs/hr)	(tpy)	(tpy)	(lb/MMBtu)	(lbs/hr)	(tpy)
CO_2	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-12	120,000	11,153	48,850	48,582	159.29	15,435	370.43
CH_4	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-3	2.3	0.21	0.94	0.93	1.54E-03	0.15	3.59E-03
N_2O	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-8	0.64	0.06	0.26	0.26	1.86E-03	0.18	4.32E-03
		Total CO_2e	**11,175**	**48,945**	**48,677**	--	**15,487**	**371.68**	

Notes:
1.) The natural gas combustion emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in Kent, WA.
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMscf) x Maximum Firing Rate (MMBtu/MMscf) / 1,020 (MMBTU/MMscf)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) The diesel fuel emissions for CH4, N_2O, and CO_2 emission factors are from AP-42 Chapter 1.3 Table 1.3-8 and Table 1.3-12 respectively.

Dual Fuel Property Information			Source
Natural Gas Heating Value	1042.6	BTU/cft	PSCAA NOC Worksheet #12383
Diesel Heating Value	0.14	MMBtu/gal	PSCAA NOC Worksheet #12383

Global Warming Potentials		Source
GWP CO_2 =	1	40 CFR 98 Subpart A, Table A-1
GWP CH_4 =	28	40 CFR 98 Subpart A, Table A-1
GWP N_2O =	265	40 CFR 98 Subpart A, Table A-1

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Table 5. Emissions input for Air Disperion Modeling Analysis

Model ID		WA Pollutant Common Name									
	Pollutant Name	Acrolein	Arsenic	Cadmium	Formaldehyde	Chromium(VI)	Hydrogen chloride	Hydrogen fluoride	Hydrogen sulfide	Mercury, elemental	Nitrogen dioxide
	CAS Number (for Toxics)	107-02-8	7440-38-2	7440-43-9	50-00-0	--	7647-01-0	7664-39-3	7783-06-4	7439-97-6	10102-44-0
	Model Pollutant ID	ACR	ARS	CAD	FORM	CHROM	HCL	HF	H2S	HG	1-NO2
	Averaging Period	24-Hour	Annual	Annual	Annual	Annual	24-Hour	24-Hour	24-Hour	24-Hour	1-Hour
	Description	lb/hour	tpy	tpy	tpy	tpy	lb/hour	lb/hour	lb/hour	lb/hour	lb/hour
BOIL_1	36.5 MMBtu/hr Dual Fuel	9.45E-05	3.13E-05	1.69E-04	8.89E-03	0	0	0	0	9.10E-06	4.02E-02
BOIL_2	36.5 MMBtu/hr Dual Fuel	9.45E-05	3.13E-05	1.69E-04	8.89E-03	0	0	0	0	9.10E-06	4.02E-02
BOIL_3	96.9 MMBtu/hr Dual Fuel	2.51E-04	8.30E-05	4.48E-04	2.36E-02	0	0	0	0	2.42E-05	1.07E-01
BOIL_4	96.9 MMBtu/hr Dual Fuel	4.17E-02	1.38E-04	4.68E-04	2.63E-02	2.43E-02	4.29E-02	4.29E-02	4.29E-02	5.12E-04	1.26E+00
Total		**4.21E-02**	**2.84E-04**	**1.25E-03**	**6.77E-02**	**2.43E-02**	**4.29E-02**	**4.29E-02**	**4.29E-02**	**5.55E-04**	**1.45E+00**

Model ID		Criteria Pollutant Modeling											
	Pollutant Name	Carbon Monoxide	Carbon Monoxide	Sulfur Dioxide	Sulfur Dioxide	Sulfur Dioxide	Sulfur Dioxide	PM10	PM10	PM2.5	PM2.5	Nitrogen Dioxide	Nitrogen Dioxide
	CAS Number (for Toxics)	--	--	--	--	--	--	--	--	--	--	--	--
	Model Pollutant ID	1-CO	8-CO	SO2	3-SO2	24-SO2	A-SO2	PM10	A-PM10	PM2.5	A-PM2.5	A-NO2	NO2
	Averaging Period	1-hour	8-hour	1-hour	3-hour	24-hour	annual	24-hour	annual	24-hour	annual	annual	1-hour
	Description	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	tpy	lb/hr
BOIL_1	36.5 MMBtu/hr Dual Fuel	1.31E+00	1.31E+00	2.10E-02	2.10E-02	2.10E-02	9.20E-02	2.66E-01	1.17E+00	2.66E-01	1.17E+00	1.76E+00	4.02E-01
BOIL_2	36.5 MMBtu/hr Dual Fuel	1.31E+00	1.31E+00	2.10E-02	2.10E-02	2.10E-02	9.20E-02	2.66E-01	1.17E+00	2.66E-01	1.17E+00	1.76E+00	4.02E-01
BOIL_3	96.9 MMBtu/hr Dual Fuel	3.49E+00	3.49E+00	5.58E-02	5.58E-02	5.58E-02	2.44E-01	7.06E-01	3.09E+00	7.06E-01	3.09E+00	4.67E+00	1.07E+00
BOIL_4	96.9 MMBtu/hr Dual Fuel	7.75E+00	7.75E+00	1.47E-01	1.47E-01	8.63E-02	2.48E-01	8.97E-01	3.12E+00	7.96E-01	3.12E+00	4.95E+00	1.26E+01
Total		**1.39E+01**	**1.39E+01**	**2.45E-01**	**2.45E-01**	**1.84E-01**	**6.76E-01**	**2.14E+00**	**8.55E+00**	**2.03E+00**	**8.54E+00**	**1.31E+01**	**1.45E+01**

Best Available Control Technology Analysis

Introduction

Boeing submitted a Notice of Construction (NOC) application to the Puget Sound Clean Air Agency (PSCAA) in June 2025 to install four new boilers in Building 3-150. The purpose of the new boilers is to provide steam, hot water, and comfort heating to the Boeing Company North Boeing Field/Plant 2 site (Site). The proposed boilers are natural gas-fired with ultra-low sulfur diesel (ULSD) used as a backup fuel during testing, maintenance, and time periods of curtailment or emergencies while natural gas is not available.

The proposed boilers are summarized as follows:

- Two Cleaver Brooks boilers each with 30,000 pounds per hour (lbs/hr) capacity at an approximate 36.5 million British thermal units per hour (MMBtu/hr) heat input.
- Two Cleaver Brooks boilers each with 80,000 lb/hr capacity at an approximate 96.9 MMBtu/hr heat input.

Boeing submitted proposed best available control technology (BACT) limits as part of the NOC application. PSCAA requested additional BACT information including a top-down BACT analysis for the boiler installation project. In response to PSCAA comments, Boeing has prepared this BACT analysis.

BACT Analysis Regulatory Background and Approach

New air pollution sources in Washington State must control criteria pollutant emissions to the BACT level and toxic air pollutant (TAP) emissions to the toxic BACT (tBACT) levels. Washington Administrative Code (WAC) 173-460 and PSCAA Regulation III, Article 2, require that new sources first demonstrate they will use tBACT to control TAPs and then demonstrate that the TAP emissions will not exceed the acceptable source impact levels provided in the regulation. BACT and tBACT analyses follow the same general approach and often result in the same outcome.

A BACT analysis typically consists of five steps, called the “top-down” BACT approach. The five steps are as follows:

1. Identify all potential control technologies.
2. Eliminate technically infeasible options.
3. Rank effectiveness of remaining control technologies.
4. Evaluate control technologies on a case-by-case basis for economic, environmental, and energy impacts.
5. Select the BACT.

The top-down approach ranks available control technologies in descending order of control effectiveness. To be “available,” a technology must be effectively demonstrated in a commercial application under comparable operating conditions. After available technologies are compiled and ranked, the technologies must be evaluated for technical feasibility, starting with the most effective technology. A control technology can be considered infeasible because of technical considerations, energy requirements, environmental impacts, or economic impacts. If the most effective technology is eliminated in this fashion, then the next most effective technology is evaluated using these same criteria. The process is repeated until either a technology is selected or there are no remaining technologies to consider.

