Prevention of Significant Deterioration Application for Changes Related to 777X Production

Prepared for

Boeing Commercial Airplanes

Submitted to:

Washington Department of Ecology

February 2014

Prepared by

CH2MHILL

Contents

Tables

Figures

Acronyms and Abbreviations

AA	airplane assembly
acfm	actual cubic feet per minute
AFB	Air Force Base
AQRV	air quality-related value
BACT	best available control technology
CARB	California Air Resources Board
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CIC	corrosion-inhibiting compound
CO	carbon monoxide
CO_2e	carbon dioxide equivalent
dscfm	dry standard cubic feet per minute
Ecology	Washington Department of Ecology
EDC	Everett Delivery Center
EPA	U.S. Environmental Protection Agency
ESRC	Electrical Systems Responsibility Center
F	Fahrenheit
FLAG	Federal Land Managers' Air Quality Related Values Work Group
FLM	Federal Land Manager
G	gram
GHGs	greenhouse gases
H_2S	hydrogen sulfide
HAP	hazardous air pollutant
HLFC	hybrid laminar flow control
HVLP	high-volume low-pressure
km	kilometers
kW	kilowatt
kWh	kilowatt-hour
lb/gal	pounds per gallon
LAER	lowest achievable emissions rate
LH	left hand
mm Hg	millimeters mercury
MMBtu/hr	million British thermal units per hour

NAA	non-attainment area
NAAQS	National Ambient Air Quality Standards
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NOx	nitrogen oxides
NSR	New Source Review
ODS	ozone-depleting substances
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
ppb	parts per billion
ppm	parts per million
PSCAA	Puget Sound Clean Air Agency
PSD	Prevention of Significant Deterioration
Q/D	quantity divided by distance
RBLC	RACT/BACT/LAER Clearinghouse
RH	right hand
RTO	regenerative thermal oxidizer
SCAQMD	South Coast Air Quality Management District
SO_2	sulfur dioxide
SOx	sulfur oxides
tpy	tons per year
TRE	Total Resource Effectiveness
VOC	volatile organic compound
WAC	Washington Administrative Code
WBSP	wing and body structure paint
WCF	wing component fabrication

1. Project Description

1.1 Overview

Boeing Commercial Airplane's Everett facility (Boeing Everett) produces wide-body airplanes and is located in Snohomish County, Washington (Figure 1-1 and Figure 1-2). At Everett, Boeing manufactures the model 747, 767, 777, and 787 airplanes as well as airplane cabin interior components (e.g., sidewalls, stowbins) for those same models and for the Boeing 737 airplane. Boeing proposes to produce new models of the Boeing 777, hereafter referred to as the 777X models. Production of the 777X is scheduled to begin in 2017, with first delivery targeted for 2020. As production of the 777X ramps up, production of the current 777 models will decrease. By the early to mid 2020s, production of the current 777 models is expected to be phased out.

One of the main differences between the current 777 and the 777X is that the 777X wings will be primarily made of composite material rather than aluminum. In terms of size, the 777X will have a greater wing span (necessitating folding wing tips to ensure airport gate compatibility) and one of the new 777X models (currently designated the 777-9X) will have a slightly longer fuselage than the longest 777 model currently in production.

The components for the 777X wing that will be made in Everett will be manufactured in a new building located on the site as shown in Figure 1-3. Final assembly of the 777X will occur in the same factory building where the current models of the 777 are assembled.

The proposed Project involves two phases, a first phase to transition from production of traditional 777 models to 777X models (as has already been directed by Boeing Management), and a second phase (contingent on one or more future Boeing Management directives based on future market and other business conditions) to increase the maximum production capacity and thereafter, production rate, from the current rate of about 8.3 777s per month (or about 100 per year) to as many as 10.4 777X's per month (about 125 777X's per year).[1]

Because of certification requirements, production requirements, space limitations, and other factors, each phase consists of a series of events occurring over several years.

[1] Boeing Management has directed that the Phase 1 changes to transition from traditional model 777 production to 777X production be promptly undertaken. This decision is not dependent on the future potential changes included in Phase 2 to increase production capacity and rate above 8.3 airplanes per month in reaction to future potential Boeing Management directives. Similarly, the Phase 1 changes are not physically and economically dependent on the Phase 2 changes; the Phase 1 changes will be made regardless of whether or not the Phase 2 changes are made. Although Boeing believes that these phases could be permitted as separate projects, the Washington Department of Ecology also has the discretion to, at the request of Boeing, permit these phases together as contemplated by 40 Code of Federal Regulations 52.21(j)(4) and (r)(2). *See* U.S. Environmental Protection Agency (EPA), *PSD Permit Modifications: Policy Statement on Changes to a Source, a Permit Application, or Issued Permit and on Extensions to Construction Scheduling* (6/85 Draft) at p. 33. *See also* EPA, *Permitting of Multi-Phase Construction Under Prevention of Significant Deterioration Regulations* (August 20, 1979). Boeing hereby requests that Ecology permit these phases together, in order to expedite any necessary review prior to construction of Phase 2 and to eliminate any second-guessing regarding project segmentation. Boeing's use of the phrase "project" to describe the combined phases should not be construed as a position that these phases must be considered a single project for purposes of Prevention of Significant Deterioration. In PSD-12-01 for the 737 MAX Project, Ecology approved a similar two-phase project for Boeing Renton.

FIGURE 1-1
Site Location Map
(PDF)

FIGURE 1-2
Plant Layout: 3003 West Casino Road, Everett, WA
(PDF)

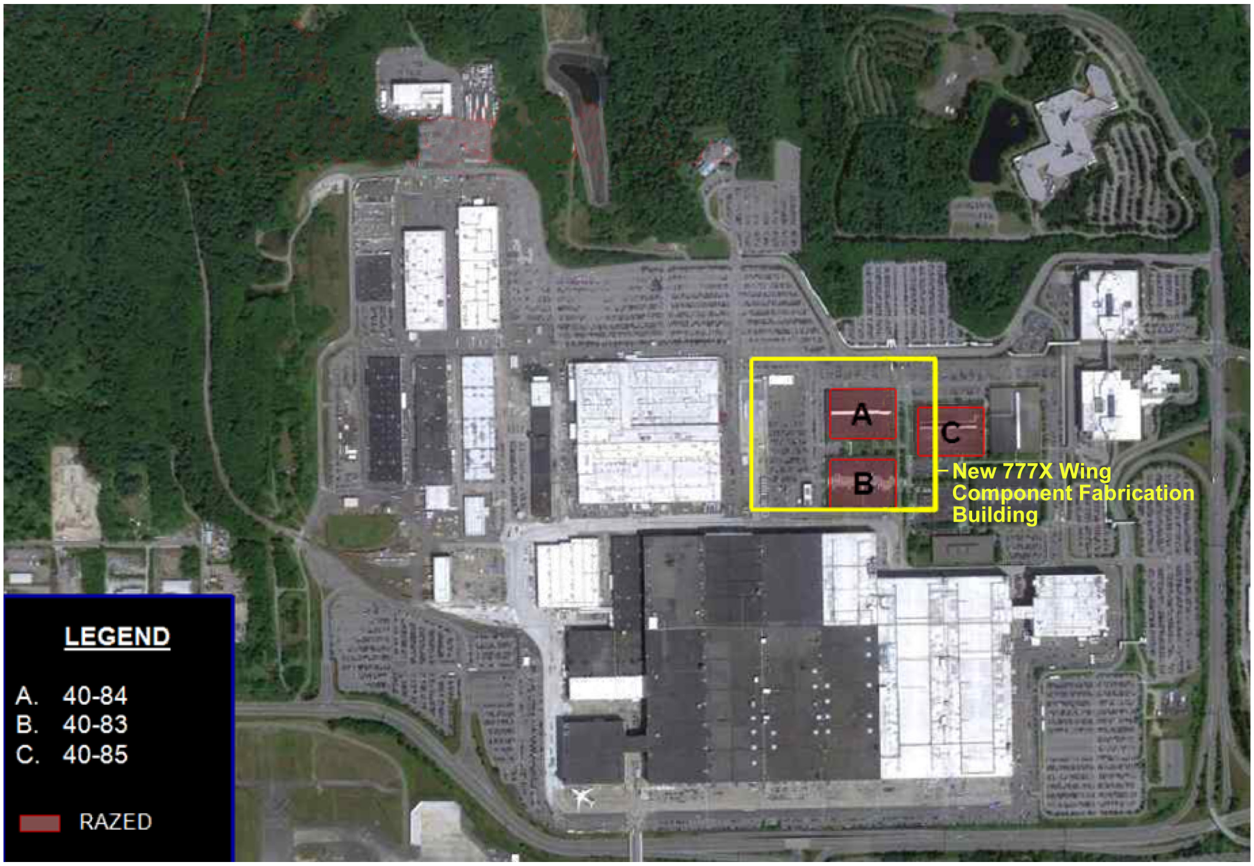

FIGURE 1-3
Location of New 777X Wing Component Fabrication Building

For example, many of the components of the 777X wing will be made in a new building (Figure 1-3) using new manufacturing processes.

The new wing component manufacturing and assembly tools and equipment for the 777X must be installed and tested, and production techniques must be proven and certified before the equipment can be used for production airplanes.

Phase 1 of the Project consists of two components. The first component of Phase 1 will be to make the changes to the facility necessary to begin production of the 777X model while maintaining production of existing 777 models at levels up to approximately 8.3 airplanes per month, consistent with Prevention of Significant Deterioration (PSD) permit No. 11-01. The changes not only include constructing a new building in which to manufacture the components for the new composite wing, but also creating additional wing and airplane assembly capacity for the 777X within the existing buildings.

The second component of Phase 1 will be an increase in 777X production capacity and rate to approximately 8.3 airplanes per month while correspondingly decreasing production of traditional 777 models, eventually transitioning to production of 777X's only. During Phase 1, Boeing does not plan to exceed a combined production rate (i.e., rate for current 777s plus 777X's) of approximately 8.3 airplanes per month.

Phase 1 will include the following substantial changes at Boeing Everett to achieve a production capacity of 8.3 777X's per month:

- Constructing a new building to fabricate 777X wing components (e.g., wing skins, spars, and stringers). The new building will include new emission units such as autoclaves and spray booths.
- Installing a new 777X wing spar build-up line in an existing factory building.
- Installing a new 777X wing assembly line in an existing factory building.
- Installing a new 777X final assembly line in an existing factory building. (This new assembly line might only be used for the low-rate initial production of the airplane. After a period of time, this new line might be phased out and all 777X final assembly moved to the existing 777 final assembly line.)
- Reconfiguring the existing 777 final assembly line to accommodate final assembly of the 777X.
- Constructing new 777X vertical fin spray booths and prep booths in an existing factory building.
- Changing existing tooling and equipment throughout the 777 factory (possibly including existing spray booths) as necessary to accommodate the larger 777X body sections and/or wings.

Phase 2, the second independent phase of this Project, will make further changes to the Everett facility in reaction to one or more future directives from Boeing Management to increase overall 777X production capacity to up to approximately 10.4 airplanes per month, and, thereafter, to utilize some or all of that capacity to increase 777X production. No such rate directives have been issued at this time, but there is a reasonable possibility that future market conditions affecting 777X demand will support production beyond the capacity achieved through Phase 1. Phase 2, tentatively scheduled to begin in 2021, will involve adding additional tooling and equipment to increase the 777X production capacity from 8.3 airplanes per month to up to 10.4 airplanes per month. For example, additional tape layup machines for fabricating wing panels might be installed in the wing component fabrication building, and additional spray booths and a composite press might be installed in the interiors manufacturing building.

Although the exact timing for each of the phases will depend in part on Boeing corporate directives, we anticipate that construction of Phase 1 will commence on or before November 1, 2014; construction of Phase 2 will commence on or before December 1, 2021.

Washington Department of Ecology (Ecology) has issued several PSD permits to Boeing Everett in past years that established volatile organic compound (VOC) emission limits directly or indirectly related to 777 production. These permits are:

- PSD-91-06, which established a VOC emission limit of 238.8 tons per year (tpy) for all 777 assembly operations.
- PSD-05-02, which established a VOC emission limit of 205 tpy for interiors manufacturing operations associated with all Boeing airplane models and a VOC

emission limit of 412 tpy for paint hangar final exterior coating operations for all Boeing airplane models.

- PSD-11-01, which established a VOC emission limit of 34 tpy for three existing 777 wing spray booths in Building 40-37.

Of these existing VOC emission limits, the 777X Project will require an increase in all but the paint hangar final exterior coating limit.

1.2 777 Assembly Operations

Model 777 assembly operations currently occur primarily in Buildings 40-04, 40-25, 40-34, 40-35, 40-36, 40-37, and 40-53.

The primary 777 assembly operations are:

- Wing component fabrication
- Wing assembly
- Body (fuselage) section assembly
- Wing and body structures seal/paint
- Airplane assembly

The 777X Project will add a new building to fabricate composite wing components for the new 777X wing. The Project will also add new operations such as a new vertical fin coating operation that will result in a more fuel-efficient vertical fin. (The vertical fin on the current 777 models is painted in the existing airplane paint hangars after the fin is installed on the airplane. The new vertical fin coating operation requires that the fin be coated in a dedicated spray booth before it is installed on the airplane.) Finally, some existing equipment, such as some body section spray booths, might have to be modified to accommodate the larger 777X body sections.

Each of these operations is described below.

1.2.1 Wing Component Fabrication

The wings of the 777X will be primarily made of composite material. The main wing components that will be made of composite material include upper and lower panels, front and rear spars, and upper and lower panel stringers. The manufacturing process of each of these parts is similar and involves the following primary steps.

- Wing component layup
- Curing in an autoclave
- Trimming and drilling
- Washing
- Non-destructive inspection
- Preparation for priming (e.g., abrading, solvent cleaning)
- Priming
- Wing component build-up

Part layup involves the manual or automated layup of composite material (in the form of resin pre-impregnated tape or sheets) onto a mandrel (or mold) which is preformed into the shape of the part being fabricated. Emissions associated with the part layup primarily occur from preparing the mandrel between each layup/cure cycle. Preparing the mandrel involves cleaning the surface with solvent, applying a mold release compound, and applying a tackifier solution. Once the part is laid up on the mandrel, a vacuum bag is sealed around the part and the assembly is then sent to an autoclave for curing. In the autoclave, vacuum from a vacuum pump is used to hold the bagged part under negative pressure while the autoclave is pressurized with nitrogen and heated to the curing temperature of up to approximately 350°F. The part is then held under negative pressure for the entire curing cycle (approximately 12 to 14 hours). Emissions during the curing cycle are offgases from the composite material and combustion emissions from the indirect gas-fired heater that is used to heat the autoclave. The offgases travel through the vacuum system and are exhausted by the vacuum pump. Boeing is planning for as many as three autoclaves, each equipped with a gas-fired heater with a rated heat input of approximately 40 million British thermal units per hour (MMBtu/hr). The curing cycle will begin with the autoclave initially being brought up to the curing temperature with the natural gas-fired heater for approximately 1 to 2 hours and then an electric heater will be used to maintain the curing temperature for the reminder of the cure cycle.

Once the part is cured, it is taken out of the autoclave, removed from the bag, and undergoes various machining operations (e.g., trimming and drilling). After machining is complete, the part is placed in a wash stall and washed using an aqueous solution and water rinse. After washing, the parts are inspected for defects. Following inspection, the parts are placed in a prep booth where the part surface is abraded and cleaned with solvent prior to being moved to a spray booth to be coated with a primer. The spray equipment used to apply the primer will either be cleaned within the spray booth or at specially designed equipment cleaning booths. After priming, the part might be moved to a heated cure booth to allow the primer to cure. VOC emissions will result from the solvent cleaning, spray coating, and curing of the parts as well as from cleaning of spray equipment. The trimming, drilling, abrading, and spray coating operations result in particulate emissions which can be controlled using a dust collection system and spray booth exhaust filters.

