APPENDIX E

Air Quality Calculations and Modeling

Summary	Summarizes total emissions by calendar year for Modified Alternative 1 - Construction Phase (Saipan).
Combustion	Estimates emissions from non-road equipment exhaust.
Fugitive	Estimates particulate emissions from construction activities including earthmoving, vehicle traffic, and windblown dust.
Grading	Estimates the number of days of site preparation, to be used for estimating heavy equipment exhaust and earthmoving dust emissions.
Construction Commuter	Estimates emissions for construction workers commuting to the site.
Haul Truck On-Road	Estimates emissions from hauling construction materials to the project site.

Summary of Air Quality Emissions from Divert EIS - Modified Alternative 1 - Construction Phase (Saipan)

	NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Construction Combustion	6.39	0.94	2.75	0.41	0.44	0.43	738.47
Construction Fugitive Dust	-	-	-	-	48.52	3.88	-
Construction Commuter	4.33	4.78	44.22	0.08	0.67	0.43	7,933.88
Haul Truck On-Road	13.36	1.24	7.14	0.04	0.43	0.41	3,464.53
TOTAL	***24.08***	***6.96***	***54.11***	***0.53***	***50.06***	***5.15***	***12,136.88***

Annual Summary of Air Quality Emissions from Divert EIS - Modified Alternative 1 - Construction Phase (Saipan)*

	Point and Area Sources Combined						
	NO_x (tpy)	VOC (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CO_2 (metric tons)
CY 01	8.03	2.32	18.04	0.18	16.69	1.72	3,670.13
CY 02	8.03	2.32	18.04	0.18	16.69	1.72	3,670.13
CY 03	8.03	2.32	18.04	0.18	16.69	1.72	3,670.13

* Construction duration is estimated to be 36 months and the emissions are assumed to be distributed evenly over the construction period.

Combustion Emissions - Modified Alternative 1 - Construction Phase (Saipan)
Combustion Emissions of VOC, NO_x, SO_2, CO, $PM_{2.5}$, PM_{10}, and CO_2 due to Construction

Assumptions
When multiple options exist under the general construction activites the most conservative value will be used to quantify air emission.

General Construction Activities	**Area Disturbed (ft^2)**
Construct Maintenance Facility	6,100 ft^2
Construct Airport/Seaport Fuel Storage (operational, Bulk and at the Port of Saipan)	324,958 ft^2
Construct Fuel Hydrant System	161,172 ft^2
Construct Hazardous Cargo Pad	250,470 ft^2
Construct Parking Apron	502,682 ft^2

Total General Construction Area:	1,245,382	ft^2	
	28.6	acres	
Total Demolition Area:	0	ft^2	
	0.0	acres	
Total Pavement Area:	502,682	ft^2	
	11.5	acres	
Total Disturbed Area:	1,245,382	ft^2	
	28.6	acres	
Construction Duration:	36	months	
1 Yr Project Construction Activity:	240	days/yr	Assume 12 months, 4 weeks per month, 5 days per week.

Emission Factors Used for Construction Equipment

References: Guide to Air Quality Assessment, SMAQMD, 2004; and U.S. EPA NONROAD Emissions Model, Version 2005.0.0
Emission factors are taken from the NONROAD model and were provided to e²M by Larry Landman of the Air Quality and Modeling Center (Landman.Larry@epamail.epa.gov) on 12/14/07. Factors provided are for the weighted average US fleet for CY2007.
Assumptions regarding the type and number of equipment are from SMAQMD Table 3-1 unless otherwise noted.

Grading

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Bulldozer	1	13.60	0.96	5.50	1.02	0.89	0.87	1456.90
Motor Grader	1	9.69	0.73	3.20	0.80	0.66	0.64	1141.65
Water Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	3	41.64	2.58	15.71	0.83	2.55	2.47	4941.53

Paving

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Paver	1	3.83	0.37	2.06	0.28	0.35	0.34	401.93
Roller	1	4.82	0.44	2.51	0.37	0.43	0.42	536.07
Truck	2	36.71	1.79	14.01	3.27	1.99	1.93	4685.95
Total per 10 acres of activity	4	45.37	2.61	18.58	0.91	2.78	2.69	5623.96

Demolition

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Loader	1	13.45	0.99	5.58	0.95	0.93	0.90	1360.10
Haul Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	2	31.81	1.89	12.58	0.64	1.92	1.87	3703.07