The five-step BACT analyses must be conducted for each proposed emission source and applicable pollutants. Control technologies identified are obtained from industry standards and the following BACT databases:

- Bay Area Air Quality Management District (BAAQMD) Permit Handbook and BACT/Toxics Best Available Control Technology Workbook online
- California Environmental Protection Agency Air Resource Board BACT clearinghouse
- San Joaquin Valley Air Pollution Control District BACT clearinghouse
- South Coast Air Quality Management District (SCAQMD) BACT determinations
- Texas Commission of Environmental Quality (TCEQ) BACT guidelines
- U.S. Environmental Protection Agency (EPA) Reasonably Available Control Technology/BACT/Lowest Achievable Emission Rate Clearinghouse database
- San Diego County Air Pollution Control District (SDAPCD) guidance document titled *New Source Review Requirements for Best Available Control Technology (BACT)*, revised November 2023.

Summary of Rationale for Selecting Natural Gas

Boeing has selected natural gas as the primary fuel for the boilers. Natural gas is considered to be one of the preferred clean, low nitrogen, low sulfur fuels for boilers. The boilers must be able to burn backup fuel during time periods of curtailment or emergencies while natural gas is not available. Available backup fuels for natural gas-fired boilers include propane, liquefied petroleum gas (LPG), or ULSD. Boeing evaluated the potential for using propane or LPG but determined they were not feasible as backup fuel based on three main issues. The issues primarily relate to the limited amount of space available on the Site and the need to allow for movement of vehicles and manufacturing materials around the Site, as follows:

- Boeing Fire Department recommends a 75-foot setback distance from buildings and likely a fixed fire suppression system for propane or LPG. Diesel tanks can be installed right next to the boiler house with UL2085 tank construction.
- Diesel has a higher energy content than propane. This makes the diesel tank size smaller than propane, specifically 30,000-gallon diesel versus 50,000-gallon propane based on 48-hour backup fuel capacity at a quarter of peak boiler load.
- Boeing fueling group refuels all diesel tanks at the Site including backup generators and boiler backup fuel tanks. The reliability of in-house refilling of the tanks allowed Boeing to size the system for only 48 hours, at a fraction of the peak load. For propane or LPG, Boeing will need to rely on an outside vendor to fill the tank, and therefore the propane tank size may need to be even larger than 50,000 gallons.

Boeing has not done a cost-estimate comparison of the backup fuel choices, and cost-effectiveness evaluations typically are not required for backup fuels; however, it is clear that the propane and LPG will cost significantly more than ULSD due to the setback distance that will require a long trench work, larger tanks, and a dedicated fire suppression system.

For the above-stated reasons, Boeing has determined that propane or LPG are not feasible as a backup fuel due to the limited space onsite and the additional cost of installation and instead proposes natural gas-fired boilers with ULSD used as backup fuel to provide steam, hot water, and comfort heating to the

Site. These dual fuel-fired boilers will emit nitrogen oxides (NO_x), particulate matter (PM) with diameters that are 10 micrometers and smaller (PM_{10}), PM with diameters that are 2.5 micrometers and smaller ($PM_{2.5}$), carbon monoxide (CO), sulfur dioxide (SO_2), and volatile organic compounds (VOCs). The primary pollutants of concern for natural gas and fuel oil boilers are NO_x, CO, and SO_2, but PM and VOCs are also addressed.

Boeing completed BACT analyses for each proposed emission source and applicable pollutants. The following sections describe the analyses..

BACT for NO_x, CO, and VOCs

NO_x and CO are gaseous pollutants that are primarily formed through the combustion process. NO_x formation from combustion occurs by three mechanisms. The principal NO_x formation mechanism for natural gas combustion is thermal NO_x. Thermal NO_x arises from the thermal dissociation and subsequent reaction of nitrogen and oxygen (O_2) molecules in the combustion air. The second mechanism of NO_x formation is prompt NO_x. Prompt NO_x formation occurs through reactions of nitrogen molecules in the combustion air and hydrocarbon radicals from the fuel and is usually negligible when compared to the amount of NO_x formed by thermal NO_x. The third mechanism of NO_x formation is fuel NO_x. Fuel NO_x stems from the reaction of fuel-bound nitrogen compounds with O_2. Natural gas is low in fuel-bound nitrogen compounds.

While exhaust gas is within the combustion unit, about 90 percent of NO_x exists in the form of nitric oxide (NO). The balance is nitrogen dioxide (NO_2), which is unstable at high temperatures. Once the flue gas is emitted into the atmosphere, most of the NO_x is ultimately converted to NO_2.

CO forms as a result of incomplete combustion of fuel. CO emissions are a function of O_2 availability, flame temperature, residence time at flame temperature, combustion zone design, and turbulence. These control factors, however, also result in high emission rates of NO_x. Conversely, a low NO_x emission rate achieved through flame temperature control can result in higher levels of CO emissions. Thus, a compromise is established whereby the flame temperature reduction is set to achieve the lowest NO_x emission rate possible while keeping the CO emission rates at acceptable levels.

The formation of VOCs, also called products of combustion, is dependent on the composition of the fuel and combustion practices. Good combustion practices are used to reduce VOC emissions. Because CO and most VOCs are both products of incomplete combustion, meeting CO BACT emission levels and using good combustion practices is also considered BACT for VOCs.

Boilers 10 to 50 MMBtu/hr

Step 1 of the BACT process is to identify all potential control technologies. Control technologies for NO_x available for dual-fuel boilers in the 10 to 50 MMBtu/hr range include:

- Low NO_x burners (LNB)
- Ultra-low NO_x burners (ULNB)
- Flue gas recirculation (FGR)
- LNB plus FGR
- Selective catalytic reduction (SCR)

Step 2 eliminates technically infeasible options. LNB are frequently designed to achieve NO_x emission rates around 30 parts per million (ppm) NO_x. ULNB are designed to achieve emission concentrations less than 30 ppm NO_x and ideally achieve emission concentrations less than 10 ppm NO_x. However, many LNB can meet emission limits of 9 ppm NO_x. This can cause confusion when reviewing technology requirements, as a burner capable of achieving less than 10 ppm NO_x can be called a LNB or an ULNB.

Typically, dual-fuel boilers and liquid fuel (diesel) boilers do not use ULNB since the design of ULNB requires clean, gaseous fuels, that are essentially free of fuel-bound nitrogen, to get the required combustion properties needed to achieve single-digit NO_x emissions rates. Therefore, ULNB are technically not feasible for dual-fuel boilers unless both fuels are gaseous, and even then, the gaseous fuel must be very low in sulfur and compounds that can create ash (PM). Therefore, technology references to natural gas/diesel ULNB are LNB capable of single-digit emission concentrations, typically 9 ppm NO_x.

Step 3 ranks the effectiveness of control technologies. As part of this process, industry standards and existing BACT determinations from the BACT databases identified in Section 1 are reviewed. BAAQMD and SDAPCD have published BACT determinations for natural gas/fuel oil boilers less than 50 MMBtu/hr. SCAQMD did not have a BACT determination but did have a Major Source/Lowest Achievable Emission Rates (LAER) determination for a 39.5 MMBtu/hr boiler.

Table 1. BACT Determinations for Boilers 10 to 50 MMBtu/hr

Agency	NO_x BACT Limit	CO BACT Limit	Technology
BAAQMD	No limit provided	100 ppmv @ 3% O_2 dry	Achieved in Practice: LNB+FGR Good Combustion Practice
SDAPCD	Firing Natural Gas: 9.0 ppmvd @ 3% O_2 Firing Backup Fuel: No limit provided	No limit provided	Achieved in Practice: LNB+FGR+Oxygen Controller Good Combustion Practice
SCAQMD	Firing Natural Gas: 5.0 ppmvd NO_x @ 3% O_2, 15-min average Firing Backup Fuel: 40 ppmvd NO_x @ 3% O_2, 15-min average Ammonia Slip: 5.0 ppmvd NH_3 @ 3% O_2, 60-min average	Firing Natural Gas: 100 ppmvd CO @ 3% O_2, 15-min average Firing Backup Fuel: 400 ppmvd CO @ 3% O_2, 15-min average	Major Source/LAER LNB+SCR Good Combustion Practice
TCEQ	Case-by-case analysis required	Case-by-case analysis required	Case-by-case analysis required

ppmv = parts per million by volume

California has areas that are nonattainment for ozone, and NO_x is a precursor for ozone, so frequently BACT determinations in California are LAER. LAER is defined as the most stringent control technology that has been required or designated as Achieved in Practice and does not take into account the cost effectiveness of the emission control. The state of California also has California BACT, which is the most stringent level of BACT but is only defined under state law for SCAQMD. California BACT allows air districts to require controls beyond LAER if they are found to be both technologically feasible and cost-effective according to California standards. In BACT determinations, California BACT is listed as BACT 1. BACT 2 is

BACT that has been designated as Achieved in Practice. In addition, BACT 2 designated as Achieved in Practice is considered to be BACT for minor sources, or also called minor source BACT (MSBACT)

Even for gaseous fuel boilers, ULNB are relatively unproven for the 10 to 50 MMBtu/hr boiler size range and require more sophisticated controls that become cost prohibitive for smaller boilers. To achieve LAER or California BACT emission rates, SCR may be added to the boiler.