Once priming is completed, certain "build-up" work will be performed on the parts. For example, the spars will have stiffeners, brackets, and other components attached, including a portion of the leading and trailing edges. The wing panels will similarly undergo some build-up work. This type of work primarily consists of open floor mechanical assembly processes (e.g., drilling, fastening) and will involve the application of VOC-containing products such as hand-wipe cleaning solvents, sealants, and touch-up coatings. At this time, it is anticipated that all the wing component fabrication work described above will take place in a new building with the exception of some wing spar build-up work and possibly wing panel build-up work that will occur in an existing building, and the emission units (e.g., vacuum pumps, prep booths, and spray booths) associated with the fabrication work will be new. The new emission units and activities and related VOC emissions for ~~the~~ wing component fabrication ~~building~~ are shown in Table 1-1. The table also lists open floor activities that will take place as part of wing component fabrication~~in the new building~~. Boeing believes that such activities should not be treated as new emission units since similar open floor activities occur throughout Boeing's

Everett facility and can be easily moved about. However, in order to expedite this permitting process they are listed in Table 1-1.[2]

[2] We are conservatively assuming that open floor operations should be treated as new emissions units even though we believe that adding tool and work positions at which open floor activities take place merely debottleneck those activities (even if a new structure is constructed to house those expanded activities). We do not intend to be bound by this approach with respect to future projects.

TABLE 1-1. WING COMPONENT FABRICATION VOC EMISSIONS FROM NEW EMISSION UNITS					
Unit ID	Emission Unit or Activity	New or Modified	Combustion Emissions (lb/plane)	Open Floor Emissions (lb/plane)	Stack Non-combustion Emissions (lb/plane)
WCF-1	Open floor activities which include prep of layup mandrels (e.g., hand-wipe cleaning and application of mold release and tackifier) and wing panel and wing spar build-up (e.g. hand-wipe cleaning and sealant application)	New	0.00	~~2,047~~1,895	0
WCF-2	Gas-fired heater for liquid nitrogen vaporization unit	New	0.33	0	0
WCF-3a	Gas-fired process heater for autoclave #1	New	1.45	0	0
WCF-3b	Gas-fired process heater for autoclave #2	New	1.45	0	0
WCF-3c	Gas-fired process heater for autoclave #3	New	1.45	0	0
WCF-4	Vacuum pump(s) servicing autoclaves	New	0.00	0	114
WCF-5	Dust collector(s) used to collect particulates from trimming, drilling, and other machining operations on cured components	New	0.00	0	0
WCF-6a	Wing panel wash stall #1	New	0.12	0	0
WCF-6b	Wing panel wash stall #2	New	0.12	0	0
WCF-6c	Wing spar and stringer wash stall #1	New	0.03	0	0
WCF-6d	Wing spar and stringer wash stall #2	New	0.03	0	0
WCF-7	Gas-fired plasma unit for treatment of wing panel stringers	New	0.17	0	0
WCF-8a	Wing panel prep booth(s) (abrasive blast/sanding, solvent hand-wipe, edge seal) (see Note 1)	New	0.46	0	504
WCF-8b	Wing spar prep booth (abrasive blast/sanding, solvent hand-wipe, edge seal)	New	0.00	0	70
WCF-9a	Wing panel spray booth #1	New	1.39	0	273~~409~~
WCF-9b	Wing panel spray booth #2	New	1.39	0	273~~409~~
WCF-9d	Wing panel spray booth #3	New	1.39	0	273
WCF-9c	Wing spar spray booth	New	0.33	0	118

TABLE 1-1. WING COMPONENT FABRICATION VOC EMISSIONS FROM NEW EMISSION UNITS

Unit ID	Emission Unit or Activity	New or Modified	Combustion Emissions (lb/plane)	Open Floor Emissions (lb/plane)	Stack Non-combustion Emissions (lb/plane)
WCF-10a	Wing panel primer curing booth #1	New	0.70	0	Note 2
WCF-10b	Wing panel primer curing booth #2	New	0.70	0	Note 2
WCF-10c	Wing spar primer curing booth	New	0.17	0	Note 2
WCF-11	Small quantity paint mix booth	New	0.00	0	Less than 1
WCF-12a	Coating equipment cleaning booth #1	New	0.00	0	16
WCF-12b	Coating equipment cleaning booth #2	New	0.00	0	16
WCF-14	Wing spar seal booth(s) #1 (See Note 4)	New	0.18	0	152

Notes:
1. Currently Boeing is considering building one or two wing panel prep booths.; however, for the purposes of this application only one booth will be considered. If Boeing decides to build two wing panel prep booths, the 504 pounds of VOC emission will be divided between the two booths.
2. Curing emissions are minimal and included in the spray booth emissions.
3. All the emission units and activities shown above will be installed in Phase 1 of the Project.
4. Currently Boeing is considering building as many as four wing spar seal booths.; however, for the purposes of this application only one booth will be considered. If Boeing decides to build more than one wing spar seal booth, the 152 pounds of VOC emission per plane will be divided between the multiple booths.

All the emission units shown in Table 1-1 will be installed in Phase 1 of the Project. Additional tooling and equipment such as tape-laying machines and additional work positions might be installed in Phase 2, but no additional emission units associated with wing component fabrication are anticipated in Phase 2.

1.2.2 Wing Assembly

After the wing panel and wing spar build-up work is complete, the 777X wings will be assembled from the completed panels, spars, and ribs (which will be manufactured elsewhere). Again, this assembly work primarily consists of open floor mechanical assembly processes and will involve the application of VOC-containing products such as hand-wipe cleaning solvents, sealants, and touch-up coatings.

It is anticipated that the 777X wing assembly line will be located in the main factory building as is the existing 777 wing assembly line, but at a new location within that building. Neither Phase 1 nor Phase 2 should require the installation or establishment of any new emission units or modification of any existing emission units associated with wing assembly.

1.2.3 Body Section Assembly

Body section assembly primarily involves the assembly of individual body section panels into forward, aft, and mid body sections. As with wing assembly, this work primarily consists of open floor mechanical assembly processes and involves the application of VOC-containing products such as hand-wipe cleaning solvents, sealants, and touch-up coatings.

It is anticipated that 777X body section assembly work will be located in the main factory building as is the existing 777 body section assembly work, but all 777 body section assembly work will transition to a new location within that building. Neither Phase 1 nor Phase 2 should require the installation or establishment of any new VOC emission units or modification of any existing emission units associated with body section assembly.

1.2.4 Wing and Body Structures Seal/Paint and Vertical Fin Paint

Once the 777X wings and individual body sections are assembled, they will be moved to the existing 777 wing and body section spray booths in Building 40-37 for cleaning, sealing, and coating. The 777X wings will be cleaned, primed, and topcoated in the same booths where the existing 777 model wings are cleaned, primed, and topcoated. Similarly, 777X body sections will have their interior structures and a small portion of their exterior structures (e.g., the area under the wing fairing) cleaned, sealed, primed, and sprayed with a corrosion-inhibiting compound (CIC) in the same booths that the existing 777 model body structures use.

In Phase 1 of the Project, some of the existing 777 body section booths might need to be lengthened to accommodate the slightly longer forward and aft fuselage sections of the 777-9X.

Also as part of Phase 1, Boeing intends to add a new prep booth and three new spray booths to coat the 777X vertical fins. As noted previously, the 777 vertical fin painting is currently completed in the existing Boeing Everett airplane paint hangars after the fin is installed on the airplane. The new coating operation will result in less aerodynamic drag and requires that the fin be coated in dedicated spray booths before it is installed on the airplane.

In Phase 2 of the 777X Project, two additional robotic cleaning and coating machines might need to be added to the existing wing booths to achieve a production capacity of up to 10.4 airplanes per month.

The new or modified emissions units and related VOC emissions for the wing and body structures seal/paint and vertical fin paint are listed in Table 1-2.

1.2.5 Airplane Assembly

Airplane assembly operations include the installation of various airplane systems (e.g., hydraulic, fuel, electrical) in the wing and body sections; the installation of the empennage (i.e., vertical fin and horizontal stabilizers) onto the aft body section; assembly of the body sections and wings into a completed structure; integration of the airplane systems; installation of landing gear, engines, and interior components (e.g., seats, sidewalls, partitions); and functional testing. Most of these activities occur on the open floor and involve the application of VOC-containing products such as hand-wipe cleaning solvents, sealants, and touch-up coatings.

As discussed earlier in this document, a new 777X airplane assembly line will be located in the main factory building as is the existing 777 airplane assembly line, but at a new location within that building. This new assembly line might only be used for the low-rate initial production of the airplane. After a period of time, this new line might be phased out and all 777X final assembly moved to the existing 777 final assembly line, reconfigured for the 777X.

The only new or modified emission units associated with 777X airplane assembly that will be installed as part of Phase 1 of the Project are two wing stub ventilated spray coating enclosures. These enclosures will be used to capture emissions from coating certain portions of the wing stub and wing stub join areas. The enclosures will be filtered as required by the Aerospace National Emission Standards for Hazardous Air Pollutants (NESHAP). One new enclosure will be installed in the new 777X airplane assembly line, and the existing wing stub spray booth that is part of the existing 777 assembly line will be modified or replaced.

Other than these two ventilation systems, neither Phase 1 nor Phase 2 should require the installation or establishment of any new emission units or the modification of any existing emission units associated with airplane assembly. VOC emissions from the wing stub ventilated spray coating enclosures are shown in Table 1-3.

TABLE 1-2. WING AND BODY STRUCTURES SEAL/PAINT AND VERTICAL FIN PAINT VOC EMISSIONS FROM NEW AND MODIFIED EMISSION UNITS

Unit ID	Emission Unit or Activity	New or Modified	Combustion Emissions (lb/plane)	Open Floor Emissions (lb/plane)	Stack Non-combustion Emissions (lb/plane)
WBSP-1a	Robotic wing spray booth for LH wing	Modified	0.00	0	472
WBSP-1b	Robotic wing spray booth for RH wing	Modified	0.00	0	472
WBSP-2	Forward body section spray booth	Modified	0.00	0	209
WBSP-3	Mid body section spray booth	Modified	0.00	0	217
WBSP-4	Aft body section spray booth	Modified	0.00	0	209
WBSP-6	Forward body section CIC spray booth	Modified	0.00	0	194
WBSP-7	Mid body section CIC spray booth	Modified	0.00	0	98
WBSP-8	Aft body section CIC spray booth	Modified	0.00	0	194
WBSP-10	Vertical fin HLFC prep booth	New	0.39	0	20
WBSP-11a	Vertical fin HLFC spray booth #1	New	1.14	0	70
WBSP-11b	Vertical fin HLFC spray booth #2	New	1.14	0	70
WBSP-11c	Vertical fin HLFC spray booth #3	New	1.14	0	70

WBSP = wing and body structure paint
LH = left hand
RH = right hand
HLFC = hybrid laminar flow control

TABLE 1-3. AIRPLANE ASSEMBLY VOC EMISSIONS FROM NEW AND MODIFIED EMISSION UNITS					
Unit ID	**Emission Unit or Activity**	**New or Modified**	**Combustion Emissions (lb/plane)**	**Open Floor Emissions (lb/plane)**	**Stack Non-combustion Emissions (lb/plane)**
AA-2a	Wing stub spray coating enclosure #1	New	0.00	0	22
AA-2b	Wing stub spray coating enclosure #2	Modified	0.00	0	22

1.2.6 Existing PSD VOC Emission Limits Affecting 777 Assembly

Ecology-issued PSD permit PSD-91-06 established a VOC emission limit of 238.8 tpy for all 777 assembly operations. The 777X Project will require that this emission limit be increased to 513 tpy to account for new wing component fabrication emissions, the higher production rate anticipated in Phase 2 of the 777X Project, and the new vertical fin prep and spray booths.

Ecology-issued PSD permit PSD-11-01 established a VOC emission limit of 34 tpy for the robotic wing spray booths and a per wing average emission limit of 0.17 ton. The 777X Project will require that these emission limits be increased to 59 tpy and 0.25 ton per wing to account for the higher production rate anticipated in Phase 2 of the 777X Project, the larger size of the composite wing, and the different materials used to clean and coat the composite wing.

1.3 Airplane Manufacturing Support Operations

1.3.1 Facilities

In addition to the new heating equipment associated with specific production emissions units listed in Tables 1-1 and 1-2, there will be additional open space heating and general process heating requirements in the new wing component fabrication building that total approximately 111 MMBtu/hr. Table 1-4 lists the expected emissions from these heating processes.

TABLE 1-4. COMFORT AND PROCESS HEATING VOC EMISSIONS FROM NEW 777X WING COMPONENT FABRICATION BUILDING					
Unit ID	**Emission Unit or Activity**	**New or Modified**	**Combustion Emissions (lb/plane)**	**Open Floor Emissions (lb/plane)**	**Stack Non-combustion Emissions (lb/plane)**
F-1	Combustion equipment for comfort or process heating	New	16.88	0	0

The 777X Project is expected to require as many as nine new 2,750-kilowatt (kW) backup emergency diesel generators for the autoclaves and one 750-kW backup diesel generator for other wing manufacturing activities. Table 1-5 lists the expected VOC emissions from these engines.

TABLE 1-5. EMERGENCY DIESEL GENERATORS VOC EMISSIONS			
Unit ID	**Emission Unit or Activity**	**New or Modified**	**Combustion Emissions (tons/yr)**
F-2a	Nine 2,750-kW diesel generators	New	0.94
F-2b	750-kW diesel generator	New	0.03

1.3.2 Interiors Production Operations

Interiors production operations primarily occur in the Interiors Responsibility Center's (IRC's) Building 40-56 and support all airplane models produced at Boeing Everett, as well as the 737 model produced at Boeing Renton. Interiors production involves the manufacture of stowbins, sidewalls, ceilings, partitions, closets, and other cabin interior components. Air emissions primarily occur from activities such as spray coating, hand-wipe cleaning, screen printing, composite curing, and the use of miscellaneous adhesives, resins, and other VOC-containing products.

No changes to the IRC emission units are anticipated for Phase 1 of the 777X Project. However, for Phase 2, it is anticipated that three adhesive spray booths, a paint booth, and a crushed core press will need to be added to the IRC to achieve a 777X interiors production rate capacity of up to 10.4 shipsets per month. Table 1-6 lists these new emission units and their estimated VOC emissions.

TABLE 1-6. IRC VOC EMISSIONS FROM NEW EMISSION UNITS					
Unit ID	**Emission Unit or Activity**	**New or Modified**	**Combustion Emissions (lb/plane)**	**Open Floor Emissions (lb/plane)**	**Stack Non-combustion Emissions (lb/year)**
IRC-1a	Adhesive spray booth #1	New	0	0	17,700
IRC-1b	Adhesive spray booth #2	New	0	0	17,700
IRC-1c	Adhesive spray booth #3	New	0	0	17,700
IRC-2	Paint spray booth	New	0	0	10,000
IRC-3	Crushed core press	New	0	0	4,500

Ecology-issued PSD permit PSD-05-02 established a VOC emission limit of 205 tpy for all interiors production operations at Boeing Everett. This limit covers emissions from 777 interiors production as well as interiors production for other Boeing airplane models. The 777X Project will require that this emission limit be increased to 239 tpy to account for the additional emissions from the new emission units anticipated to achieve the higher production rate of up to 10.4 shipsets per month.

The estimated VOC emissions from interiors production for each 777X are 0.53 ton per airplane.

1.3.3 Everett Delivery Center Operations

Everett Delivery Center (EDC) paint hangar and pre-flight/delivery operations primarily occur in Buildings 45-01, 45-03, and 45-04 paint hangars; in Building 45-02; in Building 45-334 at the Everett Modification Center (including the paint hangar in Bay 4 Building 45-334), and on the flightline; and support all airplane models produced at Boeing Everett. Air emissions primarily occur from activities such as exterior prep and spray-coating activities in the paint hangars, and the use of hand-wipe cleaning solvents and miscellaneous adhesives, resins, and other VOC-containing products on the flightline. Ecology-issued PSD permit PSD-05-02 establishes a VOC emission limit of 412 tpy for all airplane manufacturing operations that occur at the EDC, including 777 paint hangar and pre-flight and delivery operations. The Project will not require any increase in this VOC emission limit.

Boeing Everett paint hangars, which are all part of EDC, are operating at or near capacity. The current paint hangar capacity is less than that necessary to serve the combined production of all airplane models at Boeing Everett today, requiring many airplanes to be flown offsite for final decorative coating. There are currently no plans to increase onsite paint hangar capacity to support the increased 777X production rate enabled by Phase 2 of the Project; thus, the Project will not result in an emission increase at the paint hangars. However, other EDC work such as coating and cleaning of 777 rudders and elevators (the moving surfaces on the vertical fin and horizontal stabilizer, respectively) and the preflight/delivery work that occurs on each airplane on the flightline before it is delivered, will increase as a result of this Project. The estimated emissions from these activities are 0.15 ton of VOCs per 777X produced.

Neither Phase 1 nor Phase 2 should require the installation or establishment of any new emission units or the modification of any existing emission units associated with the EDC operations.