Building Construction

Equipment[d]	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Stationary								
Generator Set	1	2.38	0.32	1.18	0.15	0.23	0.22	213.06
Industrial Saw	1	2.62	0.32	1.97	0.20	0.32	0.31	291.92
Welder	1	1.12	0.38	1.50	0.08	0.23	0.22	112.39
Mobile (non-road)								
Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Forklift	1	5.34	0.56	3.33	0.40	0.55	0.54	572.24
Crane	1	9.57	0.66	2.39	0.65	0.50	0.49	931.93
Total per 10 acres of activity	6	39.40	3.13	17.38	3.12	2.83	2.74	4464.51

Architectural Coatings

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c]	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Air Compressor	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77
Total per 10 acres of activity	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77

a) The SMAQMD 2004 guidance suggests a default equipment fleet for each activity, assuming 10 acres of that activity, (e.g., 10 acres of grading, 10 acres of paving, etc.). The default equipment fleet is increased for each 10 acre increment in the size of the construction project. That is, a 26 acre project would round to 30 acres and the fleet size would be three times the default fleet for a 10 acre project.
b) The SMAQMD 2004 reference lists emission factors for reactive organic gas (ROG). For the purposes of this worksheet ROG = VOC. The NONROAD model contains emissions factors for total HC and for VOC. The factors used here are the VOC factors.
c) The NONROAD emission factors assume that the average fuel burned in nonroad trucks is 1100 ppm sulfur. Trucks that would be used for the Proposed Actions will all be fueled by highway grade diesel fuel which cannot exceed 500 ppm sulfur. These estimates therefore over-estimate SO2 emissions by more than a factor of two.
d) Typical equipment fleet for building construction was not itemized in SMAQMD 2004 guidance. The equipment list above was assumed based on SMAQMD 1994 guidance.

PROJECT-SPECIFIC EMISSION FACTOR SUMMARY

Source	Equipment Multiplier*	Project-Specific Emission Factors (lb/day)						
		NO_x	VOC	CO	SO_2**	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	3	124.924	7.731	47.130	2.498	7.637	7.407	14824.579
Paving Equipment	1	45.367	2.606	18.578	0.907	2.776	2.693	5623.957
Demolition Equipment	1	31.808	1.886	12.584	0.636	1.923	1.865	3703.074
Building Construction	1	39.396	3.130	17.382	3.116	2.829	2.744	4464.512
Air Compressor for Architectural Coating	1	3.574	0.373	1.565	0.251	0.309	0.300	359.773
Architectural Coating**			46.893					

*The equipment multiplier is an integer that represents units of 10 acres for purposes of estimating the number of equipment required for the project.
**Emission factor is from the evaporation of solvents during painting, per "Air Quality Thresholds of Significance", SMAQMD, 1994
Example: SMAQMD Emission Factor for Grading Equipment NOx = (Total Grading NOx per 10 acre)*(Equipment Multiplier)

Summary of Input Parameters

	Total Area (ft^2)	Total Area (acres)	Total Days	
Grading:	1,245,382	28.59	6	(from "Grading" worksheet)
Paving:	502,682	11.54	55	
Demolition:	0	0.00	0	
Building Construction:	331,058	7.60	240	
Architectural Coating	331,058	7.60	20	(per SMAQMD "Air Quality of Thresholds of Significance", 1994)

NOTE: The 'Total Days' estimate for paving is calculated by dividing the total number of acres by 0.21 acres/day, which is a factor derived from the 2005 MEANS Heavy Construction Cost Data, 19th Edition, for 'Asphaltic Concrete Pavement, Lots and Driveways - 6" stone base', which provides an estimate of square feet paved per day. There is also an estimate for 'Plain Cement Concrete Pavement', however the estimate for asphalt is used because it is more conservative. The 'Total 'Days' estimate for demolition is calculated by dividing the total number of acres by 0.02 acres/day, which is a factor also derived from the 2005 MEANS reference. This is calculated by averaging the demolition estimates from 'Building Demolition - Small Buildings, Concrete', assuming a height of 30 feet for a two-story building; from 'Building Footings and Foundations Demolition - 6" Thick, Plain Concrete'; and from 'Demolish, Remove Pavement and Curb - Concrete to 6" thick, rod reinforced'. Paving is double-weighted since projects typically involve more paving demolition. The 'Total Days' estimate for building construction is assumed to be 230 days, unless project-specific data is known.