Washington State is in compliance with the national ambient air quality standard for NO_x and ozone, so LAER is not required. The Washington State Department of Ecology’s (Ecology’s) draft 2006 *Suitability of Boilers for Air Quality General Order* is a BACT analysis focused on NO_x as an indicator criteria pollutant. It is part of the basis for what is considered generic BACT for boilers. In this analysis, Ecology evaluated the control technologies for small natural gas-fired boilers (4 to 50 million Btu/hr). Ecology’s analysis indicated that selective catalytic reduction was cost prohibitive and selective noncatalytic reduction was technically infeasible for removing NO_x from natural gas-fired boilers in the 4 to 50 million Btu/hr size range. Technically feasible technology for boilers in this size range are low NO_x burners, ultra-low NO_x burners, and O_2 controller or flue-gas recirculation. In addition, as discussed above and indicated in Table 1, lower NO_x emissions result in higher CO emissions and the addition of SCR results in emissions of ammonia due to ammonia slip.

The SDAPCD BACT determination shown in Table 1 is the most appropriate for Boeing’s 36.52 MMBtu/hr boilers. Proposed BACT limits were also submitted as part of the NOC application to PSCAA in June 2025. The BACT determination was for a natural gas-fired water-tube boiler at the Boeing Developmental Center in Tukwila, Washington, NOC Worksheet #12383, submitted on August 17, 2023. A search on the EPA RACT/BACT/LAER Clearinghouse did not yield any more recent BACT determinations for industrial/commercial natural gas boilers under 100 MMBtu/hour.

For Washington State, the need to be able to reliably burn natural gas, and diesel makes LNB with FGR the most effective, feasible control technology for NO_x and results in good combustion practices for CO. Oxygen controllers, also called O_2 trim systems, are an integral part of all boilers and are not usually called out as a BACT requirement. Based on the information above, Boeing is proposing the Manufacturer's Performance Guarantee for the two 36.52-MMBtu/hr boilers. While firing natural gas, NO_x emissions for the burner (from 25 percent to 100 percent Maximum Continuous Rating) are 0.011 lb/MMBtu, on a dry basis. CO emissions are 0.036 lb/MMBtu, also corrected to 3 percent O_2 on a dry basis.

EPA’s five-step analysis is complete if you select the feasible control option in Step 2 that has the highest control efficiency in Step 3. The Manufacturer’s Performance Guarantee meets the minor source BACT limits (Achieved in Practice) provided in Table 1 above. Boeing has selected the highest recommended control option; therefore, the BACT analysis is complete.

The formation of VOCs, also called products of combustion, is dependent on the composition of the fuel and combustion practices. Good combustion practices are used to reduce VOC emissions. Reducing CO emission concentrations to 50 ppmvd corrected to 3 percent O_2 (0.036 lb/MMBtu) by means of good combustion practices also demonstrates BACT for the control of VOC.

Boilers 50 to 250 MMBtu/hr

Steps 1 and 2 of the BACT process discussed for the 10 to 50 MMBtu/hr boilers in the preceding section also apply to the 50 to 250 MMBtu/hr boiler size range. However, **Step 3** industry standards and existing BACT determinations from the BACT databases will vary for the different size ranges.

BAAQMD, SDAPCD, and TCEQ have published BACT determinations for natural gas/fuel oil boilers greater than 50 and less than 250 MMBtu/hr (Table 2).

Table 2. BACT Determinations for Boilers 50 to 250 MMBtu/hr

Agency	NO_x BACT Limit	CO BACT Limit	Technology
BAAQMD	No limit provided	50 ppmv @ 3% O_2 dry	Achieved in Practice: ULNB+FGR Good Combustion Practice
SDAPCD	Firing Natural Gas: 5.0 ppmvd @ 3% O_2 Firing Backup Fuel: Not an option	No limit provided	LAER/California BACT SCR on Uncontrolled Boiler Good Combustion Practice
SDAPCD	Firing Natural Gas: 9.0 ppmvd @ 3% O_2 Firing Backup Fuel: < 170 ppmvd @ 3% O_2	No limit provided	Achieved in Practice: LNB+FGR+Oxygen Controller Good Combustion Practice
TCEQ	Firing Natural Gas: 0.01 Lb NO_x/MMBtu Firing Fuel Oil: Limited to 760 hours per year	Case-by-case analysis required	Emission limits typically achieved using dry-low NO_x combustors, limiting fuel consumption, SCR, and/or water or steam injection. Specify technique(s).

As stated above, California has areas that are nonattainment for ozone, and NO_x is a precursor for ozone, so frequently BACT determinations in California are LAER. The state of California also has California BACT, which is the most stringent level of BACT but is only defined under state law for SCAQMD. BACT for minor sources in California (MSBACT) is designated as Achieved in Practice. Washington State is in compliance with the national ambient air quality standard for NO_x and ozone, so LAER is not required. The first option provided by SCAQMD, a LAER/California BACT determination, is for a Major source. The technological option is for an uncontrolled boiler with SCR and is for natural gas only and not for dual-fuel boilers. SCAQMD's second BACT determination is BACT for minor sources. LNB with FGR and an oxygen controller has been designated as Achieved in Practice and allows for the combustion of natural gas with fuel oil as a backup fuel. The TCEQ BACT for NO_x of 0.01 lb/MMBtu allows for emissions up to 0.014 lb/MMBtu, so slightly higher than SCAQMD limit of 9 ppmvd at 3 percent O_2, which is equivalent to 0.011 lb/MMBtu.

Proposed BACTs limit were also submitted as part of the NOC application to PSCAA in June 2025. The BACT determination was for a natural gas-fired water-tube boiler at the Boeing Developmental Center in Tukwila, Washington, NOC Worksheet #12383, submitted on August 17, 2023. A search on the EPA RACT/BACT/LAER Clearinghouse did not yield any more recent BACT determinations for industrial/commercial natural gas boilers under 100 MMBtu/hour.

For Washington State, the Achieved in Practice BACT determinations in Table 2, and the need to be able to reliably burn natural gas and diesel, make LNB with FGR the most effective, feasible control technology for NO_x and support good combustion practices for CO. Oxygen controllers, also called O_2 trim systems, are an integral part of all boilers and are not usually called out as a BACT requirement. Based on the information above, Boeing is proposing the Manufacturer's Performance Guarantee for the two 96.9 MMBtu/hr boilers. While firing natural gas, NO_x emissions for the burner (from 25 percent to 100 percent Maximum Continuous Rating) are 0.011 lb/MMBtu, on a dry basis. CO emissions are 0.036 lb/MMBtu, also corrected to 3 percent O_2 on a dry basis. Boeing has selected the highest recommended control option, that is BACT and not LAER, therefore Steps 4 the economic analysis is not required.

The Manufacturer's Performance Guarantee meets California's minor source BACT limits (Achieved in Practice) provided in Table 2. Washington State is in attainment for Ozone, so LAER which is required for major sources in California, is not required. In addition, even though Boeing is a major source for NOx and CO based on potential to emit, actual emissions of NOx and CO are typically less than reporting thresholds as shown in Table 3. The difference in potential to emit and actual emissions is mainly due to Boeing's need to size equipment for worse case scenarios and the need for backup equipment in case of equipment failure.