1.3.4 Propulsion Systems Operations

Propulsion Systems operations primarily occur in Building 40-54 and involve receiving airplane engines and engine struts for 747, 767, and 777 models from offsite and preparing them for installation on the airplane. Air emissions are relatively minor and primarily occur from the open floor use of hand-wipe cleaning solvents, touch-up coatings, and miscellaneous adhesives, resins, and other VOC-containing products. The VOC emissions from this operation are not subject to a PSD or Puget Sound Clean Air Agency (PSCAA) established VOC annual emission limit. The estimated emissions from Propulsion Systems are 0.005 ton of VOCs per engine. The 777X has two engines; therefore, the estimated emissions are 0.01 ton of VOCs per 777X produced.

Neither Phase 1 nor Phase 2 should require the installation or establishment of any new emission units or the modification of any existing emission units associated with propulsion systems operations.

1.3.5 Emergent Operations

Emergent operations primarily involve the emergent, non-routine fabrication and repair of aerospace components. Emergent operations support all airplane models produced at Boeing Everett. Air emissions from emergent operations are relatively minor and primarily occur from spray coating and the use of hand-wipe cleaning solvents and miscellaneous adhesives, resins, and other VOC-containing products. The VOC emissions from this operation are not subject to a PSD VOC emission limit. The estimated emissions from these activities are 0.06 ton of VOC per 777X produced.

Neither Phase 1 nor Phase 2 should require the installation or establishment of any new emission units or the modification of any existing emission units associated with emergent operations.

1.3.6 Electrical Systems Production Operations

Electrical Systems production operations primarily occur in the space that the Electrical Systems Responsibility Center (ESRC) shares with the IRC in Building 40-56, and in Building 40-02, and primarily support the 747, 767, and 777 airplane models produced at Boeing Everett, as well as the 737 model produced at Boeing Renton. Electrical Systems production operations involve the assembly of wiring harnesses, power panels, and other electrical components. Air emissions are relatively insignificant and occur from the use of hand-wipe cleaning solvents and miscellaneous adhesives, resins, and other VOC-containing products. The VOC emissions from this operation are not subject to a PSD VOC emission limit. The estimated emissions from these activities are 0.013 ton of VOC per 777X produced.

Neither Phase 1 nor Phase 2 should require the installation or establishment of any new emission units or the modification of any existing emission units associated with electrical systems production operations.

1.4 Summary of Proposed PSD Permit Changes

Table 1-7 lists the proposed changes to the VOC emission limits in the current PSD permits. In addition to those proposed limit changes, Boeing is proposing to limit annual natural gas usage from new combustion units related to the 777X Project to 1,000,000 MMBtu/yr.

TABLE 1-7. PROPOSED PSD VOC EMISSION LIMIT CHANGES

PSD Permit	Emission Unit or Activity	Current Limit	Proposed Limit	Increase (tpy)
91-06	777 Assembly	238.8 tpy	513 tpy	274.2
05-02	Interiors	205 tpy	239 tpy	34
11-01	Wing Painting	34 tpy	59 tpy	Note 1
11-01	Wing Painting	0.17 tons per wing	0.24 tons per wing	Note 1
Total Proposed Increase				**308.2**

Note 1: These emissions are included in 777 Assembly current and proposed emission limits.

2. Prevention of Significant Deterioration

The Prevention of Significant Deterioration program is intended to protect current levels of air quality and to ensure that the air quality does not significantly deteriorate in areas that meet the National Ambient Air Quality Standards (NAAQS). The program requires proposed major sources or major modifications to existing major sources to undergo a specific review procedure. The federal PSD requirements are contained in 40 Code of Federal Regulations (CFR) 52.21; however, the U.S. Environmental Protection Agency (EPA) has delegated much of the implementation of the program to the Washington Department of Ecology. Ecology implements the PSD program under Washington Administrative Code (WAC) 173-400- 720. Under 40 CFR 52.21(a)(2)(iv)(a), "a project is a major modification for a regulated NSR [New Source Review] pollutant if it causes two types of emissions increases—a significant emissions increase (as defined in paragraph (b)(40) of this section), and a significant net emissions increase (as defined in paragraphs (b)(3) and (b)(23) of this section)." The significant emissions increase analysis (often called Step 1) looks only at the emissions from the proposed project, and the significant net emissions increase analysis (often called Step 2) looks at additional increases and decreases from "contemporaneous" projects at the source.

For the significant emissions increase analysis, the proposed Project will involve both constructing new emissions units and modifying existing units. The PSD regulations require use of the hybrid test for projects that involve both the addition of new emissions units and the modification of existing emissions units (40 CFR 52.21(a)(2)(iv)(f)). Under the hybrid test, a significant emissions increase of a regulated NSR pollutant is projected to occur if the sum of the emissions increases for each emissions unit, using the actual-to-projected-actual applicability test (40 CFR 52.21(a)(2)(iv)(c)) for modified units and the actual-to-potential applicability test (40 CFR 52.21(a)(2)(iv)(d)) for new units, equals or exceeds the significance threshold for that pollutant (as defined in paragraph 40 CFR 52.21 (b)(23)). The actual-to-projected-actual applicability test involves adding the projected (future) actual emissions from existing emissions units that are modified as part of the project or that are otherwise expected to experience an emission increase as a result of the project, and then subtracting the past actual emissions (referred to as "baseline actual emissions") from those units. In lieu of projecting future actual emissions for a particular existing emissions unit, an applicant can choose instead to use the unit's potential to emit as the unit's post-project emissions (40 CFR 52.21(b)(41)(ii)(d)). The actual-to-potential test, which is required for all new units being constructed as part of the project, involves totaling the potential emissions of the proposed new emissions units, then subtracting past actual emissions of those units. A new unit that is being constructed as part of the project has a baseline of zero (40 CFR 52.21(b)(48)(iii)).

If the project would result in a significant emissions increase, then a significant net emissions increase analysis is often conducted. However, EPA has clearly stated that calculating a net emissions increase is at the source's option (see, for example, 67 Federal Register 80186, at 80197 [December 31, 2002]), and therefore a source may seek a PSD permit based on a calculated significant emission increase alone. For this Project, Boeing is exercising that option and forgoing the Step 2 significant net emission increase analysis.

Because the Boeing Everett facility currently has the potential to emit more than 250 tpy of a regulated NSR pollutant (VOC), Boeing Everett is considered a "major stationary source" for PSD purposes, as defined by 40 CFR 52.21 (b)(1)(i).

As a result of the possible increased 777 production rate enabled by Phase 2 of this Project, emissions from the existing 777 assembly operations are expected to increase as well as emissions from other operations where Boeing Everett produces or processes 777 components (including interiors production, some EDC operations, and Propulsion Systems operations). Further, the amount of steam and heat produced at the Everett facility will likely increase to support the increased production.

2.1 Significant Emissions Increases

As stated previously in this application, this Project will involve both modifying existing emissions units and constructing new emissions units; therefore, a hybrid test is required under 40 CFR 52.21(a)(2)(iv)(f). The hybrid test involves using the actual-to-projected-actual applicability test (40 CFR 52.21(a)(2)(iv)(c)) for modified and debottlenecked units, and the actual-to-potential applicability test (40 CFR 52.21(a)(2)(iv)(d)) for new units to be constructed as part of the project.

2.1.1 Actual-to-Projected-Actual Applicability Test for Modified and Debottlenecked Emissions Units

For existing emissions units that are being modified or debottlenecked as part of the project, the PSD baseline emissions are the emissions averaged over any 24-consecutive-month period in the 10 years before Ecology receives a complete application for the project. For a regulated NSR pollutant, when a project involves more than one emissions unit, only one 24-consecutive-month period may be used to determine the baseline actual emissions for all emissions units being changed; however, a different 24-consecutive-month period can be used for each regulated NSR pollutant (40 CFR 52.21(b)(48)(ii)(d)). For this Project, the 10-year period from which the baseline period may be selected for all NSR regulated pollutants begins in 2004 and includes the full calendar years 2005 through 2013. For "new" units constructed prior to the project (i.e., units that have been in operation for less than 2 years), baseline actual emissions are the units' potential to emit (40 CFR 52.21(b)(48)(iii)).

Table 2-1 presents the VOC emissions from 777 assembly operations and the number of 777s produced for the 9 years 2005 through 2013. Boeing has selected 2012 and 2013 calendar years as the baseline period for VOC emissions.

Increased 777X production enabled by Phase 2 of the Project would be expected to result in increased emissions from the existing 777 assembly operations and related combustion from boilers and heaters. Table 2-2 lists the projected actual emissions (at the maximum production rate of approximately 10.4 airplanes per month, or 125 airplanes per year) from the 777X assembly operations and from the related operations that would experience increased emissions as a result of increased production at the assembly operations. Details of the emission estimates are shown in Appendices A and B. Note that with the exception of boiler-related emissions, the emissions listed in Table 2-2 are specific to 777X production only.

TABLE 2-1. ESTIMATED VOC EMISSIONS FROM 777 ASSEMBLY OPERATIONS FOR 2005 THROUGH 2013

Year	# of 777s Produced	Estimated VOC Emissions Before Subtracting Waste (tons)	Estimated VOCs in Waste (tons)	Estimated VOC Emissions After Subtracting Waste (tons)	Estimated VOC Emissions per Airplane (tons)
2005	44	107.8	4.2	103.6	2.35
2006	62	117.9	5.9	112.0	1.81
2007	83	179.3	8.7	170.6	2.05
2008[a]	68	152.7	8.2	144.5	2.13
2009	83	164.5	10.1	154.4	1.86
2010	71	133.3	8.0	125.3	1.77
2011	75	146.8	8.6	138.2	1.84
2012	83	167.7	11.2	156.5	1.89
2013	99	181.1	17.1	164	1.66

[a] A 2-month work stoppage occurred in 2008.

TABLE 2-2. PROJECTED ACTUAL EMISSIONS OF REGULATED NSR POLLUTANTS FOR EXISTING 777 ASSEMBLY OPERATIONS AND RELATED 777 OPERATIONS (tpy)

Operation	CO	NOx	PM	SOx	Lead	VOC	CO_2e
777 Assembly			[a]			266	
Interiors			[a]			66	
EDC			[a]			19	
Propulsion			[a]			1	
Emergent			[a]			8	
ESRC			[a]			2	
Boilers[b]	55	67	5.1	1.5	0.0004	4	79,500
Total	**55**	**67**	**6.35**	**1.5**	**0.0004**	**366**	**79,500**

[a] Non-combustion PM emissions will primarily be generated from spray coating operations. Total combined PM emissions from spray coating operations from all 777 operations are estimated to be less than or equal to approximately 0.01 ton per airplane. Therefore, total combined PM projected actual emissions from all 777 spray coating operations are estimated to be less than or equal to 0.01 ton/airplane x 125 airplanes/yr = 1.25 tpy.
[b] All combustion-related emissions are accounted for in Boilers.
CO = carbon monoxide
EDC = Everett Delivery Center
NOx = nitrogen oxides
CO_2e = carbon dioxide equivalent
ESRC = Electrical Systems Responsibility Center
PM = particulate matter

Because the existing boilers and heaters provide heat and energy to all operations at the Boeing Everett facility, including operations such as office buildings and other airplane model manufacturing that are not directly related to 777 production, emissions from boilers and heaters are treated differently than those from the other operations. The projected actual emission rate for combustion operations is the baseline rate for the entire Boeing Everett facility plus the expected additional heat that would be required to support 777X production at the maximum potential production rate, based on an average heat usage of 3,206 MMBtu per airplane. Details of the emission estimates are shown in Appendices A and B.

VOC emissions from the EDC operations do not include final painting of the airplane exterior, which is performed in paint hangars. Currently, the paint hangars at Boeing's Everett facility are operating at or near capacity, with many airplanes being flown offsite for final coating. Because there are currently no plans to increase paint hangar capacity to support the 777X, the Project will not result in increased emissions at Everett from paint hangars.

Table 2-3 shows the baseline actual emissions for calendar years 2012 and 2013 from the 777 assembly operations and related operations that are expected to experience an emission increase as a result of the increased 777X production enabled by Phase 2 of the Project, except that carbon dioxide equivalent (CO_2e) is based on 2006 and 2007, which was the 2-year period with the greatest CO_2e production rate.

TABLE 2-3. BASELINE ACTUAL EMISSIONS OF REGULATED NSR POLLUTANTS FOR EXISTING 777 ASSEMBLY OPERATIONS AND RELATED 777 OPERATIONS (tpy)

Operation	CO	NOx	PM	SOx	Lead	VOC	CO_2e
777 Assembly			[a]			160	
Interiors			[a]			48	
EDC			[a]			14	
Propulsion			[a]			1	
Emergent			[a]			5	
ESRC			[a]			1	
Boilers[b]	50	60	4.5	1.1	0.0003	3	72,000
Total	**50**	**60**	**5.5**	**1.1**	**0.0003**	**233**	**72,000**

[a] Non-combustion PM emissions will primarily be generated from spray coating operations. Total combined PM emissions from spray coating operations from all 777 operations are estimated to be less than or equal to approximately 0.01 ton per airplane. Therefore, total combined PM baseline actual emissions from all 777 spray coating operations for calendar years 2012 and 2013 are estimated to be less than or equal to 1 tpy.
[b] All combustion-related emissions are accounted for in Boilers.

During the baseline period, Boeing Everett did not operate above any legally enforceable emission limitation and there are no new emission standards that affect these units or activities that have come into effect between the baseline period and the date of this application. Therefore, no adjustments are required under 40 CFR 52.21(b)(48)(ii)(b) or (c).

2.1.2 Actual-to-Potential Test for Newly Constructed Emissions Units

For emissions units that will be newly constructed as part of the Project, baseline emissions are zero and post-project emissions are the units' potential to emit. Thus, the emission increase from these units resulting from the Project is their potential to emit. The proposed new emissions units and their associated potential to emit are identified in Table 2-4. The potential to emit for the new non-combustion emissions units is based on a maximum production rate of 125 airplanes per year. The potential emissions from new combustion emissions units are based on a voluntary total combined heat input limit of 1,000,000 MMBtu per year for all new combustion units associated with this Project. Detailed calculations are included in Appendices A and B.

TABLE 2-4. EMISSIONS INCREASES OF REGULATED NSR POLLUTANTS FOR NEW UNITS (tpy)

	CO	NOx	PM	SOx	Lead	VOC	CO_2e
Wing Component Fabrication Emission Units (non-combustion)			<0.5			235	
Vertical Fin Prep and Spray Booths			<0.1			14	
Wing Stub Spray Coating Enclosure			<0.1			1	
Interiors Emission Units			<0.1			34	
Emergency Engines	11	18	0.6	0.74	0	1	2,100
Combustion Emission Units	20	6	4	0.50	0	3	59,400
Total for New Units	**31**	**24**	**5.4**	**1.24**	**0**	**288**	**61,500**

2.1.3 Hybrid Total Emissions Increase

The total emissions increase relating to the 777X Project is the sum of the increases from the existing units (projected actual minus baseline actual emissions) and the potential to emit from the newly constructed units and is presented in Table 2-5.

TABLE 2-5. EMISSIONS INCREASES OF REGULATED NSR POLLUTANTS FOR EXISTING AND NEWLY CONSTRUCTED EMISSIONS UNITS (tpy)

	CO	NOx	PM	SOx	Lead	VOC	CO_2e
Baseline Actual Emissions	50	60	5.5	1.1	0.0003	233	72,000
Projected Actual Emissions from Existing Units	55	67	6.4	1.5	0.0004	365	79,500
Potential Emissions from New Units	31	24	5.4	1.2	0	288	61,500
Emissions Increase	35	31	6.3	1.7	0.0001	419	69,000
PSD Significant Rate	100	40	10	40	0.6	40	75,000
Significant	**No**	**No**	**No**	**No**	**No**	**Yes**	**No**

The federal rule in 40 CFR 52.21 (b)(23) defines a significant increase to be equal to or exceeding any of the rates listed in Table 2-6. The Project is not expected to emit measurable quantities of fluorides, H_2S, total reduced sulfur, or reduced sulfur compounds. The expected increase in ozone-depleting substances is about 2.25 tons per year (see Appendix B).[3] As shown in Table 2-5, the emissions increases from the Project will not exceed the significant emission rate of any regulated NSR pollutant except for VOCs; therefore, the Project will only have a significant emissions increase for VOCs.