Total Project Emissions by Activity (lbs)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	749.54	46.39	282.78	14.99	45.82	44.44	88,947
Paving	2,495.20	143.31	1,021.81	49.90	152.69	148.10	309,318
Demolition	-	-	-	-	-	-	0
Building Construction	9,455.12	751.15	4,171.75	747.92	678.97	658.60	1,071,483
Architectural Coatings	71.48	945.33	31.31	5.02	6.19	6.00	7,195
Total Emissions (lbs):	**12,771.34**	**1,886.18**	**5,507.65**	**817.84**	**883.66**	**857.15**	**1,476,943**

Results: Total Project Annual Emission Rates

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Total Project Emissions (lbs)	12,771.34	1,886.18	5,507.65	817.84	883.66	857.15	1,476,943
Total Project Emissions (tons)	6.39	0.94	2.75	0.41	0.44	0.43	738.47

Construction Fugitive Dust Emissions - Proposed Action [Modified Alternative 1 - Construction Phase (Saipan)]

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
General Construction Activities	0.19	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.42	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
$PM_{2.5}$ Emissions			
$PM_{2.5}$ Multiplier	0.10	(10% of PM_{10} emissions assumed to be $PM_{2.5}$)	EPA 2001; EPA 2006
Control Efficiency	0.50	(assume 50% control efficiency for PM_{10} and $PM_{2.5}$ emissions)	EPA 2001; EPA 2006

Project Assumptions

New Roadway Construction (0.42 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	11.5	acres

General Construction Activities (0.19 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	17.1	acres

	Project Emissions (tons/year)			
	PM_{10} uncontrolled	**PM_{10} controlled**	**$PM_{2.5}$ uncontrolled**	**$PM_{2.5}$ controlled**
New Roadway Construction	58.16	29.08	5.82	2.91
General Construction Activities	38.87	19.44	1.94	0.97
Total	**97.04**	**48.52**	**7.76**	**3.88**

Construction Fugitive Dust Emission Factors

General Construction Activities Emission Factor

0.19 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM_{10}/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM_{10}/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions From Construction Operations, calculated the 0.19 ton PM_{10}/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM_{10}/acre-month) and 75% of the average emission factor (0.11 ton PM_{10}/acre-month). The 0.19 ton PM_{10}/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM_{10}/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particulate (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District as well as the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas.

New Road Construction Emission Factor

0.42 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM_{10}/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

$PM_{2.5}$ Multiplier **0.10**

$PM_{2.5}$ emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM_{10} and $PM_{2.5}$ **0.50**

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas (EPA 2006). Wetting controls will be applied during project construction.

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Grading Schedule - Proposed Action [Modified Alternative 1 - Construction Phase (Saipan)]

Estimate of time required to grade a specified area.

Input Parameters
Construction area: 28.6 acres/yr (from Combustion Worksheet)
Qty Equipment: 9.0 (calculated based on 3 pieces of equipment for every 10 acres)

Assumptions.
Terrain is mostly flat.
An average of 6" soil is excavated from one half of the site and backfilled to the other half of the site; no soil is hauled off-site or borrowed.
200 hp bulldozers are used for site clearing.
300 hp bulldozers are used for stripping, excavation, and backfill.
Vibratory drum rollers are used for compacting.
Stripping, Excavation, Backfill and Compaction require an average of two passes each.
Excavation and Backfill are assumed to involve only half of the site.

Calculation of days required for one piece of equipment to grade the specified area.

Reference: Means Heavy Construction Cost Data, 19th Ed., R. S. Means, 2005.

Means Line No.	Operation	Description	Output	Units	Acres per equip-day	equip-days per acre	Acres/yr (project-specific)	Equip-days per year
2230 200 0550	Site Clearing	Dozer & rake, medium brush	8	acre/day	8	0.13	28.59	3.57
2230 500 0300	Stripping	Topsoil & stockpiling, adverse soil	1,650	cu. yd/day	2.05	0.49	28.59	13.98
2315 432 5220	Excavation	Bulk, open site, common earth, 150' haul	800	cu. yd/day	0.99	1.01	14.30	14.41
2315 120 5220	Backfill	Structural, common earth, 150' haul	1,950	cu. yd/day	2.42	0.41	14.30	5.91
2315 310 5020	Compaction	Vibrating roller, 6 " lifts, 3 passes	2,300	cu. yd/day	2.85	0.35	28.59	10.03
TOTAL								47.91

Calculation of days required for the indicated pieces of equipment to grade the designated acreage.