Table 3. Annual Actual Emissions in Tons per Year

Pollutant	2018	2019	2020	2021	2022	2023
NO_X	19	25.5	19	22	19	14.5
CO	15	19	15	17	16	ND

ND – Data was not provided

The formation of VOCs, also called products of combustion, is dependent on the composition of the fuel and combustion practices. Good combustion practices are used to reduce VOC emissions. Reducing CO emission concentrations to 50 ppmvd corrected to 3 percent O_2 (0.036 lb/MMBtu) by means of good combustion practices also demonstrates BACT for the control of VOC.

Sulfur Dioxide and Particulate Matter

BACT determinations from the various agencies indicate that BACT for the control of SO_2 and PM supports good combustion practices and fuel selection. PM is reduced by switching to fuels with low ash content. Natural gas and ULSD are both low in sulfur and ash content. Post-combustion controls are not required or recommended for these fuels. SDAPCD determined that the use of natural gas ensures compliance with PM BACT. Boeing is proposing good combustion practices and the use of natural gas and ULSD as BACT for SO_2 and PM.

In addition, the two 36.5 MMBtu/hr and 96.9 MMBtu/hr boilers are subject to Part 60, subpart Dc, of Title 40 of the *Code of Federal Regulations* (40 CFR pt. 60, subpart Dc). Subpart Dc applies to steam-generating units for which construction, modification, or reconstruction commenced after June 9, 1989, and that have a maximum design heat input capacity of 100 MMBtu/hr or less but greater than or equal to 10 MMBtu/hr. The standards in Subpart Dc aim to limit emissions of pollutants such as SO_2 and PM.

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Table 1. Project Criteria Emissions Summary

Source	Quantity	Potential to Emit (tons/year)								
		NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	VOC	HAPs	WAC TAPs	CO_2e
30,000 lb/hr (36.5 MMBtu/hr) Dual Fuel (Natural Gas and ULSD) Boiler	2	3.7	11.6	2.3	2.3	0.19	1.6	1.0	13.0	36,951
80,000 lb/hr (96.9 MMBtu/hr) Dual-Fuel (Natural Gas and ULSD) Boiler	2	9.9	30.9	6.2	6.2	0.50	4.3	2.7	34.5	98,097
Total Emissions (tpy)		**13.6**	**42.5**	**8.6**	**8.6**	**0.7**	**5.9**	**3.8**	**47.5**	**135,048**
Prevention of significant deterioration Significant Emission Rate (SER)		40	100	15	10	40	(40 for Ozone)	N/A	N/A	N/A
Above the SER?		**No**	**No**	**No**	**No**	**No**	**N/A**	**N/A**	**N/A**	**N/A**

Notes:
N/A - not applicable
PTE based on 8,712 hours of operation run on natural gas and 48 hours on ultra-low sulfur diesel (ULSD) for all boilers.
SER based on 40 CFR 52.21 (23) (i)

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Table 2. Project TAP Emissions Summary

TAP Emissions from Dual-Fuel (Natural Gas and Ultra-Low Sulfur Diesel) Boilers

Pollutant	CAS #	Washington Administrative Code Toxic Air Pollutant (WAC TAP)	Hazardous Air Pollutant (HAP)	Natural Gas Emissions									Diesel Fuel (ULSD) Emissions[1]						Total Project Emissions[2] (Natural Gas + ULSD)			SQER Thresholds[3]			Do emissions exceed the SQER thresholds?		
				36.5 MMBtu/hr Boilers (Qty 2) Max Emissions			96.9 MMBtu/hr Boilers (Qty 2) Max Emissions			Natural Gas Total (Qty 4)			36.5 MMBtu/hr Boilers (Qty 2) Max Emissions			96.9 MMBtu/hr Boilers (Qty 2) Max Emissions											
				(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lb/24-hr)	(lb/yr)	(lbs/hr)	(lbs/24-hr)	(lbs/yr)	(lbs/hr)	(lbs/24-hr)	(lbs/yr)
1,3-butadiene	106-99-0	X	X	0	0	0	0	0	0	0	0	0	7.82E-03	0.06	0.38	0.02	0.17	1.00	0.01	0.08	0.50	--	--	5.4	No	No	No
Acetaldehyde	75-07-0	X	X	4.05E-04	9.73E-03	3.55	1.08E-03	0.03	9.43	1.48E-03	0.04	12.98	0.18	1.46	8.79	0.49	3.89	23.32	0.24	1.97	24.61	-	-	60	No	No	No
Acrolein	107-02-8	X	X	1.89E-04	4.54E-03	1.66	5.02E-04	0.01	4.40	6.91E-04	0.02	6.05	0.09	0.75	4.51	0.25	1.99	11.96	0.13	1.01	12.02	-	0.026	-	No	Yes	No
Ammonia	7664-41-7	X	X	0.08	1.96	716.09	0.22	5.21	1,901.07	0.30	7.17	2,617.15	0	0	0	0	0	0	0.30	7.17	2,617.15	-	37	-	No	No	No
Arsenic	7440-38-2	X	X	1.43E-05	3.43E-04	0.13	3.79E-05	9.10E-04	0.33	5.22E-05	1.25E-03	0.46	1.74E-03	0.01	0.08	4.61E-03	0.04	0.22	2.34E-03	0.02	0.57	-	-	0.049	No	No	Yes
Benzene	71-43-2	X	X	2.13E-04	5.11E-03	1.86	5.65E-04	0.01	4.95	7.78E-04	0.02	6.81	1.83E-03	0.01	0.09	4.86E-03	0.04	0.23	2.92E-03	0.04	6.91	-	-	21	No	No	No
Cadmium	7440-43-9	X	X	7.70E-05	1.85E-03	0.67	2.04E-04	4.91E-03	1.79	2.81E-04	6.76E-03	2.47	7.04E-04	5.63E-03	0.03	1.87E-03	0.01	0.09	1.11E-03	0.01	2.51	-	-	0.039	No	No	Yes
Carbon Monoxide	630-08-0	X		2.63	63.07	23,021.28	6.98	167.44	61,116.77	9.60	230.52	84,138.05	5.84	46.72	280.32	15.50	124.03	744.19	13.87	264.62	84,342.70	43	-	-	No	No	No
Chlorobenzene	108-90-7	X	X	0	0	0	0	0	0	0	0	0	1.04E-04	8.34E-04	5.01E-03	2.77E-04	2.21E-03	0.01	1.38E-04	1.11E-03	6.64E-03	-	74	-	No	No	No
Copper	--	X		0	0	0	0	0	0	0	0	0	2.01E-03	0.02	0.10	5.33E-03	0.04	0.26	2.66E-03	0.02	0.13	0.19	-	-	No	No	No
Dichlorobenzene	--		X	8.40E-05	2.02E-03	0.74	2.23E-04	5.35E-03	1.95	3.07E-04	7.37E-03	2.69	0	0	0	0	0	0	3.07E-04	7.37E-03	2.69	N/A	N/A	N/A	No	No	No
Ethylbenzene	100-41-4	X	X	4.83E-04	0.01	4.23	1.28E-03	0.03	11.24	1.77E-03	0.04	15.47	4.56E-04	3.65E-03	0.02	1.21E-03	9.69E-03	0.06	1.77E-03	0.04	15.47	-	-	65	No	No	No
Formaldehyde	50-00-0	X	X	4.06E-03	0.10	35.57	0.01	0.26	94.44	0.01	0.36	130.02	0.09	0.70	4.18	0.23	1.85	11.10	0.13	1.24	135.31	-	-	27	No	No	Yes
Hexane	110-54-3	X	X	0.06	1.52	553.24	0.17	4.02	1,468.75	0.23	5.54	2,021.99	6.41E-03	0.05	0.31	0.02	0.14	0.82	0.23	5.54	2,021.99	-	52	-	No	No	No
Hexavalent chromium	--	X	X	0	0	0	0	0	0	0	0	0	7.61E-05	6.09E-04	3.65E-03	2.02E-04	1.62E-03	9.70E-03	1.01E-04	8.08E-04	4.85E-03	-	-	6.50E-04	No	No	Yes
Hydrogen chloride	7647-01-0	X	X	0	0	0	0	0	0	0	0	0	0.10	0.78	4.66	0.26	2.06	12.36	0.13	1.03	6.18	-	0.67	-	No	Yes	No
Hydrogen fluoride	7664-39-3	X	X	0	0	0	0	0	0	0	0	0	0.10	0.78	4.66	0.26	2.06	12.36	0.13	1.03	6.18	-	1.00	-	No	Yes	No
Hydrogen sulfide	7783-06-4	X	X	0	0	0	0	0	0	0	0	0	0.10	0.78	4.66	0.26	2.06	12.36	0.13	1.03	6.18	-	0.15	-	No	Yes	No
Lead	--	X	X	0	0	0	0	0	0	0	0	0	2.35E-03	0.02	0.11	6.24E-03	0.05	0.30	3.12E-03	0.02	0.15	-	-	14	No	No	No
Manganese	--	X	X	0	0	0	0	0	0	0	0	0	7.98E-04	6.38E-03	0.04	2.12E-03	0.02	0.10	1.06E-03	8.47E-03	0.05	-	0.022	-	No	No	No
Mercury	7439-97-6	X	X	1.82E-05	4.37E-04	0.16	4.83E-05	1.16E-03	0.42	6.65E-05	1.60E-03	0.58	1.12E-03	8.97E-03	0.05	2.98E-03	0.02	0.14	1.53E-03	0.01	0.65	-	2.20E-03	-	No	Yes	No
Naphthalene	91-20-3	X	X	3.19E-05	7.65E-04	0.28	8.46E-05	2.03E-03	0.74	1.16E-04	2.79E-03	1.02	1.64E-03	0.01	0.08	4.35E-03	0.03	0.21	2.25E-03	0.02	1.12	-	-	4.8	No	No	No
Nickel	--	X	X	0	0	0	0	0	0	0	0	0	1.30E-03	0.01	0.06	3.45E-03	0.03	0.17	1.72E-03	0.01	0.08	-	-	0.62	No	No	No
Nitrogen dioxide (NO2)	10102-44-0	X		0.08	1.93	703.43	0.21	5.12	1,867.46	0.29	7.04	2,570.88	0.95	7.59	45.55	2.52	20.16	120.93	1.45	16.27	2,626.23	0.87	-	-	Yes	No	No
Propylene	115-07-1	X	X	0.04	0.89	325.08	0.10	2.36	863.01	0.14	3.26	1,188.09	0.03	0.25	1.48	0.08	0.65	3.92	0.14	3.26	1,188.09	-	220	-	No	No	No
Selenium	--	X	X	0	0	0	0	0	0	0	0	0	3.13E-03	0.03	0.15	8.31E-03	0.07	0.40	4.15E-03	0.03	0.20	-	1.5	-	No	No	No
Sulfur dioxide (SO2)	7446-09-5	X	X	0.04	1.01	368.01	0.11	2.68	976.99	0.15	3.68	1,345.00	0.11	0.89	5.33	0.29	2.36	14.15	0.25	4.42	1,349.40	1.2	-	-	No	No	No
Toluene	108-88-3	X	X	7.70E-04	0.02	6.75	2.04E-03	0.05	17.91	2.81E-03	0.07	24.66	2.29E-03	0.02	0.11	6.09E-03	0.05	0.29	4.84E-03	0.08	24.76	-	370	-	No	No	No
Xylenes	1330-20-7	X	X	1.40E-03	0.03	12.27	3.72E-03	0.09	32.57	5.12E-03	0.12	44.83	8.34E-04	6.67E-03	0.04	2.21E-03	0.02	0.11	5.12E-03	0.12	44.83	-	1.6	-	No	No	No
			Total TAP Emissions	**2.94**	**70.56**	**25,754.25**	**7.81**	**187.32**	**68,372.25**	**10.75**	**257.88**	**94,126.51**	**7.62**	**60.96**	**365.78**	**20.23**	**161.84**	**971.06**	**17.15**	**309.13**	**94,433.99**						
			Total HAP Emissions	**0.23**	**5.56**	**2,030.28**	**0.62**	**14.77**	**5,389.98**	**0.85**	**20.33**	**7,420.27**	**0.83**	**6.63**	**39.81**	**2.20**	**17.61**	**105.68**	**1.83**	**28.22**	**7,467.61**						