TABLE 2-6. POLLUTANT AND PSD SIGNIFICANT EMISSION RATES

Pollutant	Significant Emission Rate (tpy)
CO	100
NO_x	40
SO_2	40
PM	25
PM_{10}	15
$PM_{2.5}$	10
Ozone	40 (VOCs or NOx)[a]
Lead	0.6
Fluorides	3
Sulfuric Acid Mist	7
H_2S	10
Total Reduced Sulfur	10
Reduced Sulfur Compounds	10
Ozone-Depleting Substances	100[b]
Greenhouse Gases	75,000 (CO_2e)

Note: There are additional rates for municipal waste combustors and landfills; however, Boeing does not combust or landfill municipal waste at the Boeing Everett facility.
[a] VOC and NO_x are precursors of ozone.
[b] WAC 173-400-720(4)(b)(iii)(B).
SO_2 = sulfur dioxide
PM_{10} = particulate matter less than 10 microns in diameter
$PM_{2.5}$ = particulate matter less than 2.5 microns in diameter
H_2S = hydrogen sulfide

2.2 Significant Emissions Increase Analysis

As stated in 40 CFR 52.21(a)(2)(iv)(a), “If the project causes a significant emissions increase, then the project is a major modification only if it also results in a significant net emissions increase.” The proposed Project will result in a significant emissions increase only for VOCs; therefore, the Project will be subject to PSD for VOCs and will be considered a major modification only if it also results in a significant net emissions increase of VOCs. 40 CFR 52.21(b)(3)(i) outlines the steps necessary to calculate the net emissions increase. However, EPA has clearly stated that calculating a net emission increase is at the source’s option (see, for example, 67 Federal

[3] EPA has not established a significance level of ozone-depleting substances (ODS) in 40 CFR 52.21; however, in a March 19,1998, letter to Kevin Tubbs of American Standard, John Seitz of EPA stated that in 1996, EPA proposed a 100-ton-per-year threshold and did not receive any adverse comments. The letter went on to state that EPA would not object if a state did not require PSD review of ODS emissions less than 100 tons per year. See http://www.epa.gov/region7/air/nsr/nsrmemos/rfrigrnt.pdf.

Register 80186, at 80197 [December 31, 2002]), and therefore a source may seek a PSD permit based on a calculated significant emission increase alone. As stated previously, for this Project, Boeing is exercising that option and forgoing the Step 2 significant net emission increase analysis.

As shown in Table 2-5, the emissions increases from the Project will not exceed the significant emission rate of any regulated NSR pollutant except for VOCs; therefore, the Project is submitted for PSD review only for VOCs. As noted above, the emissions from painting completed airplanes in the paint hangars were not included because Boeing currently operates those activities at near capacity and will not be adding additional paint hangars as part of this Project. The paint hangars will not experience an increase in utilization as a result of this Project. Even if those activities were included, the Project would not be a major modification for any non-VOC NSR regulated pollutant. This conclusion is supported by an Ecology determination that the additional paint hangar that was proposed by Boeing Everett in 2006 (but never built) was only subject to PSD review for VOCs (see PSD 06-04 issued by Ecology in 2007).

In addition to regulated NSR pollutants, greenhouse gases (GHGs) are subject to regulation as of January 2, 2011. EPA's PSD rule under 40 CFR 52.21(b)(49) states the following:

- Beginning January 2, 2011, the pollutant GHGs is subject to regulation if:

    (a) The stationary source is a new major stationary source for a regulated NSR pollutant that is not GHGs, and also will emit or will have the potential to emit 75,000 tpy CO2e or more; or

    (b) The stationary source is an existing major stationary source for a regulated NSR pollutant that is not GHGs, and also will have an emissions increase of a regulated NSR pollutant, and an emissions increase of 75,000 tpy CO2e or more.

Boeing Everett is an existing major stationary source for a regulated NSR pollutant that is not GHGs, and the proposed Project is expected to result in a significant increase of VOCs; however, the Project will not result in an emissions increase of 75,000 tpy of CO_2e.

40 CFR 52.21(b)(49) continues:

- Beginning July 1, 2011, in addition to the provisions in paragraph (b)(49)(iv) of this section, the pollutant GHGs shall also be subject to regulation

    (a) At a new stationary source that will emit or have the potential to emit 100,000 tpy CO2e; or

    (b) At an existing stationary source that emits or has the potential to emit 100,000 tpy CO2e, when such stationary source undertakes a physical change or change in the method of operation that will result in an emissions increase of 75,000 tpy CO2e or more.

Boeing Everett is an existing stationary source with the potential to emit 100,000 tpy CO2e; however, the Project will not result in an emissions increase of 75,000 tpy of CO_2e. Therefore, the GHG emissions from the Project are not subject to PSD review.

2.3 PSD Requirements

A PSD permit application must demonstrate that:

- Best available control technology (BACT) will be used for each new emissions unit that will emit the pollutant for which PSD is triggered, and will be used for each modified emissions unit that will experience a net increase in emissions of the pollutant for which PSD is triggered as a result of the modification to that unit.
- Allowable emissions increases from the project will not cause or contribute to a violation of any ambient air quality standard or increment.
- The project will not significantly adversely impact air quality related values such as soils, vegetation, and visibility in Class I areas.
- Sections 3, 4, and 5 address these requirements.

3. Best Available Control Technology Analysis

As required by 40 CFR 52.21(j)(3), a major modification shall apply best available control technology (BACT) for each regulated NSR pollutant for which it would result in a significant net emissions increase at the source. This requirement applies to each proposed new emission unit, and each emissions unit at which a net emissions increase in the pollutant would occur as a result of a physical change or change in the method of operation in the unit. Thus, emission units that are not new units or modified units are not subject to BACT, regardless of whether such units will experience an increase in emissions of that pollutant as a result of the project. Further, new or modified units that are associated with a project but will not emit that pollutant (for new units) or will not experience an increase in emissions of that pollutant "as a result of" the project (for modified units) will not be subject to BACT.

40 CFR 52.21(b)(12) defines BACT as follows:

> Best available control technology means an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under Act *[sic]* which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant. In no event shall application of best available control technology result in emissions of any pollutant that would exceed the emissions allowed by any applicable standard under 40 CFR parts 60 and 61. If the Administrator determines that technological or economic limitations on the application of measurement methodology to a particular emissions unit would make the imposition of an emissions standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of best available control technology. Such standard shall, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and shall provide for compliance by means which achieve equivalent results.

As discussed in Section 2 of this application, the only regulated NSR pollutant for which the Project results in a plant-wide significant emission increase is VOCs.

Therefore, this section presents a BACT analysis focusing on VOCs for these new and modified prep booths, spray booths, combustion sources, and fugitive (open floor) sources using the EPA top-down approach. This top-down BACT analysis includes the following steps:

- Identify pollution control technology options available in the market.
- Evaluate the options and remove technically infeasible options.
- Rank remaining control technologies by control effectiveness.

- Evaluate effective controls considering energy, environmental, and economic impacts.
- Select BACT based on analysis.

This BACT analysis considers those technologies that reduce VOC emissions from the prep booths, paint spray booths, combustion, and fugitive operations that will take place in the new or modified units.

3.1 Prep and Spray Paint Booths BACT Analysis

There are several proposed new or modified prep and spray paint booths anticipated for the Project at Boeing's Everett facility as shown in Table 3-1. The table also shows the total potential VOC emissions based on the anticipated annual hours of operation for each of the new or modified emission units.

TABLE 3-1. NEW AND MODIFIED BOOTHS

Emission Unit	Booth Type	Quantity	New/Modified	Annual Hours of Operation (per booth)	VOC Emissions (tpy/ booth)	Exhaust Rate (acfm)
WCF-8a	Wing panel prep booth(s) (abrasive blast/sanding, solvent handwipe, edge seal)	Min. of 1 Max. of 2	New	2,000	31.6 (assumes only 1 booth will be built)	32,500
WCF-8b	Wing spar prep booth (abrasive blast/sanding, solvent handwipe, edge seal)	1	New	1,000	4.4	7,800
WCF-9a, b, and db	Wing panel spray booths	32	New	500	17.125.6	195,000
WCF-9c	Wing spar spray booth	1	New	500	7.4	46,800
WCF-10a and b	Wing panel primer curing booths	2	New	500	1.6	97,500
WCF-10c	Wing spar primer curing booth	1	New	500	0.4	23,400
WCF-11	Small quantity paint mix booth	1	New	250	0.1	3,635
WCF-12a and b	Coating equipment cleaning booths	2	New	250	1.0	3,635
WCF-14	Wing spar seal booth	Min. of 1 Max. of 4	New	1000	9.5 (assumes only 1 booth will be built)	25,000
WBSP-1a and b	Robotic wing spray booths	2	Might be modified to add new robot	2,275	31.3	120,000

TABLE 3-1. NEW AND MODIFIED BOOTHS

Emission Unit	Booth Type	Quantity	New/Modified	Annual Hours of Operation (per booth)	VOC Emissions (tpy/ booth)	Exhaust Rate (acfm)
WBSP-2	Forward body section spray booth	1	Might need to be modified to accommodate larger sections	1,000	12.5	54,900
WBSP-3	Mid body section spray booth	1	Might need to be modified to accommodate larger sections	1,000	12.5	65,750
WBSP-4	Aft body section spray booth	1	Might need to be modified to accommodate larger sections	1,000	12.5	64,000
WBSP-6	Forward body section CIC spray booth	1	Might need to be modified to accommodate larger sections	625	12.1	33,500
WBSP-7	Mid body section CIC spray booth	1	Might need to be modified to accommodate larger sections	625	6.1	44,800
WBSP-8	Aft body section CIC spray booth	1	Might need to be modified to accommodate larger sections	625	12.1	33,500
WBSP-10	Vertical fin HLFC prep booth	1	NEW (Currently this work is done on the 777 vertical fin with final coat in the airplane paint hangars.)	500	1.3	50,000
WBSP-11a,b,c	Vertical fin HLFC spray booths	3	NEW (Currently this work is done with final coat in the airplane paint hangars.)	500	4.4	150,000
AA-2	Wing stub spray booths	2	One new, one modified	1,000	1.4	4,000
IRC-1a,b,c	Adhesive spray booths	3	NEW	2,000	8.9	20,000
IRC-2	Paint spray booth	1	NEW	2,000	5	20,000

acfm = actual cubic feet per minute

VOC emission estimates for paint spray booths include gun and line cleaning operations because the paint containers and the spray guns are connected by long lines that need to be cleaned. Although the cleaning solution is collected in containers, for the purposes of the emissions estimates and this BACT analysis, a portion of the gun and line cleaning solvent is assumed to be emitted through the booth.

BACT analysis was performed for each emission unit operating at the emission rates and exhaust flow rates listed in Table 3-1. Boeing currently uses a combination of low-VOC coatings, high-transfer-efficiency application techniques, and good work practices (such as keeping containers of coating closed when not in use) to minimize VOC emissions. The Aerospace National Emission Standard for Hazardous Air Pollutants (NESHAP) and/or PSCAA regulations require low-VOC coatings, high-transfer-efficiency coating techniques, and these work practices; therefore these coatings, application techniques, and work practices are considered the base case for BACT.

The cleaning and coating operations that are planned for the new and modified spray paint booths are as follows:

- **Aircraft parts cleaning** – Before the parts of the airplane can be sealed and/or coated, they first must be cleaned and prepped.
- **Aircraft parts sealing** – Areas on certain parts of the airplane (e.g., parts that will become part of a fuel tank or the pressurized fuselage) must be sealed prior to coating.
- **Aircraft parts priming** – Priming provides corrosion protection and ensures the necessary bond between the surface of the airplane components and the topcoat.
- **Aircraft parts topcoat** – The topcoat is the final coating of the normally visible surfaces of the airplane. The topcoat not only provides the final protection of the airplane surface, but on the exterior of the fuselage and empennage also provides the decorative color to the airplane.
- **Aircraft parts corrosion-inhibiting compound** (CIC) – Portions of the airplane that are not normally visible often need a special coating to further protect them from corrosion.
- **Adhesive spray booths** – Interior composite panels (e.g., aircraft cabin sidewalls and ceilings) are sprayed with adhesive to apply a decorative laminate.
- **Spray equipment cleaning** – The spray equipment used to perform the operations above is cleaned after each use. A small amount of solvent evaporates while cleaning the spray equipment.

3.1.1 Available Control Technologies

BACT databases from EPA (EPA, RACT/BACT/LAER Clearinghouse [RBLC]), California Air Resources Board (CARB), and South Coast Air Quality Management District (SCAQMD) were reviewed for possible control technologies that are both available on the market and proven practice in the aerospace or other industries with similar requirements for coating very large objects. The technologies reviewed are summarized in Table 3-2.

3.1.2 BACT Feasibility Review

The control technologies in Table 3-2 have been demonstrated and achieved in practice and therefore could be feasible technologies for implementation at Boeing prep and spray paint booth operations.

TABLE 3-2. BACT REVIEW

Control Technology	Equipment Description	Company	Date Implemented	Pollutant Controlled	Control Efficiency	Emission Limit	Database Reference
Thermal oxidizer	Spray Booth	Watkins Manufacturing Corporation	10/28/2002	VOC	98.9%	95% control	CARB, BACT Clearinghouse
Regenerative thermal oxidizer	Spray Booth	Arcadia, Inc.	2/6/2001	VOC	99.3%	.89 lb/hr	CARB, BACT Clearinghouse, SCAQMD Clearinghouse
Regenerative thermal oxidizer	Spray Booth	Huck International – Deutsch Operations	NA	VOC	90.6%	59 lb/day	CARB, BACT Clearinghouse, SCAQMD Clearinghouse
Regenerative thermal oxidizer with concentrator	Spray Booth	Kal-Gard Coating & Mfg, E/M Corp.	8/14/2008	VOC	Not Available	2 tpy	CARB, BACT Clearinghouse
Regenerative thermal oxidizer with concentrator	Spray Booth	Douglas Production Division	3/30/94	VOC	93.2%	341 gal/ day	CARB, BACT Clearinghouse, SCAQMD Clearinghouse
Carbon adsorption	Spray Booth	Lippert Components, Inc.	5/8/2002	VOC	99.3%	85.5% control	CARB, BACT Clearinghouse
Carbon adsorption	Spray Booth	Northrop-Grumman	2/25/91	VOC	90%	414 lb/day	CARB, BACT Clearinghouse
Low-VOC coatings, HVLP coating gun, best management practices	Spray Booth	Dean Baldwin Painting LP	09/21/2011	VOC	NA	4.5 lb VOC/gal coating	EPA, RBLC Clearinghouse
Low-VOC coatings, HVLP coating gun, best management practices	Spray Booth	Time Aviation Services Inc.	6/18/99	VOC	NA	3 gal/day	CARB, BACT Clearinghouse
Low-VOC coatings, HVLP coating gun, best management practices	Spray Booth	California Air National Guard, Fresno	1/22/97	VOC	NA	5.23 lb VOC/ gal coating	CARB, BACT Clearinghouse
Low-VOC coatings, HVLP coating gun, enclosed gun cleaner	Spray Booth	Toter	12/16/99	VOC	NA	1.09 lb VOC/ gal	CARB, BACT Clearinghouse

NA = not applicable
HVLP = high-volume low-pressure

Note that Boeing considers the use of low-VOC coating, high-transfer-efficiency spray equipment, and good work practices to minimize VOC emissions to be the base case for BACT.

3.1.3 Ranking of BACT by Control

The potential control options provided in Table 3-2 have been ranked in Table 3-3 based on the control efficiencies documented as being achieved in practice.

TABLE 3-3. RANKING OF CONTROL TECHNOLOGIES

Type of Control Technology	Control Efficiency	Ranking
Regenerative thermal oxidizer	99.3%	1
Carbon adsorption	99.3%	2
Thermal oxidizer	98.9%	3
Regenerative thermal oxidizer with concentrator	93.2%	4
Low-VOC coatings, HVLP coating gun, best management practices	NA	5

3.1.4 Cost-effectiveness Evaluation

Reputable vendors of paint operation control technologies were identified based on contacts within the aerospace industry and were contacted to assess implementation of the different controls available in the marketplace (listed in Table 3-3). Vendor quotes were collected and are summarized in the cost-effectiveness evaluation spreadsheets located in Appendix C. Cost-effectiveness evaluations followed published EPA guidance for VOC Control by Incinerators and by Carbon Adsorption (EPA, 2002). Sections 3.1.4.1 through 3.1.4.6 discuss those results.