(Equip)(day)/yr: 47.91
Qty Equipment: 9.00
Grading days/yr: 5.32

Construction/Staff Commuter Emissions - Modified Alternative 1 - Construction Phase (Saipan)

Emissions from construction workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road).

Assumptions:
Passenger vehicle emission factors for scenario year 2015 are used.

The average roundtrip commute for a construction/staff worker =	40	miles
Number of construction days =	240	days
Number of construction/Staff workers (daily) =	1500	people

Note: None

Passenger Vehicle Emission Factors for Year 2015 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00060188	0.00066355	0.00614108	0.00001070	0.00009259	0.00006015	1.10192837

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Available online: <http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road)>. Accessed 18 August 2015.
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Construction Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**8667.025**	**9555.088**	**88431.513**	**154.140**	**1333.268**	**866.155**	**15867768.595**
tons	**4.334**	**4.778**	**44.216**	**0.0771**	**0.6666**	**0.4331**	**7933.884**

Example Calculation: NO_x emissions (lbs) = 60 miles/day * NO_x emission factor (lb/mile) * number of construction days * number of workers

No Statistical Area Available for GSN

				Point Source Emissions						Area Source Emissions (Non-Point and Mobile Sources)					
Row #	State	County	Tier-1	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
No Data Available															
Grand Total				0	0	0	0	0	0	0	0	0	0	0	0

SOURCE:

http://www.epa.gov/ttn/chief/eiinformation.html

USEPA - AirData NET Tier Report

*Net Air pollution sources (area and point) in tons per year (2002)

Site visited on 02 February 2012.

No Air Quality Control Region Identified

	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
CNMI	0	0	0	0	0	0
CNMI DEQ	0	0	0	0	0	0

Construction/Haul Truck Emissions - Modified Alternative 1 - Construction Phase (Saipan)

Emissions from hauling construction supplies, demoliton debris, fill, and excavated material are estimated in this spreadsheet.

Emission Estimation Method: AFCEE Air Emissions Factor Guide to Air Force Mobile Sources, Dec. 2009.

Concrete Mixing and Dump Truck Assumptions:
Dump trucks carry 11 cubic yards of material per trip.
Concrete mixing trucks carry 10 cubic yards of material per trip.
The average distance from the port to Commercial Concrete Supply Company is 7 miles; therefore, dump trucks will travel 14 miles round trip.
The average distance from the Commercial Concrete Supply Company (CCSC) to the project site is 2 miles; therefore, concrete trucks will travel 4 miles round trip.

Fill Materials Assumptions:
Haul trucks carry 20 cubic yards of material per trip.
The average distance from the project site to the materials source is 20 miles; therefore, building material haul trucks will travel 40 miles round trip.
Estimated number of trips required by haul trucks = total amount of material/20 cubic yards per truck

Amount of demoltion debris =	0	cubic yards	No Demolition in the Proposed Action
Amount of cement transported from port to CCSC =	1,122	cubic yards	
Amount of concrete transported from CCSC to project site =	17,980	cubic yards	
Amount of Excavation Materials for New Buildings =	553,503	cubic yards	Construction area multiped by depth of disturbance which is assumed to be 12 feet.
Amount of Building Materials =	415,127	cubic yards	Construction area multipled by 9 feet.

Number of dump trucks required (port to CCSC) =	102	heavy duty diesel haul truck trips, Cells rounded up
Number of concrete mixing trucks required (CCSC to project site) =	1798	heavy duty diesel haul truck trips,Cells rounded up
Number of trucks required (Building Materials) =	48,432	heavy duty diesel haul truck trips
Miles per trip (port to CCSC) =	14	miles
Miles per trip (CCSC to project site) =	4	miles
Miles per trip (Building Materials) =	40	miles

Low Altitude Heavy Duty Diesel Vehicle 8b (HDDV8b) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV8b	**6.23**	**0.58**	**3.33**	**0.02**	**0.2**	**0.19**	**1615**

Notes:
Emission factors for all pollutants are from Appendix A - On-Raod Vehicle Emission Factors within AFCEE Air Emissions Factor Guide to Air Force Mobile Sources, Dec. 2009.
Emission factors from calendar year 2015 were used assuming the average vehicle model year is 2005.