Notes:

1.) "Diesel Fuel" refers to ultra-low sulfur diesel (ULSD), which will be used as a backup fuel for the boilers. 24-hour emissions are based on 8 hours per day and annual emissions are based on 48 hours per year.

2.) Totals the proposed two 36.5 MMBtu/hr and two 96.9 MMBtu/hr dual-fuel boilers that run on natural gas and ULSD. For the 1-hour emissionsemissions are calculated by taking the maximum of all four boilers operating on natural gas or three boilers (two 36.5 MMBtu/hr and one 96.9 MMBtu/hr) operating on natural gas and one 96.9 MMBtu/hr boiler operating on ULSD. The 24-hour emissions are calculated by taking the maximum of all four boilers operating on natural gas or three boilers (two 36.5 MMBtu/hr and one 96.9 MMBtu/hr) operating on natural gas for 24 hours and one 96.9 MMBtu/hr boiler operating on natural gas for 16 hours and on ULSD for 8 hours. Annual emissions are calculated for three boilers (two 36.5 MMBtu/hr and one 96.9 MMBtu/hr) operating on natural gas for 8,760 hours and one 96.9 MMBtu/hr boiler operating on natural gas for 8,712 hours and on ULSD for 48 hours per year.

3.) Small Quantity Emission Rate (SQER)

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Table 3. 36.5 MMBtu/hr Boiler Emissions Summary

Number of Units	2
Unit Maximum Rating (MMBtu/hr)	36.5

Boiler Information	Natural Gas	Diesel Fuel[1]
Annual Operating Hours (hrs/yr)	8,760	48
Daily Operating Hours (hrs/day)	24	8

Notes:
1.) "Diesel Fuel" refers to ultra-low sulfur diesel (ULSD), which will be used as a backup fuel for the boilers.

Criteria Pollutant Emissions from Dual-Fuel (Natural Gas and Diesel) Boilers

Pollutant	Natural Gas				Diesel Fuel		
	Boiler Emission Factor [1] (lb/MMBtu)	Single Boiler Max Hourly Emissions [2] (lbs/hr)	Single Boiler Max Annual Emissions (8760 usage) [3] (tpy)	Single Boiler Max Annual Emissions (8712 usage) [3] (tpy)	Boiler Emission Factor [4] (lb/MMBtu)	Single Boiler Max Hourly Emissions [2] (lbs/hr)	Single Boiler Max Annual Emissions [3] (tpy)
NO_X	0.011	0.40	1.76	1.75	0.130	4.75	0.11
CO	0.036	1.31	5.76	5.72	0.080	2.92	0.07
PM_{10}	0.007	0.27	1.17	1.16	0.013	0.48	0.01
$PM_{2.5}$	0.007	0.27	1.17	1.16	0.010	0.37	0.01
SO_2	5.75E-04	0.02	0.09	0.09	1.52E-03	0.06	0.00
VOC	0.005	0.18	0.80	0.79	0.006	0.22	0.01

Notes:

1.) NO_x and CO emission factors from Manufacturer's Specifications and Expected Emissions Data. PM_{10}, $PM_{2.5}$, and SO_2, emission factors from AP-42 Ch 1.4 Table 1.4-2. VOC emission factor from Boeing's NOC Worksheet #12383 BACT recommendation for natural gas-fired boilers under 100 MMBtu.

2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Maximum Firing Rate (MMBtu/hr)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)

4.) NO_x and CO emission factors from Manufacturer's Specifications and Expected Emissions Data. PM_{10}, $PM_{2.5}$, and VOC emission factors from the typical emissions summary from the Manufacturer. Per AP-42 Chapter 1.3 Table 1.3-7, PM10 is 55% cumulative mass % stated size and PM2.5 is 42%. SO_2 derived based on 15 ppm sulfur content.