The cost-effectiveness analyses use the standard default values for construction as provided by EPA unless otherwise noted in Section 3. Boeing Everett expects that the installation of any add-on control technology at an existing portion of the facility would require complicated retrofit construction and expenses. The existing facility has limited space available for the footprint of additional equipment, which might require that any add-on controls be placed on the roof. The need for additional structural support would have to be evaluated, and the existing natural gas lines might need to be upgraded to supply sufficient flow and pressure to operate the control equipment as designed. Complicated retrofits can increase installation costs by a factor of 50 percent. New equipment installation would also accrue installation expenses above the standard default values. Delivery of new equipment and staging is anticipated to pose limitations with tight spaces around existing equipment. Providing utilities such as natural gas is expected but not currently available at every location. For these reasons, overall construction costs for both retrofits and for new equipment installed at Boeing Everett's existing facility are expected to be above standard EPA default values for construction of a new facility.

3.1.4.1 Thermal Oxidizer

A thermal oxidizer introduces the VOC emissions in an air stream to a burner that destroys those emissions prior to release to the atmosphere through a stack. This control technology has been improved upon over the years to also include preheating the incoming air stream to obtain additional fuel efficiencies. In prior BACT Reviews for Boeing (PSD Application for 737 MAX Production and Capacity Increase, February 2013), the thermal oxidizer technologies have proven to be the most expensive technology to implement for this application. It was implemented only once in the industry over 10 years ago (see Table 3-2 above). Since this implementation, other control technologies for coating applications have been implemented.

3.1.4.2 Carbon Adsorption

Carbon adsorption uses a filter bank of canisters that contain activated carbon which adsorbs the VOC emissions as the air stream passes through before being released to the atmosphere. Vendor information for the carbon adsorption technology was obtained from Thermal Recovery Systems (TRS). Those equipment cost and operating parameters are provided in Appendix C. The carbon adsorption control technology overall cost-effectiveness in dollars per ton removed is discussed in Section 3.1.5.

3.1.4.3 Regenerative Thermal Oxidizer

A regenerative thermal oxidizer (RTO) was ranked as one of the top control technologies available based on control efficiency. VOC emissions created from cleaning and coating activities are burned inside an enclosed chamber. Heat from the exhaust gas is recovered in a heat exchanger, which allows for fuel efficiencies in sustaining the high burn temperature. Vendor information for the RTO technology was obtained from Epcon. The equipment cost and operating parameters are provided in Appendix C. The RTO control technology overall cost-effectiveness in dollars per ton removed is discussed in Section 3.1.5.

3.1.4.4 Regenerative Thermal Oxidizer with Concentrator

This control technology augments the RTO methodology with the addition of a concentrator wheel. The wheel provides for a more concentrated VOC content in a smaller air stream for burning. The concentration of VOCs allows greater fuel efficiencies to be obtained during operation. Vendor information for the RTO with concentrator control technology was obtained from Anguil. Those equipment cost and operating parameters are provided in Appendix C. The RTO with concentrator control technology overall cost-effectiveness in dollars per ton removed is discussed in Section 3.1.5.

3.1.4.5 Low-VOC Coatings, High-Transfer-Efficiency Coating Techniques, and Good Work Practices

Boeing Everett currently uses low-VOC coatings that meet specifications for airplane coating operations. Boeing also uses high-transfer-efficiency coating techniques, such as high-volume low-pressure (HVLP) spray guns, which provide a high transfer efficiency and reduce the overall amount of paint required to perform a job. In addition, Boeing uses good work practices to minimize VOC emissions, including storing coatings and solvents in closed containers, bagging solvent hand-wipe cleaning rags when not in use, and capturing and containing solvent used for cleaning spray equipment. The VOC emissions standards for uncontrolled use of cleaning solvents and coatings as required by 40 CFR 63 Subpart GG, Aerospace NESHAP, and PSCAA Regulation II, 3.09, will be applied in this operation. No cost analysis was performed because Boeing considers this to be the base case for BACT.

3.1.5 Summary of Cost-effectiveness Analysis

The costs of control technologies identified as being available and technologically feasible for the new and modified prep booths and spray booths are summarized in Tables 3-4 thru 3-7. These cost estimates are conservative (potentially underestimating the costs) and include an additional construction expense estimated at 15 percent of the Total Purchased Equipment Cost. In some cases that additional expense was included in the vendor's quote, and in others the expense was added.

Vendor information was not collected for every booth configuration and VOC loading rate expected for the 777X Project. Vendor cost basis information is summarized in Table 3-4. Costs were scaled from the parameters quoted from vendors in Table 3-4 to match those emission units listed in Table 3-1. The carbon adsorption quote from Thermal Recovery Systems was obtained in 2011 for a previous Boeing PSD application using a 25,000 cubic feet per minute (cfm) air flow rate. The same quote was used in this analysis using a conservative cost approach to not include inflation costs. The RTO quote from Epcon was for a 33,500-cfm and a 100,000-cfm booth. Quotes for RTO with concentrator from Anguil were provided for 46,800-cfm, 120,000-cfm, 195,000-cfm and 400,000-cfm capacity booths. RTO with concentrator equipment operating costs were only obtained for the 400,000-cfm unit as operating costs are minimal compared to the equipment costs.

For control equipment that would be installed in existing buildings, a 15 percent contingency factor was applied. This is a very conservative estimate considering that the thermal oxidizers would likely be outside the building. This would considerable duct work and foundation supports.

TABLE 3-4. SUMMARY OF VENDOR QUOTE BASIS

Type of Control Technology	Vendor	Air Flow Rates (cfm)	Operating Costs Included in Quote?	Equipment Cost Contingency Included in Quote
Regenerative canister thermal oxidizer	Epcon	33,500	Yes	15%
Regenerative canister thermal oxidizer	Epcon	100,000	Yes	0%
Carbon adsorption	TRS	25,000	Yes	0%
Regenerative thermal oxidizer with Zeolite concentrator	Anguil	46,800 120,000 195,000	No[a]	15%
Regenerative thermal oxidizer with Zeolite concentrator	Anguil	400,000	Yes	15%

[a] Operating costs were scaled from four 100,000-cfm units.

The standard method of evaluating the cost effectiveness of various air pollution control options is to calculate the annualized cost of each option and divide that by the amount of emissions that would be removed by that option. Using this approach, the annualized cost of removing one ton of VOC emissions was calculated for each applicable control option and is summarized in Tables 3-5, 3-6, and 3.7.

TABLE 3-5. SUMMARY OF COSTS FOR WING COMPONENT FABRICATION (WCF) CONTROL TECHNOLOGIES BY EMISSION UNIT

Emission Unit	Unit Description	TRS Carbon Adsorption Control Costs ($/ton of VOC controlled)	Anguil Regenerative Thermal Oxidizer with Zeolite Concentrator Control Costs ($/ton of VOC controlled)	Epcon Canister Regenerative Thermal Oxidizer Control Costs ($/ton of VOC controlled)
WCF-8a	Wing panel prep booth(s) (abrasive blast/sanding, solvent handwipe, edge seal) (See Note 1)	$177,294	$9,177	$11,638
WCF-8b	Wing spar prep booth (abrasive blast/sanding, solvent handwipe, edge seal)	$181,961	$19,135	$21,459
WCF-9a, b, and d9b	Wing panel spray booth (See Note 2)	$179,228	$34,789	$47,347
WCF-9c	Wing spar spray booth	$180,074	$42,914	$48,706
WCF-10a and 10b	Wing panel primer curing booth	$217,873	$275,799	$377,238
WCF-10c	Wing spar primer curing booth	$245,353	$403,271	$454,442
WCF-11	Small quantity paint mix booth	$333,083	$498,125	$533,096
WCF-12a and 12b	Coating equipment cleaning booth	$184,~~248~~137	$31,133	$33,318
WCF-14	Wing spar seal booth(s) (See Note 3)	$179,439	$20,722	$24,382

Note 1: As explained in Note 1 to Table 1-1, Boeing is considering building one or two wing panel prep booths. It is conservatively assumed for purposes of calculating the control technology costs that only one wing panel prep booth will be built. If the control technology costs were instead based on two booths, the costs would be higher than those shown in the above table.
Note 2: Although the current plan is to build three wing panel spray booths, it is conservatively assumed for purposes of calculating the control technology costs that only two wing panel spray booths will actually be built. If the control technology costs were instead based on three booths, the costs would be higher than those shown in the above table.
Note 3: As explained in Note 4 to Table 1-1, Boeing is considering building from one to as many as four wing spar seal booths. It is conservatively assumed for purposes of calculating the control technology costs that only one wing spar seal booth will actually be built. If the control technology costs were instead based on two or more booths, the costs would be higher than the costs shown in the above table.

TABLE 3-6. SUMMARY OF COSTS FOR WING AND BODY STRUCTURE PAINT (WBSP) CONTROL TECHNOLOGIES BY EMISSION UNIT

Emission Unit	Unit Description	TRS Carbon Adsorption Control Costs ($/ton of VOC controlled)	Anguil Regenerative Thermal Oxidizer with Zeolite Concentrator Control Costs ($/ton of VOC controlled)	Epcon Canister Regenerative Thermal Oxidizer Control Costs ($/ton of VOC controlled)
WBSP-1a and 1b	Robotic wing spray booth – 120,000 acfm	$180,958	$22,944	$40,850
WBSP-1a and 1b	Robotic wing spray booth – 90,000 acfm	$179,209	$18,050	$24,331
WBSP-1a and 1b	Robotic wing spray booth – 60,000 acfm	$178,248	$14,126	$13,357
WBSP-2	Forward body section spray booth	$179,65	$32,206	$38,495
WBSP-3	Mid body section spray booth	$180,185	$36,908	$43,945
WBSP-4	Aft body section spray booth	$180,313	$37,366	$44,477
WBSP-6	Forward body section CIC spray booth	$177,730	$21,008	$23,958
WBSP-7	Mid body section CIC spray booth	$182,221	$54,501	$63,344
WBSP-8	Aft body section CIC spray booth	$177,730	$21,008	$23,958
WBSP-10	Vertical fin HLFC prep booth	$211,205	$291,315	$329,290
WBSP-11a, 11b, and 11c	Vertical fin HLFC spray booth	$190,538	$118,905	$153,698

TABLE 3-7. SUMMARY OF COSTS FOR AIRPLANE ASSEMBLY (AA) AND INTERIOR FABRICATION (IRC) CONTROL TECHNOLOGIES BY EMISSION UNIT

Emission Unit	Unit Description	TRS Carbon Adsorption Control Costs ($/ton of VOC Controlled)	Anguil Regenerative Thermal Oxidizer with Zeolite Concentrator Control Costs ($/ton of VOC Controlled)	Epcon Canister Regenerative Thermal Oxidizer Control Costs ($/ton of VOC Controlled)
AA-2a and 2b	Wing stub spray booth	$199,978	$44,284	$47,829
IRC-1a, 1b, and 1c	Adhesive spray booth	$183,800	$24,144	$29,528
IRC-2	Paint spray booth	$191,095	$42,735	$52,265

As described in the *Prevention of Significant Deterioration Application of Changes Relating to 777 Production Rate Increase BACT Supplement*, February 2012, the robotic wing spray booths (WPSB-1a and 1b) are designed to operate in three operating modes, with ventilation rates of 120,000 cfm, 90,000 cfm, and 60,000 cfm. In that supplement three options were evaluated:

- Option A is to use a VOC control system for each booth designed to handle all 120,000 acfm. This option would ensure that all VOC emissions are treated by the control system. It would operate all the time that coating or cleaning occurred. About 29.5 tons of VOC per year would be treated by each system and no VOC would be untreated.
- Option B is to use a VOC control system for each booth designed only to handle up to 60,000 acfm, the most common operating mode of the robotic booth. Any exhaust above 60,000 acfm would be vented directly to the atmosphere without going through the VOC control system. Because the 60,000 acfm mode represents most of the operation and potential emissions, most emissions would be controlled. About 26 tons of VOC would be treated per year and about 3 tons per year would be untreated.
- Option C is similar to Option B except that the VOC control system for each booth would be designed to handle up to 90,000 acfm, and any exhaust greater than 90,000 acfm would be vented directly to the atmosphere. About 291 tons of VOC would be treated per year and 0.4 ton per year would be untreated.

Each of these options was evaluated and the results are presented in Table 3-6. It should also be noted that under that current plan a decision to modify the Robotic Wing Spray Booth by installing a second robotic spray system in each booth will not be made until Phase 2 of the Project and at that time BACT will likely be reevaluated. Phase 2 is tentatively scheduled to begin in 2021.

3.1.6 Comparison with other Aerospace BACT Determinations

Because of the unique nature of Boeing's operations at this facility, comparison with other aerospace facilities is of limited usefulness. For example, Boeing is currently the only manufacturer of large commercial airplanes in the United States, although Airbus is scheduled to start up a new airplane assembly plant in Alabama soon. A review of RBLC entries of the last 10 years for aerospace surface coatings (Process Type 41.001) shows entries for Boeing commercial airplane operations in the Puget Sound area and one entry for a Dean Baldwin aircraft refinishing operation in Indiana (Table 3-8). None of those entries indicates that add-on controls were considered BACT. Also note that no BACT determinations for the Alabama Airbus facility are listed in the RBLC even though the plant is under construction.

A further review of the RBLC entries for permits between 1990 and 2003 (Table 3-9) indicates some BACT decisions for aerospace coating operations that required add-on controls. However, evaluation of the location of each of those operations indicates that each was in an ozone non-attainment area at the time of permitting. For example, Huck International is located in Los Angeles, an ozone non-attainment area; CA-0881 issued in 1996 indicates "BACT-PSD," yet CA-0980 issued to the same company a year earlier indicates that lowest achievable emissions rate (LAER) was required. Similar issues can be found with Kal-Gard Coating, also located in Los Angeles, permit ID numbers CA-0889, CA-1045, and CA-0977. For each of these RBLC entries, we believe that the control determinations were intended to implement LAER for those operations under non-attainment area New Source Review rather than BACT under the PSD program.

TABLE 3-8. RBLC AEROSPACE COATING ENTRIES SINCE 2000 (PROCESS TYPE 41.001)

ID	Company	State	Permit Date	Process	Control Method Description	BACT
WA-0326	Boeing Commercial Airplanes Group	WA	10/12/2005	Exterior coating operations		N/A
WA-0326	Boeing Commercial Airplanes Group	WA	10/12/2005	Final assembly		N/A
WA-0326	Boeing Commercial Airplanes Group	WA	10/12/2005	Interiors manufacturing		N/A
WA-0330	Boeing Commercial Airplanes Group	WA	10/12/2005	Paint hangar final exterior coating	A BACT review was not required because Ecology determined that there was no physical change, or change in the method of operation, that causes or results in an emissions increase.	BACT-PSD
WA-0330	Boeing Commercial Airplanes Group	WA	10/12/2005	787 final assembly	A BACT review was not required because Ecology determined that there was no physical change, or change in the method of operation, that causes or results in an emissions increase.	BACT-PSD
WA-0330	Boeing Commercial Airplanes Group	WA	10/12/2005	Interiors manufacturing	A BACT review was not required because Ecology determined that there was no physical change, or change in the method of operation, that causes or results in an emissions increase.	BACT-PSD
WA-0340	The Boeing Company	WA	07/27/2007	Paint hangar/final exterior coating		Other Case-by-Case
WA-0344	Boeing Commercial Airplanes Group	WA	10/07/2008	Paint booth/hangar	Compliance with 40 CFR Part 63, Subpart GG and low-VOC vapor pressure cleaning solvents and strippers with low-pressure applicators or manual application for depainting.	BACT-PSD
IN-0126	Dean Baldwin Painting LP	IN	09/21/2011	Aircraft refinishing		Other Case-by-Case
WA-0347	The Boeing Company Boeing Renton	WA	02/19/2013	Paint booths/ hangars/floor activities	Compliance with 40 CFR Part 63, Subpart GG and low-VOC vapor pressure cleaning solvents and strippers with low-pressure applicators or manual application for depainting.	BACT-PSD
WA-0348	The Boeing Company Boeing Renton	WA	02/19/2013	Paint booth/final exterior coating	Compliance with 40 CFR Part 63, Subpart GG and low-VOC vapor pressure cleaning solvents and strippers with low-pressure applicators or manual application for depainting.	BACT-PSD