HDDV8b Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**26,726.10**	**2,488.14**	**14,285.38**	**85.80**	**857.98**	**815.08**	**6,929,051.32**
tons	**13.36**	**1.24**	**7.14**	**0.04**	**0.43**	**0.41**	**3,464.53**

Example Calculation: NO_x emissions (lbs) = 40 miles per trip * 48,432 trips * NO_x emission factor (g/mile) * lb/453.6 g

Summary	Summarizes total emissions by calendar year for Modified Alternative 1 - Implementation Phase (Saipan).
Airfield Operations	Airfield operations consist of taxi, take-off and landings (sorties/LTOs), touch-and-go operations (TGOs), and low flybys (LFB) by aircraft.
Fuel Truck and Commuter Vehicle Emissions	Estimates emissions for workers and operational vehicles commuting to the site of the Proposed Action.
Fuel Transfer Emissions	Fuel loading operations under the Proposed Action involves the loading of fuel into tanker trucks and aircraft.
Internal Combustion Engine (ICE) Emissions	Estimates Emissions from Internal Combustion Engines (e.g Generators)
Fuel Storage Tanks	Estimates emissions from Above Ground Storage Tanks.

Criteria Pollutant and VOC Emissions Summary for Modified Alternative 1 - Implementation Phase (Saipan) (tons/year)

Source Category	PM10	PM2.5	CO	NOx	SOx	VOCs
Airfield Operations	0.055	0.053	18.672	6.771	0.982	1.246
Fuel Truck and Commuter Vehicle Emissions	0.023	0.019	0.279	0.536	0.001	0.048
Fuel Transfer	N/A	N/A	N/A	N/A	N/A	0.339
Fuel Storage Tanks	N/A	N/A	N/A	N/A	N/A	1.332
Total Criteria and VOC Pollutant Emissions (tons/year)	**0.08**	**0.07**	**18.95**	**7.31**	**0.98**	**2.96**

Greenhouse Gas (GHG) Emissions Summary for Modified Alternative 1 - Implementation Phase (Saipan) (metric tonnes/year)

Source Category	CO_2-equivalent (lb/year)	CO_2-equivalent (kg/year)	CO_2-equivalent (metric tonne/year)
Airfield Operations*	366,634,444	166,305,384	166,305
Fuel Truck and Commuter Vehicle Emissions	292,969	132,891	133
Fuel Transfer	0	0	0
Fuel Storage Tanks	0	0	0
Total GHG Emissions	**366,927,413**	**166,438,275**	**166,438**

DATA - Airfield Operations for Modified Alternative 1 - Implementation Phase (Saipan)

Aircraft exercises under this alternative are based on assuming 2 to 4 KC-135R aircraft operating up to 8 weeks per year for a maximum of 720 KC-135R operations per year. Each operation is equivalent to one landing or one take-off (1 LTO Cycle = 2 operations).

Landing and Takeoff (LTO) Cycles

Description	Quantity
# of KC-135R LTO's per year	360

Legend

Airfield Activity Data (Worst Case Scenario)

Aircraft Model	Aircraft Model Used to Match to Available Emission Factors	Engine Model	# Engines	APU Model	# APUs	Notes	LTO Cycles
KC-135R	KC-135-R	F108-CF-201	4	No data on APUs		See below	360
Note: F108-CF-201 is the military designation of the CFM56-2B-1 engine.							

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 1 - Implementation Phase (Saipan)

Aircraft Criteria Pollutant Emission Factors

						Emission Factors in lb Pollutant per 1000 lb Fuel Burned						
Aircraft Model	Engine Model	# Eng.	Reference Thrust Mode	LTO/TGO Thrust Mode	Fuel Flow (lb/hr)	PM10	PM2.5	CO	NO_X	SO_2	VOCs	TIM
KC-135R	F108-CF-201	4	Idle	Idle	1016	0.06	0.06	30.70	4.00	1.06	2.10	47.7
KC-135R	F108-CF-201	4	Approach	Approach	2468	0.06	0.05	4.20	8.20	1.06	0.09	5.2
KC-135R	F108-CF-201	4	Climbout	Climbout	6500	0.05	0.05	0.90	16.00	1.06	0.06	1.6
KC-135R	F108-CF-201	4	Takeoff	Takeoff	7818	0.07	0.06	0.90	18.05	1.06	0.05	0.7

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-8

APU Emission Factors

			APU Emission Factors in lb Pollutant per hour						
Aircraft Model	# APU	APU Model	PM10	PM2.5	CO	NO_X	SO_2	VOCs	APU (hr)
KC-135R	No Data Available.								