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Table 3. 36.5 MMBtu/hr Boiler Emissions Summary

TAP Emissions from Dual-Fuel (Natural Gas and Diesel) Boilers

Pollutant	CAS #	Washington Administrative Code Toxic Air Pollutant (WAC TAP)	Hazardous Air Pollutant (HAP)	Emission Factor Source Natural Gas [1]	Emission Factor Source Diesel [4]	Natural Gas				Diesel Fuel		
						Boiler Emission Factor [1]	Single Boiler Max Hourly Emissions [2]	Single Boiler Max Annual Emissions (8760 usage) [3]	Single Boiler Max Annual Emissions (8712 usage) [3]	Boiler Emission Factor [4]	Single Boiler Max Hourly Emissions [5]	Single Boiler Max Annual Emissions [3]
						(lb/MMscf)	(lbs/hr)	(tpy)	(tpy)	(lb/MMBtu)	(lbs/hr)	(tpy)
1,3-butadiene	106-99-0	X	X	--	AB2588	--	0	0	0	1.07E-04	3.91E-03	9.39E-05
Acetaldehyde	75-07-0	X	X	Average of CATEF (median value) and AB2588	AB2588	5.79E-03	2.03E-04	8.88E-04	8.83E-04	2.51E-03	0.09	2.20E-03
Acrolein	107-02-8	X	X	AB2588	Average of AB2588 and Hot Spots 1999 (median value)	2.70E-03	9.45E-05	4.14E-04	4.12E-04	1.29E-03	0.05	1.13E-03
Ammonia	7664-41-7	X	X	Average of WebFIRE and AB2588	--	1.17	0.04	0.18	0.18	--	0	0
Arsenic	7440-38-2	X	X	WebFIRE	Average of AB2588, SDAPCD and Hot Spots 1999 (median value)	2.04E-04	7.14E-06	3.13E-05	3.11E-05	2.38E-05	8.68E-04	2.08E-05
Benzene	71-43-2	X	X	Average of WebFIRE, CATEF (median value), AB2588 and SDAPCD	Average of AB2588 and CATEF (median value)	3.04E-03	1.06E-04	4.66E-04	4.63E-04	2.51E-05	9.15E-04	2.20E-05
Cadmium	7440-43-9	X	X	AP-42, Section 1.4, Table 1.4-3	Average of AB2588 and SDAPCD	1.10E-03	3.85E-05	1.69E-04	1.68E-04	9.64E-06	3.52E-04	8.45E-06
Carbon Monoxide	630-08-0	X		Manufacturer's Specifications Data	Manufacturer's Specifications Data	37.53	1.31	5.76	5.72	0.08	2.92	7.01E-02
Chlorobenzene	108-90-7	X	X	--	AB2588	--	0	0	0	1.43E-06	5.21E-05	1.25E-06
Copper	--	X		--	Average of AB2588 and SDAPCD	--	0	0	0	2.75E-05	1.00E-03	2.41E-05
Dichlorobenzene	--		X	SDAPCD	--	1.20E-03	4.20E-05	1.84E-04	1.83E-04	--	0	0
Ethylbenzene	100-41-4	X	X	AB2588	Average of AB2588 and CATEF (median value)	6.90E-03	2.42E-04	1.06E-03	1.05E-03	6.25E-06	2.28E-04	5.48E-06
Formaldehyde	50-00-0	X	X	Average of WebFIRE, CATEF (median value), AB2588 and SDAPCD	Average of AB2588, SDAPCD and CATEF (median value)	5.80E-02	2.03E-03	8.89E-03	8.84E-03	1.19E-03	0.04	1.04E-03
Hexane	110-54-3	X	X	Average of AB2588 and SDAPCD	Average of AB2588, SDAPCD and CATEF (median value)	0.90	0.03	0.14	0.14	8.79E-05	3.21E-03	7.70E-05
Hexavalent chromium	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (5% of Cr max)	--	0	0	0	1.04E-06	3.81E-05	9.14E-07
Hydrogen chloride	7647-01-0	X	X	--	AB2588	--	0	0	0	1.33E-03	0.05	1.16E-03
Hydrogen fluoride	7664-39-3	X	X	--	AB2588	--	0	0	0	1.33E-03	0.05	1.16E-03
Hydrogen sulfide	7783-06-4	X	X	--	AB2588	--	0	0	0	1.33E-03	0.05	1.16E-03
Lead	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	3.22E-05	1.18E-03	2.82E-05
Manganese	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	1.09E-05	3.99E-04	9.57E-06
Mercury	7439-97-6	X	X	WebFIRE	Average of AB2588, SDAPCD and Siemens Survey (max)	2.60E-04	9.10E-06	3.99E-05	3.96E-05	1.54E-05	5.61E-04	1.35E-05
Naphthalene	91-20-3	X	X	Average of AB2588 and SDAPCD	Average of AB2588 and CATEF (median value)	4.55E-04	1.59E-05	6.98E-05	6.94E-05	2.24E-05	8.19E-04	1.96E-05
Nickel	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	1.78E-05	6.49E-04	1.56E-05
Nitrogen dioxide (NO2)	10102-44-0	X		Manufacturer's Specification Data for 10% of NOx emission factor	Manufacturer's Specification Data for 10% of NOx emission factor	1.15	0.04	0.18	0.17	0.01	0.47	1.14E-02
Propylene	115-07-1	X	X	AB2588	Average of AB2588 and CATEF (median value)	0.53	0.02	0.08	0.08	4.21E-04	0.02	3.69E-04
Selenium	--	X	X	--	Average of AB2588 and SDAPCD	--	0	0	0	4.29E-05	1.56E-03	3.75E-05
Sulfur dioxide (SO2)	7446-09-5	X	X	AP-42 Table 1.4-2	100% of fuel sulfur	0.60	0.02	0.09	0.09	1.52E-03	0.06	1.33E-03
Toluene	108-88-3	X	X	Average of WebFIRE, AB2588 and SDAPCD	AB2588	0.01	3.85E-04	1.69E-03	1.68E-03	3.14E-05	1.15E-03	2.75E-05
Xylenes	1330-20-7	X	X	AB2588	AB2588	0.02	7.00E-04	3.07E-03	3.05E-03	1.14E-05	4.17E-04	1.00E-05
					Total TAP Emissions	--	**1.47**	**6.44**	**6.40**	--	**3.81**	**0.09**
					Total HAP Emissions	--	**0.12**	**0.51**	**0.50**	--	**0.41**	**0.01**

Notes:
1.) The natural gas combustion emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in Kent, WA.
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMscf) x Maximum Firing Rate (MMBtu/MMscf) / 1,020 (MMBTU/MMscf)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) The diesel fuel emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in Kent, WA.
5.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Unit Maximum Rating (MMBtu/hr)

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Table 3. 36.5 MMBtu/hr Boiler Emissions Summary

GHG Emissions

Pollutant	Emission Factor Source for Natural Gas [1]	Emission Factor Source Diesel [4]	Natural Gas				Diesel Fuel		
			Boiler Emission Factor [1]	Single Boiler Max Hourly Emissions [2]	Single Boiler Max Annual Emissions (8760 usage) [3]	Single Boiler Max Annual Emissions (8712 usage) [3]	Boiler Emission Factor [4]	Single Boiler Max Hourly Emissions [5]	Single Boiler Max Annual Emissions [6]
			(lb/MMscf)	(lbs/hr)	(tpy)	(tpy)	(lb/MMBtu)	(lbs/hr)	(tpy)
CO_2	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-12	120,000	4,201	18,401	18,300	159.29	5,814	139.53
CH_4	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-3	2.3	0.08	0.35	0.35	1.54E-03	0.06	1.35E-03
N_2O	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-8	0.64	0.02	0.10	0.10	1.86E-03	0.07	1.63E-03
		Total CO_2e	**4,209**	**18,436**	**18,335**	**--**	**5,833**	**140.00**	

Notes:
1.) The natural gas combustion emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in Kent, WA.
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMscf) x Maximum Firing Rate (MMBtu/MMscf) / 1,020 (MMBTU/MMscf)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) The diesel fuel emissions for CH4, N_2O, and CO_2 emission factors are from AP-42 Chapter 1.3 Table 1.3-8 and Table 1.3-12 respectively.