TABLE 3-9. RBLC AEROSPACE COATING ENTRIES BETWEEN 1990 AND 2000

ID	Company	State	Permit Date	Process	Control Method Description	BACT
CA-0410	Northrop 3-2 Division	CA	05/03/1990	Paint spray facility in hanger	Filter-type carbon adsorption panel over exhaust air vent.	BACT-PSD (Note ozone NAA)
CA-0451	Tracor Flight Systems, Inc.	CA	10/23/1991	Coating operation	Diagonal fan and filter cells w/ arrestor pads.	BACT-PSD
CA-0881	Huck International - Deutsch Operations	CA	02/29/1996	Four spray booths	BACT determination is Tellkamp Systems regenerative thermal oxidizer with a 1.6-MMBtu/hr natural gas burner and 3-MMBtu/hr stand-by burner. Permit limit is lb VOC/day limit.	BACT-PSD (Note ozone NAA)
CA-0889	Kal-Gard Coating & Mfg., E/M Corp.	CA	01/06/1999	Spray booths, nine Brinks, Devilbiss; Blekker	BACT determination is use of Zeolite concentrator and thermal oxidizer. Permit limit is lb VOC/day facility limit.	BACT-PSD (Note ozone NAA)
CA-0901	Time Aviation Services, Inc.	CA	06/18/1999	Spray booths, two dry filters	Permit limit is usage limit and use of SCAQMD Regulation XI compliant materials. Listings of VOC limits for individual aerospace coating types can be found at: www.aqmd.gov/rules/html/r1124.html.	BACT-PSD
CA-1045	Kal-Gard Coating & Mfg. E/M	CA	01/06/1999	Spray booth	A Zeolite concentrator and thermal oxidizer	BACT-PSD (Note ozone NAA)
WA-0283	Boeing Commercial Airplanes Group, Everett Div. Plant	WA	07/10/1991	Surface coating	Solvent substitution and best management practices. HVLP, electrostatic airless, and modified high-efficiency air-assisted airless spray equipment. Baseline emission rate: 278 tpy.	BACT-PSD
WA-0284	Boeing Commercial Airplanes Group, Everett Div. Plant	WA	10/08/1992	Surface coating	Best management practices, electrostatic air-assisted airless spray equipment. Baseline emissions: 237 tpy.	BACT-PSD
WA-0285	Boeing Commercial Airplanes Group	WA	11/26/1991	Surface coating, parts	Solvent substitute and best management practices. HVLP spray equipment. Baseline emission rate: 167 tpy.	BACT-PSD
WA-0286	Boeing Commercial Airplanes Group	WA	12/31/1990	Surface coating	Low-VOC coatings and best management practices; electrostatic air-assisted spray equipment. Baseline emissions: 182 tpy.	BACT-PSD

TABLE 3-9. RBLC AEROSPACE COATING ENTRIES BETWEEN 1990 AND 2000

ID	Company	State	Permit Date	Process	Control Method Description	BACT
WA-0287	Boeing Commercial Airplanes - Everett Facility	WA	12/23/1991	Surface coating, corrosion inhibitor	Best management practices. Electrostatic, air-assisted, or airless spray equipment. Baseline emission rate: 11.5 tpy. Control efficiency: 15-35%.	BACT-PSD
CA-0771	California Air National Guard, Fresno	CA	01/22/1997	HVLP applicator used to coat parts	Lowest available VOC content which meets military specifications.	LAER
CA-0977	Kal-Gard Coatings & Manufacturing	CA	05/28/1997	Metal parts coating operation	Zeolite concentrator and thermal oxidizer.	LAER
CA-0979	Douglas Products Division	CA	03/30/1994	Metal parts coating operation	Concentrator and thermal oxidizer.	LAER
CA-0980	Huck International - Deutsch Operations	CA	03/09/1995	Metal parts coating operation	Thermal oxidizer.	LAER
CA-0549	Edwards Air Force Base	CA	05/07/1993	Hangar-sized spray booth for aircraft up to EC-18	Carbon adsorption filter bank with flame ionization detector to detect breakthrough.	Other Case-by-Case
CA-0685	T.B.M. Inc.	CA	11/06/1995	Aircraft refinishing operation	Low-VOC coatings and Hercules GW/R enclosed gun.	Other Case-by-Case
UT-0058	Hill Air Force Base	UT	12/15/1997	Surface coating, military operations	Zeolite adsorption system - M&W condesorb fob – 26 Zeolite adsorption cells - 100,000 acfm@80 degrees Fahrenheit - max loading 122 lb VOC/hr.	Other Case-by-Case
WA-0045	Heath Tecna Aerospace Co.	WA	03/27/1992	Spray booth	Carbon adsorber (methylene chloride).	Other Case-by-Case

NAA = non-attainment area

The RBLC also indicates that add-on controls have been installed at both Edwards Air Force Base in California and Hill Air Force Base in Utah; Edwards AFB is in an ozone non-attainment area. Neither of these entries purports to reflect a BACT decision under PSD. Each of these decisions is discussed further below, based on information provided by CH2M HILL and Air Force personnel familiar with those operations.

Edwards Air Force Base (AFB) has two booths used to paint airplanes and parts, and the booths have carbon adsorption systems installed. The first booth has an air flow of 111,000 cubic feet per minute (cfm) with 2.25 tpy of uncontrolled VOC emissions. The second booth is much larger (493,000 cfm) and has only 1.65 tpy of uncontrolled VOC emissions. Both of the carbon systems were installed because the AFB believed a cost savings, compared to other control technologies, would be achieved while meeting non-attainment area requirements applying LAER and obtaining offsets.

These systems were supposed to be regenerative carbon systems, but soon after installation the regenerative portion failed and was never repaired. Today, carbon is swapped out manually at great expense, albeit infrequently because of decreased VOC emissions over the years. The use of good work practices to reduce VOC emissions by using low-VOC paints and application methods has proved more cost-effective than maintaining the carbon VOC control system and running it. This VOC control system's efficiency is not achieved in practice as designed and listed in the EPA RBLC.

Hill AFB was in an ozone non-attainment or maintenance area at the time of permitting and installed a Zeolite adsorption system. The initial installation of the unit appears to have been associated with technology demonstration and funded under a pollution prevention program. This unit has not been operational at Hill AFB for an extended period of time. We have been unable to determine how long the unit operated or the reason it was taken out of operation. Because of this lack of information, we believe that no judgment can be made as to the feasibility of such a system for Boeing Everett.

In summary, we have been unable to identify similar aerospace coating operations operated by other companies in the United States and could not find a recent BACT determination in EPA’s RBLC that requires add-on controls for similar aerospace coating operations. The few older determinations that are listed as BACT were intended to implement LAER for those operations under non-attainment area New Source Review rather than BACT under the PSD program.

3.1.7 BACT Selection

In determining BACT one must take into account energy, environmental, and economic impacts and other costs. For PSD analysis, VOC is regulated as an ozone precursor. However, as discussed in Sections 4 and 5, ozone formation in the Puget Sound area is limited by NOx emissions and not VOC emissions, and this Project is not expected to have any measurable effect on ambient ozone levels. In addition, control technologies that involve combusting the VOCs will generate some NOx emissions as well as require some additional energy.

As documented in Section 3.1.5, Boeing does not consider any of the identified add-on control technologies in Tables 3-5 through 3-7 to be economically feasible for the Boeing Everett facility. Therefore taking into account energy, environmental, and economic impacts, Boeing does not consider add-on control technologies to be BACT. Boeing will continue to implement the use of low-VOC coatings, high-transfer-efficiency coating equipment, and good work practices to minimize VOC emissions in compliance with the Aerospace NESHAP VOC emission standards in 40 CFR 63 Subpart GG and the PSCAA standards in Regulation II, Section 3.09; these requirements are listed in Table 3-10. This conclusion is consistent with other recent BACT determinations made by Ecology, PSCAA, and others for coating large aerospace parts and components.

TABLE 3-10. SUMMARY OF AEROSPACE NESHAP AND PSCAA AEROSPACE VOC EMISSION STANDARDS APPLICABLE TO THE NEW AND MODIFIED EMISSION UNITS OF THE 777X PROJECT

Production Activity	Control Technology
Low-VOC primers	Large commercial aircraft component exteriors: 5.4 lb VOC/gal. All other applications: 2.9 lb VOC/gal
Low-VOC topcoats	3.5 lb VOC/gal
Low-VOC cleaning solvents	Hand-wipe cleaning solvent: vapor pressure less than 45 millimeters mercury (mm Hg) at 20°C or solvent meets composition requirements in Table 1 in 40 CFR 63.744. Flush cleaning: use collection system to capture flushed solvent.
High-transfer-efficiency spray coating equipment	HVLP, electrostatic, or other equivalent spray coating equipment.
Paint gun cleaning, waste solvents, and rags	Capture and closed containment.

3.2 Natural Gas Combustion

Manufacturing of the new Boeing Model 777X will require the facility to install new natural gas combustion units. These units include process heaters, space heaters, and a gas-fired plasma unit for surface treatment of the wing panel stringers. These new natural gas combustion emission units are listed in Table 3-11. With the exception of the natural gas combustion units associated with the vertical fin hybrid laminar flow control (HLFC) prep (WBSP 10) and HLFC spray booths (WBSP 11 a, b, and c), all the units identified in Table 3-11 will located in the new wing component fabrication building.

These natural-gas-fired combustion units will emit NOx, PM_{10}, $PM_{2.5}$, CO, SO_2, and VOCs. Natural-gas-fired boilers and heaters less than 50 MMBtu/hr generally fall into the category of generic BACT and not case-by-case BACT. The following section presents the generic BACT analysis for VOC from natural gas combustion units.

3.2.1 Available Control Technologies

BACT databases from EPA (EPA, RBLC), CARB, and SCAQMD were reviewed for possible VOC control technologies that are both available on the market and proven in practice for similar sized natural gas boilers and heaters. It was determined that no add-on controls were listed as BACT for similar-sized natural gas process heaters, space heaters, or plasma surface treatment units.

TABLE 3-11. PROPOSED NATURAL GAS COMBUSTION UNITS

Unit ID	Description	Rated Capacity (MMBtu/hr)
10 – 50 MMBtu/hr		
WCF-3a	Gas-fired process heater for autoclave #1	40
WCF-3b	Gas-fired process heater for autoclave #2	40
WCF-3c	Gas-fired process heater for autoclave #3	40
WCF-9a	Space heating - wing panel spray booth #1	13.34
WCF-9b	Space heating - wing panel spray booth #2	13.34
WCF-9d	Space heating – wing panel spray booth #3	13.34
WBSP-11a	Space heating - vertical fin HLFC spray booth #1	10.94
WBSP-11b	Space heating - vertical fin HLFC spray booth #2	10.94
WBSP-11c	Space heating - vertical fin HLFC spray booth #3	10.94
5 – 10 MMBtu/hr		
F-4a	Combustion equipment for comfort or process heating not otherwise identified elsewhere in this table; multiple units, most of which will be less than 5 MMBtu/hr, and all of which will be less than 10 MMBtu/hr	111
WCF-2	Gas-fired heater for liquid nitrogen vaporization unit (if this option is chosen to supply autoclaves with nitrogen)	8
WCF-10a	Space heating - wing panel primer curing booth #1	6.67
WCF-10b	Space heating - wing panel primer curing booth #2	6.67
2 – 5 MMBtu/hr		
WBSP-10	Space heating - vertical fin HLFC prep booth	3.69
WCF-9c	Space heating - wing spar spray booth	3.2
WCF-8a	Space heating - wing panel prep booth	2.22
WCF-14	Space heating - wing spar seal booth	2.9
< 2 MMBtu/hr		
WCF-7	Gas-fired plasma unit for treatment of wing panel stringer	1.6
WCF-10c	Space heating - wing spar primer curing booth	1.6
WCF-6a	Space heating - wing panel wash stall #1	1.11
WCF-6b	Space heating - wing panel wash stall #2	1.11
WCF-8b	Space heating - wing spar prep booth	0.534
WCF-6c	Space heating - wing spar and stringer wash stall #1	0.267
WCF-6d	Space heating - wing spar and stringer wash stall #2	0.267

Acceptable control technologies include good combustion practices defined as follows:

- **Good Combustion Practices** – Good combustion practices involve operating the combustion unit in a manner to reduce incomplete combustion. Through the reduction of incomplete combustion, VOC emissions can be reduced. Good combustion practices are technically feasible to control VOC emissions from the natural gas combustion units.

Boeing will implement the technically feasible control technologies of good combustion practices. In addition, Boeing may choose to limit fuel usage on some or all of the new combustion devices, but that will be due to establishing emission limits for the process and not due to BACT considerations; thus, further review of economic, environmental, and energy impacts is unnecessary.

3.2.2 BACT Selection

Review of BACT databases and industry standards determined that the only technically feasible VOC control methods identified for natural gas combustion units less than 50 MMBtu/hr are good combustion practices. Boeing proposes to implement the identified technically feasible control options of good combustion practices as BACT for VOC emissions from combustion units less than 50 MMBtu/hr.

3.3 Emergency Generators

The 777X Project will need as many as nine 2,750-kW diesel emergency generators and one 750-kW diesel emergency generator for the 777X wing component fabrication building. These diesel-fired emergency generators will emit NOx, PM_{10}, $PM_{2.5}$, CO, SO_2, and VOCs and will only be used as emergency backup generators. The following section presents the generic BACT analysis for VOC emissions from diesel emergency generators.

3.3.1 Available Control Technologies

The emission standards and operating limits of the emergency generators in the size range that Boeing is proposing to use for the wing component fabrication building are contained in 40 CFR 60 New Source Performance Standards, Subpart IIII, Standards of Performance for Stationary Compression Ignition Internal Combustion Engines and are considered to be BACT. The emission standards are provided in Sections 60.4202 and 60.4205. These standards require emergency diesel engines of the size contemplated for the 777X Project to comply with the Tier 2 emission standards in 40 CFR 89.112, which are 6.4 grams per kilowatt-hour (g/kWh) for VOC and NOx combined, 3.5 g/kWh for CO, and 0.20 g/kWh for particulate. The operating requirements for emergency stationary internal combustion engines are provided in 40 CFR 60.4205, which generally limit non-emergency use to 100 hours per year. For the purposes of this permit application, it is assumed that each engine will operate 100 hours per year.

3.3.2 Available Control Technologies

BACT for emergency generators is the emission standards and operating conditions established in 40 CFR 60 Subpart IIII.

3.3.3 BACT Selection

Boeing will implement the emission standards and operating conditions established in 40 CFR 60 Subpart IIII; thus, further review of economic, environmental, and energy impacts is unnecessary.

3.4 Wing Composite Layup and Curing

The wings of the 777X will be primarily made of composite material. The main wing components include front and rear spars, upper and lower panel stringers, and upper and lower panels. Part layup involves the layup of composite material (in the form of resin pre-impregnated tape or sheets) onto a mandrel which is preformed into the shape of the part being fabricated. Once the part is laid up on the mandrel, a vacuum bag is sealed around the part and the assembly is then sent to an autoclave for curing. In the autoclave, vacuum from a vacuum pump is used to hold the bagged part under negative pressure while the autoclave is pressurized with nitrogen and heated to the curing temperature of up to approximately 350° F. The part is then held under negative pressure for the entire curing cycle, approximately 12 to 14 hours. Emissions during the curing cycle are offgases from the composite material and combustion emissions from the indirect gas-fired heater that is used to heat the nitrogen in the autoclave. The offgases travel through the vacuum system and are exhausted by the vacuum pump (emission unit WCF-4). Boeing is planning for as many as three autoclaves and six vacuum pumps.

VOC emissions from the vacuum pumps are estimated at 1.2 tpy per pump (7.2 tpy total) and were calculated based on volatile content of the uncured composite material. This VOC emission estimate is likely conservative (i.e., higher than actual) since a significant portion of the volatiles in the uncured material may be water that is released from the material during curing. The estimated air flow from each of the vacuum pumps is 100 dry standard cubic feet per minute (dscfm). This estimated air flow is consistent with the measured flow rate taken during a source test conducted on a similar vacuum pump used in a similar process at Boeing's Frederickson facility in 2013 for an EPA Section 114 Emission Data Request.

The air flow from the vacuum pumps is not constant and the emission concentrations are not consistent. At any time, one vacuum pump or six vacuum pumps may be operating depending on the number of parts being laid up and cured. Emission estimates are based on VOCs (and potentially non VOCs like water) lost from the material during the entire layup and curing process, but emissions may be higher at certain times during the process than others. The estimated emission concentrations are very low, approximately 7.5×10^{-5} lb VOC/dscf, or less than 0.05 percent, on average with the balance of the emissions being ambient air.

3.4.1 Available Control Technologies

Composite processing, except for some cleaning, coating, and composite tooling operations, is not covered under 40 CFR 63, Subpart GG. BACT databases from EPA (EPA, RBLC), CARB, and SCAQMD were reviewed for possible control technologies that are both available on the market and proven in practice in the aerospace or other industries that manufacture items from composite molds. The search provided one determination for the production of structural honeycomb for aerospace and other industrial applications by Hexcel Corporation. The search also provided two determinations since the year 2000 for polyester resin operations, Lasco Bathware and Jacuzzi Whirlpool Bath. The database provided very little information about the Hexcel operation or the type of composite material used in the process. The bathtub manufacturing facilities use a liquid polyester thermosetting resin that contains styrene monomer.

The wing components will be made of a material containing an epoxy resin rather than a polyester resin, and the resin is pre-impregnated into a woven fabric (prepreg). The composition and emission characteristics of the prepreg woven fabric emissions are significantly different than polyester resin emissions. Boeing also elected to look at carbon adsorption, which is a typical control technology for VOC emissions from a process with a stack. The potential control technologies are presented in Table 3-12.

TABLE 3-12. POTENTIAL CONTROL TECHNOLOGIES FOR VOCS FOR COMPOSITE LAYUP AND CURING

Control Technology	Database Reference	Date Implemented	Control Efficiency	Emission Limit
Thermal oxidizer or regenerative thermal oxidizer	EPA, BACT Clearinghouse – Hexcel Corporation	11/25/2009	95%	
Regenerative thermal oxidizer with concentrator	EPA, BACT Clearinghouse – Lasco Bathware	3/13/2007	95%	14.84 lb/hr
Regenerative thermal oxidizer with concentrator	CARB, BACT Clearinghouse – Jacuzzi Whirlpool Bath	10/15/2002	90%	
Carbon adsorption	Often used for control of VOC emissions	NA	>95%	

HAPs = hazardous air pollutants

3.4.2 BACT Feasibility Review

Currently, there are no control technologies demonstrated in practice for the composite processing vacuum pumps. The only information provided for the Hexcel process was that the emissions were from an oven used for the curing of honeycomb blocks and the main hazardous air pollutant (HAP) of concern was acetaldehyde. Acetaldehyde may be present in the prepreg material Boeing uses, but it is not a significant component of the material. There was no information provided in the BACT determination about the type of materials used in the Hexcel process, the airflow rate, or the emission rates from the operation. Based on this information, it could not be determined whether the Hexcel process was similar to Boeing's process.

Regenerative thermal oxidizer with concentrator – The bathtub manufacturing facilities use a polyester thermosetting resin that contains styrene monomer to manufacture bathtubs. The Lasco Bathware process has an average throughput of raw materials of 0.645 ton per hour, which includes gelcoat, laminate, and barrier coat, all of which contain styrene monomer in a liquid state. The raw materials are sprayed into open molds in a spray booth. There was no emission rate information provided for Jacuzzi Whirlpool Bath.

The VOCs released from the process are drawn into a concentrator, which captures the VOCs by adsorption. Hot gas desorbs the VOCs, which are then fed to the thermal oxidizer for incineration. The overall efficiency for capture and control is estimated to be 90 to 95 percent.

Boeing's composite process will use a prepreg containing an epoxy resin rather than a coating containing a polyester resin. The resin comes pre-impregnated into a woven material and is not in a liquid state. The vacuum pump flow rate and concentration of VOCs in the air stream are significantly lower than for the spray booths at Lasco Bathware. This assumption is based on the emission limit of 14.8 lb/hr with a control limit of 95 percent listed in the determination. This should be compared to the maximum expected uncontrolled emission rate of less than one pound per hour for each vacuum pump. In addition, combination concentrators or carbon adsorbers and thermal oxidizers are intended for sources with high air flow and a high enough VOC emission rate to make thermal oxidation viable. The autoclave process does not meet either of these criteria. Individually, combustion of the VOC emissions and carbon adsorption have additional issues which are discussed next.

Thermal incineration – Hexcel Corporation uses a thermal oxidizer or regenerative thermal oxidizer to combust the VOC emissions from the process. When using combustion units for VOC control, the VOC emissions in an air stream are injected into a burner or chamber that destroys those emissions prior to release to the atmosphere through a stack.

As mentioned above, the air flows from the vacuum pumps are not constant and the emission concentrations are not consistent. At any time, one vacuum pump or six vacuum pumps may be operating, depending on the number of parts to be laid up and cured. Emission estimates are based on VOCs lost from the material during the entire layup and curing process, but emissions may be higher at certain times during the process than others. The VOC concentrations in the air stream exhausted by the vacuum pump are also very low, approximately 7.5×10^{-5} lb VOC/dscf on average, with the balance of the emissions being ambient air. Even without knowing the exact heat content of the VOCs, it is evident that the concentration of VOCs in the offgas are low, less than 0.05 percent, and therefore the heat content of the offgas will be low. The combination of variable operation, variable flow rates, and low heat content for the offgases make destruction of the offgases in a combustion device infeasible.

Carbon adsorption - Carbon adsorption uses a filter bank of canisters that contain activated carbon, which adsorbs the VOC emissions from the air stream as it passes through the carbon before being released to the atmosphere. Carbon adsorption has not been used in practice on any aerospace composite layup and curing operation. However, carbon adsorption has been used on other low-flow, low-VOC sources and is a feasible option for offgases with the characteristics described above.

3.4.3 Ranking of BACT by Control

Carbon adsorption is the only add-on option that is feasible. However, a well designed and operated carbon adsorption system can consistently demonstrate VOC removal efficiencies over 95 percent.

3.4.4 Cost-effectiveness Evaluation

Vendor information for the carbon adsorption technology was obtained from Thermal Recovery Systems. In an email, Thermal Recovery Systems stated that based on the potential contaminants listed and their concentration, the temperature of the emission, and the high humidity (3 percent by volume), they would expect between 5 and 10 percent weight capacity for the activated carbon. If they used 8 percent as their target, they believe it would take 90 tons of carbon to control 7.2 tons per year of emissions. The cost in carbon alone would be over

$225,000 per year, or over $31,000 per ton operating costs. This does not include capital cost or labor cost. Based on this cost, Boeing does not believe that carbon adsorption is cost-effective.

3.4.5 BACT Selection

Since no control technologies have been demonstrated to be effective in practice on aerospace composite processing vacuum pumps, and a cost estimate for just the carbon needed for a carbon adsorption system exceeds $31,000 per ton of VOC removed, as documented above, Boeing does not consider any of the identified add-on control technologies in Table 3-12 to be technically or economically feasible for the Boeing facility. Boeing will continue to implement the use of low-VOC-emitting pre-impregnated materials to minimize VOC emissions from the process.

3.5 Crush Core Press

In a crush core press (emission unit IRC-3), a composite "sandwich" layup consisting of a lightweight honeycomb core material sandwiched between sheets of resin pre-impregnated woven fabric (prepreg) is placed between heated matched dies and then the press is used to apply pressure to the dies until the resin in the prepreg sheets cures and hardens. At the Boeing Everett IRC, crushed core presses are used to fabricate airplane cabin interior panels (e.g., ceilings, sidewalls) for all Boeing airplane models. Most of the emissions from the crushed core press come from the mold release agent that is applied to the surface of the matched dies. Some VOCs are also released by the curing prepreg.

Emissions from the crush core press were calculated based on the VOC content of the mold release and prepreg and the estimated volume of those materials to be used over a year. The estimated volume of materials to be used in the new crush core press was based on the volume of materials used in the existing crush core presses at Boeing Everett plus a factor of safety. For the prepreg, the estimated VOC emissions are conservative since it is assumed all the volatiles released from the curing prepreg are VOCs, whereas a significant portion of the volatiles may be water. The estimated air flow from the crush core press operation is 7,500 cfm. The total VOC emission from the unit is 4,500 lb/year or 2.25 tons/year.

3.5.1 Available Control Technologies

Composite processing, except for some cleaning, coating, and composite tooling operations, is not covered under the Aerospace NESHAP (40 CFR 63, Subpart GG). BACT databases from EPA (EPA, RBLC), CARB, and SCAQMD were reviewed for possible control technologies that are both available on the market and proven in practice in the aerospace or other industries that manufacture items from composite molds. There were no determinations found for a crush core press operation. The search provided one determination for the production of structural honeycomb for aerospace and other industrial applications by Hexcel Corporation. The database provided very little information about the Hexcel operation or the type of composite material used in the process.

The crush core press process is similar to the composite layup and curing operation in that it uses resin pre-impregnated fabric (although the prepreg used in the crush core process contains a phenolic resin rather than an epoxy resin). However, the majority of the emissions (estimated at over 90 percent) come from the use of the mold release compounds. Since there were no control technologies for aerospace crush core press emissions in the databases, we also looked at typical control technologies for VOC emissions from a process with a stack. The potential control technologies are presented in Table 3-13.

TABLE 3-13. POTENTIAL CONTROL TECHNOLOGIES FOR VOCS FOR CRUSH CORE PRESS

Control Technology	Database Reference	Date Implemented	Control Efficiency
Thermal oxidizer or regenerative thermal oxidizer	EPA, BACT Clearinghouse – Hexcel Corporation	11/25/2009	95%
Regenerative thermal oxidizer with concentrator	Often used for control of VOC emissions	NA	>90%
Carbon adsorption	Often used for control of VOC emissions	NA	>95%

3.5.2 BACT Feasibility Review

Currently, there are no control technologies demonstrated in practice for the crush core press operation. It could not be determined if the Hexcel process was applicable because the only information provided for the Hexcel process was that the emissions were from an oven used for the curing of honeycomb blocks and the main HAP of concern was acetaldehyde. Acetaldehyde may be present in the emissions from the press but is not a significant component of the prepreg material and should not be present in the mold release agent. There was no information provided in the BACT determination about the type of materials used in the Hexcel process, the airflow rate, or the emissions from the operation. Based on this information, it could not be determined whether the Hexcel process was similar to Boeing's process.

Regenerative thermal oxidizer with concentrator – The VOCs released from the process are drawn into a concentrator, which captures VOCs by adsorption. Hot gas desorbs the VOCs, which are then fed to the thermal oxidizer for incineration. The overall efficiency for capture and control is estimated to be 90 to 95 percent.

Combination concentrators or carbon adsorbers and thermal oxidizers are intended for sources with high air flow and a high enough VOC emission rate (lb/hr) to make thermal oxidation viable. The emission rate needs to be high enough to produce a moderately concentrated emission from the outlet of the concentrator. The crush core press flow rate and emission rate do not meet either of these criteria. Individually, combustion of the VOC emissions and carbon adsorption has additional issues which are discussed below.

Thermal incineration – Hexcel Corporation uses a thermal oxidizer or regenerative thermal oxidizer to combust the VOC emissions from the process. When using combustion units for VOC control, the VOC emissions in an air stream are injected into a burner or chamber that destroys those emissions prior to release to the atmosphere through a stack.

The emission concentrations in the exhaust from the crush core press are very low, approximately 8×10^{-8} lb VOC/dscf on average, with the balance of the emissions being ambient air. Even without knowing the exact heat content of the VOCs, it is evident that the concentration of VOCs in the offgas are low, and therefore the heat content of the offgas will be low. In addition, the concentration of the VOCs in the offgas is very low, conservatively as much as 15 ppm, but more likely near 7 ppm. Thermal oxidizers have demonstrated poor destruction efficiencies when the inlet concentrations are very low. The Bay Area BACT guidelines for an oxidizer or adsorber are typically:

- Less than 10 ppm at outlet; or
- Greater than 98.5 percent destruction/recovery efficiency if inlet VOCs are greater than 2,000 ppm; or
- Greater than 97 percent efficiency if inlet VOCs are greater than 200 to less than 2,000 ppm; or
- Greater than 90 percent efficiency if inlet VOCs are less than 200 ppm.

Some EPA standards allow up to 20 ppm at the outlet. The uncontrolled emission concentration for the crush core press is actually lower than the Bay Area BACT guidelines typical emission limit.

The low heat content for the offgases and low concentration of VOCs make destruction of the offgases in a combustion device not a feasible option.

Carbon adsorption - Carbon adsorption uses a filter bank of canisters that contain activated carbon, which adsorbs the VOC emissions from the air stream as it passes through the carbon before being released to the atmosphere. Carbon adsorption has not been used in practice on any aerospace crush core press operation. However, carbon adsorption has been used on other low-flow, low-VOC sources

3.5.3 Ranking of BACT by Control

Carbon adsorption is the only option that is feasible. A well designed and operated carbon adsorption systems can consistently demonstrate VOC removal efficiencies over 95 percent.

3.5.4 Cost-effectiveness Evaluation

Vendor information for carbon adsorption technology on the vacuum pumps for the composite layup and curing process was obtained from Thermal Recovery Systems. In an email, Thermal Recovery Systems stated that based on the potential contaminants listed and their concentrations, the temperature of the emission, and the high humidity (3 percent by volume), they would expect between 5 and 10 percent weight capacity for the activated carbon. If they used 8 percent as their target, they believe it would take 90 tons of carbon to control 7.2 tons per year of emissions. The cost in carbon alone would be over $225,000 per year, or over $31,000 per ton operating costs. This does not include capital cost or labor cost.

The crush core press emission concentration of $8x10^{-8}$ lb VOC/dscf is significantly lower and the air flow is significantly higher at 7,500 cfm than the emissions from the autoclave vacuum pumps ($7.5x10^{-5}$ lb VOC/dscf and air flow of 100 to 600 cfm). Because one of the mechanisms in the adsorption of compounds on carbon is the concentration gradient, or the difference between the concentration of the VOCs in the offgas and the concentration of the compound in the carbon, lower concentrations tend to have a negative effect on the weight capacity of the carbon. Increases in air flow may also lead to a decrease in the weight capacity of the carbon. Based on the $31,000 per ton operating cost for carbon on the composite layup and curing vacuum pumps, and the expected even lower weight capacity and potential increase in operating cost for the crush core process, Boeing does not believe that carbon adsorption is cost-effective. In addition, the inlet concentration, as stated above, is less than the Bay Area BACT typical emission limit of 10 ppm VOC.

3.5.5 BACT Selection

Because no control technologies have been demonstrated to be effective in practice on a crush core press and a cost estimate for just the carbon needed for a carbon adsorption system exceeds $31,000 per ton of VOC removed, as documented above, Boeing does not consider any of the identified add-on control technologies in Table 3-13 to be technically or economically feasible for the Boeing facility. Boeing will continue to implement the use of low-VOC-emitting prepreg materials to minimize VOC emissions from the process.

3.6 Open Floor Emissions

Open floor emissions (sometimes called fugitive emissions) from open floor activities are typically emissions that result from hand application of cleaners, sealants, and coatings that are not done in a confined area such as a paint booth. These activities occur throughout the manufacturing process and in very large buildings. The emissions exit the buildings via various openings (e.g., hangar doors, roll-up doors, vents) and general building air-handling systems. The VOC emissions result from the VOCs in the various solvents or coatings. This BACT analysis considers those technologies that reduce fugitive VOC emissions from the open floor activities that will take place in the new wing component fabrication process. Open floor activities that will take place as part of wing assembly, body section assembly, airplane assembly, and other related operations are not addressed here because these operations will take place in existing buildings where these open floor activities already occur.

3.6.1 Wing Component Fabrication

The wings of the 777X will be primarily made of composite material. The main wing components include front and rear spars, upper and lower panel stringers, and upper and lower panels. The manufacturing process of each of these parts is similar and involves the following major steps.

- Wing component part layup
- Curing in an autoclave
- Trimming and drilling
- Washing
- Non-destructive inspection
- Prep for priming (e.g. abrading, solvent cleaning)
- Priming
- Wing component part build-up

Fugitive VOC emissions can be generated by the following activities.

Part layup – Part layup involves the manual or automated layup of composite material (in the form of resin pre-impregnated tape or sheets) onto a mandrel which is preformed into the shape of the part being fabricated. Emissions associated with the part layup primarily occur from preparing the mandrel prior to the actual part layup process. Preparing the mandrel involves cleaning the surface with solvent, applying a mold release compound, and applying a tackifier solution.

Wing component cleaning – Open floor emissions from wipe cleaning primarily occur during the part buildup process, but can occur throughout the manufacturing process.