Dual Fuel Property Information			Source
Natural Gas Heating Value	1042.6	BTU/cft	PSCAA NOC Worksheet #12383
Diesel Heating Value	0.14	MMBtu/gal	PSCAA NOC Worksheet #12383

Global Warming Potentials		Source
GWP CO_2 =	1	40 CFR 98 Subpart A, Table A-1
GWP CH_4 =	28	40 CFR 98 Subpart A, Table A-1
GWP N_2O =	265	40 CFR 98 Subpart A, Table A-1

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Table 4. 96.9 MMBtu/hr Boiler Emissions Summary

Number of Units	2
Unit Maximum Rating (MMBtu/hr)	96.9

Boiler Information	Natural Gas	Diesel Fuel[1]
Annual Operating Hours (hrs/yr)	8,760	48
Daily Operating Hours (hrs/day)	24	8

Notes:
1.) "Diesel Fuel" refers to ultra-low sulfur diesel (ULSD), which will be used as a backup fuel for the boilers.

Criteria Pollutant Emissions from Dual-Fuel (Natural Gas and Diesel) Boilers

Pollutant	Natural Gas				Diesel Fuel		
	Boiler Emission Factor [1] (lb/MMBtu)	Single Boiler Max Hourly Emissions [2] (lbs/hr)	Single Boiler Max Annual Emissions (8760 usage) [3] (tpy)	Single Boiler Max Annual Emissions (8712 usage) [3] (tpy)	Boiler Emission Factor [4] (lb/MMBtu)	Single Boiler Max Hourly Emissions [2] (lbs/hr)	Single Boiler Max Annual Emissions [3] (tpy)
NO_X	0.011	1.07	4.67	4.64	0.130	12.60	0.30
CO	0.036	3.49	15.28	15.27	0.080	7.75	0.19
PM_{10}	0.007	0.71	3.09	3.09	0.013	1.28	0.03
$PM_{2.5}$	0.007	0.71	3.09	3.09	0.010	0.98	0.02
SO_2	0.001	0.06	0.24	0.24	0.0015	0.15	0.0035
VOC	0.005	0.48	2.12	2.12	0.006	0.58	0.01

Notes:
1.) NO_x and CO emission factors from Manufacturer's Specifications and Expected Emissions Data. PM_{10}, $PM_{2.5}$, and SO_2, emission factors from AP-42 Ch 1.4 Table 1.4-
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Maximum Firing Rate (MMBtu/hr)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) NO_x and CO emission factors from Manufacturer's Specifications and Expected Emissions Data. PM_{10}, $PM_{2.5}$, and VOC emission factors from the typical emissions summary from the Manufacturer. Per AP-42 Chapter 1.3 Table 1.3-7, PM10 is 55% cumulative mass % stated size and PM2.5 is 42%. SO_2 derived based on 15 ppm sulfur content.

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Table 4. 96.9 MMBtu/hr Boiler Emissions Summary

TAP Emissions from Dual-Fuel (Natural Gas and Diesel) Boilers

Pollutant	CAS #	Washington Administrative Code Toxic Air Pollutant (WAC TAP)	Hazardous Air Pollutant (HAP)	Emission Factor Source Natural Gas [1]	Emission Factor Source Diesel [4]	Natural Gas				Diesel Fuel		
						Boiler Emission Factor [1]	Single Boiler Max Hourly Emissions [2]	Single Boiler Max Annual Emissions (8760 usage) [3]	Single Boiler Max Annual Emissions (8712 usage) [3]	Boiler Emission Factor [4]	Single Boiler Max Hourly Emissions [5]	Single Boiler Max Annual Emissions [3]
						(lb/MMscf)	(lbs/hr)	(tpy)	(tpy)	(lb/MMBtu)	(lbs/hr)	(tpy)
1,3-butadiene	106-99-0	X	X	--	AB2588	--	0	0	0	1.07E-04	0.01	2.49E-04
Acetaldehyde	75-07-0	X	X	Average of CATEF (median value) and AB2588	AB2588	5.79E-03	5.38E-04	2.36E-03	2.34E-03	2.51E-03	0.24	5.83E-03
Acrolein	107-02-8	X	X	AB2588	Average of AB2588 and Hot Spots 1999 (median value)	2.70E-03	2.51E-04	1.10E-03	1.09E-03	1.29E-03	0.12	2.99E-03
Ammonia	7664-41-7	X	X	Average of WebFIRE and AB2588	--	1.17	0.11	0.48	0.47	--	0	0
Arsenic	7440-38-2	X	X	WebFIRE	Average of AB2588, SDAPCD and Hot Spots 1999 (median value)	2.04E-04	1.90E-05	8.30E-05	8.26E-05	2.38E-05	2.30E-03	5.53E-05
Benzene	71-43-2	X	X	Average of WebFIRE, CATEF (median value), AB2588 and SDAPCD	Average of AB2588 and CATEF (median value)	3.04E-03	2.82E-04	1.24E-03	1.23E-03	2.51E-05	2.43E-03	5.83E-05
Cadmium	7440-43-9	X	X	AP-42, Section 1.4, Table 1.4-3	Average of AB2588 and SDAPCD	1.10E-03	1.02E-04	4.48E-04	4.45E-04	9.64E-06	9.34E-04	2.24E-05
Carbon Monoxide	630-08-0	X		Manufacturer's Specifications Data	Manufacturer's Specifications Data	37.53	3.49	15.28	15.20	0.08	7.75	1.86E-01
Chlorobenzene	108-90-7	X	X	--	AB2588	--	0	0	0	1.43E-06	1.38E-04	3.32E-06
Copper	--	X		--	Average of AB2588 and SDAPCD	--	0	0	0	2.75E-05	2.66E-03	6.40E-05
Dichlorobenzene	--		X	SDAPCD	--	1.20E-03	1.12E-04	4.88E-04	4.86E-04	--	0	0
Ethylbenzene	100-41-4	X	X	AB2588	Average of AB2588 and CATEF (median value)	6.90E-03	6.41E-04	2.81E-03	2.79E-03	6.25E-06	6.06E-04	1.45E-05
Formaldehyde	50-00-0	X	X	Average of WebFIRE, CATEF (median value), AB2588 and SDAPCD	Average of AB2588, SDAPCD and CATEF (median value)	5.80E-02	5.39E-03	0.02	0.02	1.19E-03	0.12	2.77E-03
Hexane	110-54-3	X	X	Average of AB2588 and SDAPCD	Average of AB2588, SDAPCD and CATEF (median value)	0.90	0.08	0.37	0.37	8.79E-05	8.51E-03	2.04E-04
Hexavalent chromium	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (5% of Cr max)	--	0	0	0	1.04E-06	1.01E-04	2.43E-06
Hydrogen chloride	7647-01-0	X	X	--	AB2588	--	0	0	0	1.33E-03	0.13	3.09E-03
Hydrogen fluoride	7664-39-3	X	X	--	AB2588	--	0	0	0	1.33E-03	0.13	3.09E-03
Hydrogen sulfide	7783-06-4	X	X	--	AB2588	--	0	0	0	1.33E-03	0.13	3.09E-03
Lead	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	3.22E-05	3.12E-03	7.49E-05
Manganese	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	1.09E-05	1.06E-03	2.54E-05
Mercury	7439-97-6	X	X	WebFIRE	Average of AB2588, SDAPCD and Siemens Survey (max)	2.60E-04	2.42E-05	1.06E-04	1.05E-04	1.54E-05	1.49E-03	3.57E-05
Naphthalene	91-20-3	X	X	Average of AB2588 and SDAPCD	Average of AB2588 and CATEF (median value)	4.55E-04	4.23E-05	1.85E-04	1.84E-04	2.24E-05	2.17E-03	5.22E-05
Nickel	--	X	X	--	Average of AB2588, SDAPCD and Siemens Survey (max)	--	0	0	0	1.78E-05	1.72E-03	4.14E-05
Nitrogen dioxide (NO2)	10102-44-0	X		Manufacturer's Specification Data for 10% of NOx emission factor	Manufacturer's Specification Data for 10% of NOx emission factor	1.15	0.11	0.47	0.46	0.01	1.26	3.02E-02
Propylene	115-07-1	X	X	AB2588	Average of AB2588 and CATEF (median value)	0.53	0.05	0.22	0.21	4.21E-04	0.04	9.80E-04
Selenium	--	X	X	--	Average of AB2588 and SDAPCD	--	0	0	0	4.29E-05	4.15E-03	9.97E-05
Sulfur dioxide (SO2)	7446-09-5	X	X	100% of fuel sulfur - AP-42[7]	100% of fuel sulfur - AP-42[1]	0.60	0.06	0.24	0.24	1.52E-03	0.15	3.54E-03
Toluene	108-88-3	X	X	Average of WebFIRE, AB2588 and SDAPCD	AB2588	0.01	1.02E-03	4.48E-03	4.45E-03	3.14E-05	3.05E-03	7.31E-05
Xylenes	1330-20-7	X	X	AB2588	AB2588	0.02	1.86E-03	8.14E-03	8.10E-03	1.14E-05	1.11E-03	2.66E-05
					Total TAP Emissions	**--**	**3.90**	**17.09**	**17.00**	**--**	**10.12**	**0.24**
					Total HAP Emissions	**--**	**0.31**	**1.35**	**1.34**	**--**	**1.10**	**0.03**