Sealing and touch up coating – Open floor emissions from the application of sealant and miscellaneous coatings will primarily occur during the part buildup process, but can occur throughout the manufacturing process. (Most of the coating of the wing components will take place in the spray booths and will not result in open floor emissions.)

Open floor VOC emissions from the wing component fabrication building are estimated to be 128 tons per year.

3.6.2 Available Control Technologies

The open floor activities listed above are addressed and regulated under 40 CFR 63 Subpart GG, Aerospace NESHAP. In addition, the VOC emissions standards for uncontrolled use of cleaning solvents and coatings are defined in 40 CFR 63 Subpart GG Aerospace NESHAP and PSCAA Regulation II, 3.09, and will be applied to these activities. Because of the nature of these open floor activities and the fugitive emissions generated by the activities (e.g., numerous locations, low VOC concentrations, and very low emission rates) and the fact that they may occur anywhere in the manufacturing process, capture and control of the fugitive emissions is not feasible. This conclusion is supported by the fact that in developing the Aerospace NESHAP, EPA has determined that work practices rather than emission standards are the only practical way to regulate these open floor emissions.

Boeing uses good work practices (Table 3-14) to minimize VOC emissions, including storing coatings and solvents in closed containers and bagging solvent hand-wipe cleaning rags when not in use. The Aerospace NESHAP and/or PSCAA regulations require low-VOC cleaners and coatings and these work practices; therefore, these techniques are considered the base case for BACT.

TABLE 3-14. SUMMARY OF AEROSPACE NESHAP AND PSCAA AEROSPACE VOC EMISSION STANDARDS APPLICABLE TO THE NEW AND MODIFIED EMISSION UNITS OF THE 777X PROJECT

Production Activity	Control Technology
Low-VOC primers	Large commercial aircraft component exteriors: 5.4 lb VOC/gal. All other applications: 2.9 lb VOC/gal
Low-VOC topcoats	3.5 lb VOC/gal
Low-VOC cleaning solvents	Hand-wipe cleaning solvent: vapor pressure less than 45 mm Hg at 20°C or solvent meets composition requirements in Table 1 in 40 CFR 63.744. Flush cleaning: use collection system to capture flushed solvent.
High-transfer-efficiency spray coating equipment	HVLP, electrostatic, or other equivalent spray coating equipment.
Paint gun cleaning, waste solvents, and rags	Capture and closed containment.

3.6.3 BACT Feasibility Review

The use of low-VOC cleaners and coatings, and good work practices in compliance with the 40 CFR 63 Subpart GG Aerospace NESHAP requirements and the PSCAA standards in Regulation II, Section 3.09 have clearly been demonstrated and achieved in practice and are therefore considered feasible technologies to implement for the open floor activities in the new wing component fabrication building. Boeing believes this is the base case for BACT and uses these techniques for its current operations.

Boeing will implement all of the base case BACT techniques; thus, further review of economic, environmental, and energy impacts is unnecessary.

3.6.4 BACT Selection

Boeing will continue to implement the use of low-VOC coatings and cleaners, and good work practices to minimize fugitive VOC emissions in compliance with the 40 CFR 63 Subpart GG Aerospace NESHAP and the PSCAA standards in Regulation II, Section 3.09. This conclusion is consistent with other recent BACT determinations made by Ecology, PSCAA, and others for fugitive open floor VOC emissions.

4. Air Quality Impact Analysis

4.1 Impacts on Class 1 Areas

Because the proposed emission increase in VOCs from the Boeing Everett 777X Project would exceed 100 tpy, there must be a demonstration that the Project would not cause or significantly contribute to a violation of any ambient air quality standard. Furthermore, PSD rules require an analysis of air quality-related values (AQRVs) on federally designated Class I areas. Federally mandated Class I areas are defined in the Clean Air Act as having special national or regional value from a natural, scenic, recreational, or historic perspective. Class I areas include national parks over 6,000 acres and wilderness areas and memorial parks over 5,000 acres as of 1977. The impacts to these areas are stringently regulated because they have remained relatively untouched by development. Therefore, in addition to stricter PSD increment standards for criteria air pollutants, additional analyses of air quality impacts on Class I areas are required. Class I areas within 200 kilometers (km) of the Boeing Everett facility are listed in Table 4-1.

TABLE 4-1. CLASS I AREAS WITHIN 200 KM OF THE BOEING EVERETT FACILITY

Area	Distance from Boeing Everett to Class I Area (km)	VOC Emissions Increase (Quantity) Divided by Distance (Q/D) (tons VOC/km)	Allowable VOC Emissions Increase (Quantity) Divided by Distance (Q/D) (tons VOC/km)
Alpine Lakes Wilderness Area	60	6.9	5.7
Glacier Peak Wilderness Area	70	5.9	4.9
Mount Baker Recreation Area	90	4.6	3.8
Olympic National Park	91	4.6	3.7
North Cascades National Park	108	3.9	3.2
Mount Rainier National Park	123	3.4	2.8
Goat Rocks Wilderness Area	205	2.0	1.7

Air quality-related values include impacts on visibility, soil, flora, fauna, and aquatic resources within the Class I area. The Federal Land Managers' (FLMs) guidance on evaluating impacts of major projects on Class I areas is the *Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report – Revised (2010)* (National Park Service, 2010). In FLAG, the FLMs have developed a tool to screen out projects that would not have a significant impact on AQRVs based on annual emissions and distance from a Class I area. This screening tool is called the Q/D Method, which is to divide the amount of emission increases in tons per year (Q) by the distance to a federal Class I area in kilometers (D). FLAG states that "The FLM role within the regulatory context consists of considering whether emissions from a new source, or emission increases from a modified source, may have an adverse impact on AQRVs and providing comments to permitting authorities (States or EPA). Therefore, the Agencies will consider a source locating greater than 50 km from a Class I area to have negligible impacts with respect to Class I AQRVs if its total SO_2, NO_x, PM_{10}, and H_2SO_4 [sulfuric acid] annual emissions (in tons per year, based on 24-hour maximum allowable emissions), divided by the distance (in km) from the Class I area (Q/D) is 10 or less. The Agencies would not request any further Class I AQRV impact analyses from such sources." For this Project, the only pollutant that would have a significant increase is VOC. VOC is not among the pollutants that the FLMs recommend including in the calculation of Q. While VOCs and NOx are recognized as precursors to the formation of ground level ozone which is regulated as a criteria pollutant, the FLAG guidance states that "current information indicates most FLM areas are NOx limited" with respect to the formation of ground level ozone. The FLAG guidance further states "until there is enough information available for FLAG to determine whether ozone formation in each FLM area is primarily limited by NOx or VOC emissions, we will assume all FLM areas are NOx-limited and will focus on control of NOx emissions" (FLAG Executive Summary and Section 3.4.5). Because there has not been a demonstration that ozone formation in the Puget Sound region's Class I areas is not NOx-limited and VOC is the only pollutant that is expected of have a significant increase as a result of this Project, there is no need to perform the Q/D analysis and it can be presumed that the Project would have no significant adverse impacts on Class I areas.[4]

4.2 Ozone Impacts

As mentioned above, VOCs are a precursor to ozone. Boeing's proposed increase in VOC emissions is greater than 100 tpy and therefore requires an analysis of the effect that the proposed increase in emissions of VOCs would have on the area's ozone levels. The analysis of the proposed Project emissions for ozone is described below.

EPA has set primary and secondary ozone standards to protect human health and welfare. On March 12, 2008, EPA revised the primary and secondary ozone standards to 0.075 parts per million (ppm) (8-hour average).

Ozone is formed in the troposphere when sunlight causes complex photochemical reactions involving oxides of nitrogen (NOx), VOCs, and carbon monoxide that originate chiefly from gasoline engines and burning of other fossil fuels. Woody vegetation is another major source of VOCs. Factors involved in ozone formation include terrain, meteorology, temperature, the ratio of VOC emissions to NOx emissions within the surrounding airshed, and the relative reactivities of the VOC species. NOx and VOCs can be transported long distances by regional weather patterns before they react to create ozone in the atmosphere, where it can persist for several weeks. Because ozone is a regional pollutant, precursor sources both near and far can contribute to ozone formation.

Breathing ozone can trigger a variety of health problems for humans, including chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema, and asthma.

[4] Nonetheless, for informational purposes the 777X project's Q/D for all Class I areas within 200 km are shown in Table 4-1 where Q is that annual emission rate of VOC. As shown, even if VOC emissions were considered in the calculation of Q, the ratio of Q/D would be less than 10 and according to the FLAG guidance it could be presumed that the project would have no significant adverse impacts on Class I areas. Table 4-1 also shows that the proposed increases in the VOC emissions limits would also result in Q/D being less than 10.

Elevated levels of ozone can also reduce lung function by inflaming the linings of the lungs. Repeated exposure to elevated concentrations of ozone may permanently scar lung tissue.

Ozone is also phytotoxic, causing damage to a variety of vegetation (Ashmore et al., 2004). Ozone pollution has been shown to reduce plant growth, alter species composition, and predispose trees to insect and disease attack. Ozone also causes direct foliar injury to some plant species. Ozone-affected leaves are often marked with discoloration and lesions, and they age more rapidly than normal leaves (EPA, 2007).

Ozone enters plants through leaf stomata, causing changes in biochemical and physiological processes. The mesophyll cells under the upper epidermis of leaves are the most sensitive to ozone, and those are the first cells to die. The adjacent epidermal cells then die, forming a small black or brown interveinal necrotic lesion that becomes visible on the upper surface of the leaf. These lesions, termed oxidant stipple, are quite specific indicators that the plant has been exposed to ozone. There are other plant symptoms that can result from exposure to ozone; however, these symptoms are non-specific for ozone since other stressors can also cause them to occur. In general, the most reliable indicator that ozone has impacted vegetation is oxidant stipple.

In addition to affecting individual plants, ozone can also affect entire ecosystems. Research shows that plants growing in areas with high exposure to ambient ozone may undergo natural selection for ozone tolerance (EPA, 2007). The final result could be the elimination of the most ozone-sensitive genotypes from the area (National Park Service, 2010).

In the Class I areas closest to Boeing Everett, several species are known to be sensitive to ozone, including *Populus tremuloides* (quaking aspen), *Apocynum androsaemifolium* (spreading dogbane), *Abies lasiocarpa* (subalpine fir), *Populus trichocarpa* (black cottonwood), and *Pinus ponderosa* (ponderosa pine) (Brace et al., 1998). These sensitive species have been systematically evaluated and no ozone injury has been documented in the parks.

In a previous PSD permit application for the 787 Project (PSD 05-02), Boeing demonstrated and Ecology agreed that 297 tpy of VOC emissions would not cause or significantly contribute to an exceedance of any NAAQS or PSD increment. A copy of the 787 Project PSD application ambient air quality impact analysis is include in Appendix D. That study showed a projected maximum increase in ozone concentration of about 0.1 parts per billion (ppb) from a 297-tpy increase in VOC emissions. This is a small fraction of the national ambient air quality standard for ozone of 75 ppb for an 8-hour average. Similarly, for the 737 MAX Project in Renton (PSD 12-01), Boeing has demonstrated and Ecology has agreed that a 384-tpy increase from Boeing's Renton facility would also not cause or significantly contribute to an exceedance of any NAAQS or PSD increment and in the worst case would only increase the maximum ozone concentration by less than 0.35 ppb. As shown in Table 1-7, Boeing is proposing to increase Boeing Everett's allowed VOC emissions by 308.2 tpy. This is well within the range that Ecology has previously determined will not have a significant adverse impact on air quality. Therefore, an additional air quality impact analysis addressing the impact of VOC emissions from the 777X Project is not required.

5. Air Quality-Related Values

PSD regulations and guidance require an evaluation of the effects of the Project's emissions on visibility, local soils, and vegetation in Class I and II areas; the effect of increased air pollutant concentrations on flora and fauna in the Class I areas; and the effect of the Project on construction and population growth in the area surrounding the Project. The analyses assess increment consumption (if applicable) and impacts on AQRVs in Class I areas. AQRVs include regional visibility or haze, the effects of primary and secondary pollutants on sensitive plants, the effects of pollutant deposition on soils and receiving water bodies, and other effects associated with secondary aerosol formation. The FLMs for the National Park Service, U.S. Fish and Wildlife Service, and U.S. Forest Service have the responsibility of ensuring AQRVs in the Class I areas are not adversely affected.

5.1 Local Impacts on Soils, Vegetation, and Animals

According to EPA guidance,[5] for most types of soils and vegetation, ambient concentrations of criteria pollutants below the secondary NAAQS will not result in harmful effects. Only the VOC emissions from the 777X Project are subject to PSD review. VOC is regulated as a precursor to ozone; however, ozone has no secondary NAAQS. Additionally, the expected VOC emissions from the 777X Project do not trigger a detailed ambient air quality impact analysis for Class I area as discussed in Section 4.1, and Section 4.2 shows that no significant ozone increase would be expected as a result of the Project; the incremental increase in ozone concentrations directly attributable 777X Project would be less than approximately 0.4 ppb on an hourly average. Consequently, the impacts on local soils, vegetation, and animals attributable to the 777X Project will be negligible.

FLAG guidance does not indicate a specific VOC impact on vegetation in the Pacific Northwest. The National Park Service has established monitors for ozone in three Class I Areas in Washington State: Mount Rainer National Park, Olympic National Park, and North Cascades National Park. As discussed above, in the past Boeing demonstrated that similar incremental increases of VOC emissions in the Puget Sound area would result in increased ozone concentrations less than approximately 0.4 ppb on an hourly average, a very small fraction of the NAAQS of 75 ppb on an 8-hour average. Therefore, the increase in ozone from this Project is not likely to harm vegetation or animals.

5.2 Construction and Growth Impacts

Employment at Boeing Everett is expected to increase by no more than 3,000 employees as a result of this Project; this is less than 10 percent of the potential 45,000 employees at the Boeing Everett site that were added in the Southwest Everett EIS and Planned Action (City of Everett, 1997). Additionally, there will not be a significant increase in congestion on Washington's roads and highways as a result of the Project. See SEPA Addendum #1 (Revised) Southwest Everett

---

5 *Draft EPA New Source Review Workshop Manual*, Chapter D, § IIC (EPA, 1990).

Planned Action EIS SEPA # 13-019 in Appendix E. Therefore, the proposed Project is not expected to cause adverse construction- and growth-related impacts.

6. References

Ashmore, M., Emberson, L., Karlsson, P. E., and H. Pleije. 2004. New directions: a new generation of ozone critical levels for the protection of vegetation in Europe (correspondence). *Atmospheric Environment*. 38: 2213-2214.

Brace, S., Peterson, D.L., and D. Horner. 1998. Diagnosing Ozone Injury in Vascular Plants of the Pacific Northwest. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

California Air Resources Board. 2014. Statewide BACT Clearinghouse. http://www.arb.ca.gov/bact/bact.htm. California Environmental Protection Agency, Sacramento, California.

City of Everett. 1997. *Southwest Everett Planned Action/Paine Field Subarea and Environmental Impact Statement*.

EPA. 1990. *Draft EPA New Source Review Workshop Manual*. http://www.epa.gov/ttn/nsr/gen/wkshpman.pdf.

EPA. 2002. *EPA Air Pollution Control Cost Manual*. Sixth Edition (EPA 452/B-02-001). http://www.epa.gov/oaqps001/lead/pdfs/2002_01_cost_control_%20manual.pdf. United States Environmental Protection Agency Office of Air Quality Planning and Standards. January 2002.

EPA. 2007. Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information. EPA-452/R-07-007.

EPA. 2014. RACT/BACT/LAER Clearinghouse. RBLC Database. http://cfpub.epa.gov/RBLC/index.cfm?action=Home.Home&lang=en. Technology Transfer Network Clean Air Technology Center.

National Park Service. 2010. *Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report – Revised (2010)*. http://www.nature.nps.gov/air/pubs/pdf/flag/FLAG_2010.pdf.

South Coast Air Quality Management District. 2014. SCAQMD Clearinghouse. http://www.aqmd.gov/bact/287160.htm. South Coast Air Quality Management District, Diamond Bar, California.

APPENDIX A

Background PSD Applicability Analysis for the 777X and Increased Production Rate Increase

APPENDIX B

Estimate of Non-Significant PSD Pollutant Emissions Increases from the 777X Project

APPENDIX C

Prep and Spray Paint Booth BACT Costs

APPENDIX D

787 Project PSD Application Ambient Air Quality Impact Analysis

APPENDIX E

City of Everett SEPA Addendum #1 (Revised) Southwest Everett Planned Action EIS