Notes:
1.) The natural gas combustion emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMscf) x Maximum Firing Rate (MMBtu/MMscf) / 1,020 (MMBTU/MMscf)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) The diesel fuel emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in
5.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Unit Maximum Rating (MMBtu/hr)

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Table 4. 96.9 MMBtu/hr Boiler Emissions Summary

GHG Emissions

Pollutant	Emission Factor Source for Natural Gas [1]	Emission Factor Source Diesel [4]	Natural Gas				Diesel Fuel		
			Boiler Emission Factor [1]	Single Boiler Max Hourly Emissions [2]	Single Boiler Max Annual Emissions (8760 usage) [3]	Single Boiler Max Annual Emissions (8712 usage) [3]	Boiler Emission Factor [4]	Single Boiler Max Hourly Emissions [5]	Single Boiler Max Annual Emissions [6]
			(lb/MMscf)	(lbs/hr)	(tpy)	(tpy)	(lb/MMBtu)	(lbs/hr)	(tpy)
CO_2	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-12	120,000	11,153	48,850	48,582	159.29	15,435	370.43
CH_4	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-3	2.3	0.21	0.94	0.93	1.54E-03	0.15	3.59E-03
N_2O	EPA WebFIRE	AP-42 Chapter 1.3, Table 1.3-8	0.64	0.06	0.26	0.26	1.86E-03	0.18	4.32E-03
		Total CO_2e		**11,175**	**48,945**	**48,677**	--	**15,487**	**371.68**

Notes:
1.) The natural gas combustion emissions factors for the boiler are taken from the emission calculations (PSCAA NOC Worksheet #12383) of a similar Boeing Facility located in Kent, WA.
2.) Hourly Emissions (lb/hr) = Emission Factor (lb/MMscf) x Maximum Firing Rate (MMBtu/MMscf) / 1,020 (MMBTU/MMscf)
3.) Annual Emissions (tpy) = Hourly Emissions (lb/hr) x Annual Operating Hours (hr/yr) / 2,000 (lb/ton)
4.) The diesel fuel emissions for CH4, N_2O, and CO_2 emission factors are from AP-42 Chapter 1.3 Table 1.3-8 and Table 1.3-12 respectively.

Dual Fuel Property Information			Source
Natural Gas Heating Value	1042.6	BTU/cft	PSCAA NOC Worksheet #12383
Diesel Heating Value	0.14	MMBtu/gal	PSCAA NOC Worksheet #12383

Global Warming Potentials		Source
GWP CO_2 =	1	40 CFR 98 Subpart A, Table A-1
GWP CH_4 =	28	40 CFR 98 Subpart A, Table A-1
GWP N_2O =	265	40 CFR 98 Subpart A, Table A-1

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Table 5. Emissions input for Air Disperion Modeling Analysis

		WA Pollutant Common Name									
Model ID	**Pollutant Name**	**Acrolein**	**Arsenic**	**Cadmium**	**Formaldehyde**	**Chromium(VI)**	**Hydrogen chloride**	**Hydrogen fluoride**	**Hydrogen sulfide**	**Mercury, elemental**	**Nitrogen dioxide**
	CAS Number (for Toxics)	**107-02-8**	**7440-38-2**	**7440-43-9**	**50-00-0**	**--**	**7647-01-0**	**7664-39-3**	**7783-06-4**	**7439-97-6**	**10102-44-0**
	Model Pollutant ID	**ACR**	**ARS**	**CAD**	**FORM**	**CHROM**	**HCL**	**HF**	**H2S**	**HG**	**1-NO2**
	Averaging Period	**24-Hour**	**Annual**	**Annual**	**Annual**	**Annual**	**24-Hour**	**24-Hour**	**24-Hour**	**24-Hour**	**1-Hour**
	Description	**lb/hour**	**tpy**	**tpy**	**tpy**	**tpy**	**lb/hour**	**lb/hour**	**lb/hour**	**lb/hour**	**lb/hour**
BOIL_1	36.5 MMBtu/hr Dual Fuel	9.45E-05	3.13E-05	1.69E-04	8.89E-03	0	0	0	0	9.10E-06	4.02E-02
BOIL_2	36.5 MMBtu/hr Dual Fuel	9.45E-05	3.13E-05	1.69E-04	8.89E-03	0	0	0	0	9.10E-06	4.02E-02
BOIL_3	96.9 MMBtu/hr Dual Fuel	2.51E-04	8.30E-05	4.48E-04	2.36E-02	0	0	0	0	2.42E-05	1.07E-01
BOIL_4	96.9 MMBtu/hr Dual Fuel	4.17E-02	1.38E-04	4.68E-04	2.63E-02	2.43E-02	4.29E-02	4.29E-02	4.29E-02	5.12E-04	1.26E+00
Total		**4.21E-02**	**2.84E-04**	**1.25E-03**	**6.77E-02**	**2.43E-02**	**4.29E-02**	**4.29E-02**	**4.29E-02**	**5.55E-04**	**1.45E+00**

		Criteria Pollutant Modeling											
Model ID	**Pollutant Name**	**Carbon Monoxide**	**Carbon Monoxide**	**Sulfur Dioxide**	**Sulfur Dioxide**	**Sulfur Dioxide**	**Sulfur Dioxide**	**PM10**	**PM10**	**PM2.5**	**PM2.5**	**Nitrogen Dioxide**	**Nitrogen Dioxide**
	CAS Number (for Toxics)	--	--	--	--	--	--	--	--	--	--	--	--
	Model Pollutant ID	**1-CO**	**8-CO**	**SO2**	**3-SO2**	**24-SO2**	**A-SO2**	**PM10**	**A-PM10**	**PM2.5**	**A-PM2.5**	**A-NO2**	**NO2**
	Averaging Period	**1-hour**	**8-hour**	**1-hour**	**3-hour**	**24-hour**	**annual**	**24-hour**	**annual**	**24-hour**	**annual**	**annual**	**1-hour**
	Description	**lb/hr**	**lb/hr**	**lb/hr**	**lb/hr**	**lb/hr**	**tpy**	**lb/hr**	**tpy**	**lb/hr**	**tpy**	**tpy**	**lb/hr**
BOIL_1	36.5 MMBtu/hr Dual Fuel	1.31E+00	1.31E+00	2.10E-02	2.10E-02	2.10E-02	9.20E-02	2.66E-01	1.17E+00	2.66E-01	1.17E+00	1.76E+00	4.02E-01
BOIL_2	36.5 MMBtu/hr Dual Fuel	1.31E+00	1.31E+00	2.10E-02	2.10E-02	2.10E-02	9.20E-02	2.66E-01	1.17E+00	2.66E-01	1.17E+00	1.76E+00	4.02E-01
BOIL_3	96.9 MMBtu/hr Dual Fuel	3.49E+00	3.49E+00	5.58E-02	5.58E-02	5.58E-02	2.44E-01	7.06E-01	3.09E+00	7.06E-01	3.09E+00	4.67E+00	1.07E+00
BOIL_4	96.9 MMBtu/hr Dual Fuel	7.75E+00	7.75E+00	1.47E-01	1.47E-01	8.63E-02	2.48E-01	8.97E-01	3.12E+00	7.96E-01	3.12E+00	4.95E+00	1.26E+01
Total		**1.39E+01**	**1.39E+01**	**2.45E-01**	**2.45E-01**	**1.84E-01**	**6.76E-01**	**2.14E+00**	**8.55E+00**	**2.03E+00**	**8.54E+00**	**1.31E+01**	**1.45E+01**