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 1 - Implementation Phase (Saipan)

Default Time-In-Mode	Typical Duration by Mode (minutes)					
Aircraft Type	Taxi/Idle-out	Takeoff	Climbout	Approach	Taxi/Idle-in	Total
KC-135R	32.8	0.7	1.6	5.2	14.9	55.2

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-4

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 1 - Implementation Phase (Saipan)

Greenhouse Gas Emission Factors

Units	CO_2	CH_4	N_2O
kg/gal fuel	9.80	---	---
g/gal fuel	---	0.27	0.31

Reference: Footnote 2. from Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 1 - Implementation Phase (Saipan)

Criteria Pollutant and VOC Emissions per LTO by Aircraft Type

Calculated as the sum of the products of [(minutes) * (fuel flow/minute) * (lbs pollutant/lb fuel)] for each of the thrust modes.

			Emission in lb Pollutant per LTO						
Reported Aircraft Model	APU	Fuel (lb)	PM10 (lb)	PM2.5 (lb)	CO (lb)	NOx (lb)	SOx (lb)	VOCs (lb)	APU
KC - 135R	0	5144.6	0.3	0.3	103.7	37.6	5.5	6.9	0

Total Criteria Pollutant and VOC Emissions for maximum LTO's by Aircraft Type

Reported Aircraft Model	APU	Total LTO's	Fuel (lb)	PM10 (tons)	PM2.5 (tons)	CO (tons)	NOx (tons)	SOx (tons)	VOCs (tons)	APU
KC - 135R	0	360	1,852,065.6	0.05	0.05	18.67	6.77	0.98	1.25	0
Worst Case Scenario			**1,852,065.60**	**0.05**	**0.05**	**18.67**	**6.77**	**0.98**	**1.25**	0

Total gallons of fuel used for LTOs (277,671 gal.) is based on the 6.67 lb/gal density of JP-8 as provided in footnote 2. of Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 1 - Implementation Phase (Saipan)

Greenhouse Gas Emissions

Assume aircraft will use 300,000 gallons of fuel per day for 56 days.

Quantity (gallons)	Fuel Type	CH_4 (kg)	N_2O (kg)	CO_2 (kg)	CO_2-equivalent (kg)	CO_2-equivalent (metric tonne)
16,800,000	JP-8	4536	5208	164,640,000	166,305,384	166,305

The CH_4 and N_2O Global Warming Potential multipliers are 25 and 298, respectively from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014.

DATA - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 1 - Implementation Phase (Saipan)

Given: Six 10,000 gal Fuel Trucks will take 14 days at 10hrs/day to provide initial fill from Saipan port to Saipan International Airport (Site of Proposed Action). The six 10,000 gallon Fueld trucks will operate 10hrs/day for the duration of the exercises. The total exercise time is 8 weeks (56 days), therefore the fuel trucks will operate an additional 42 days after the initial fill.

Under the commercial lodging option six busses will transport a total of 256 personnel 4 roundtrips/day for a total of 24 roundtrips/day for 8 weeks.

Assumptions: A Gross Vehicle Weight (GVW) of 36,200 lbs will be used, based off of an 84 passenger Blue Bird bus.

Assume fuel truck GVW > 60,000 lbs since fuel load alone is 83,400 lbs.

Assume fuel trucks travel at 55 miles per hour

Assume 40 miles per roundtrip for busses.

Vehicle Weight Classes for Which Emission Factors are Published

Vehicle Category	Description	SCC
LDGV	Light-Duty Gasoline Vehicles (i.e., passenger cars) does not include SUVs, vans or pickups	A2201001000
LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs GVW - includes pickup trucks, sport utility vehicles and vans)	A2201020000
LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVW - includes pickup trucks, sport utility vehicles and vans)	A2201040000
HDGV2B	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs GVW)	A2201070000
HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs GVW)	A2201070000
HDGV8A	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs GVW)	A2201070000
LDDV	Light-Duty Diesel Vehicles (Passenger Cars)	
LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs GVW)	A2230002000
HDDV2B	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs GVW – includes pickup trucks)	A2230070000
HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs GVW)	A2230070000
HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	A2230070000
HDDV8B	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	A2230070000
MC	Motorcycles	A2201080000

Emission Factors - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 1 - Implementation Phase (Saipan)

Emission Factors for Calendar Year 2015

Vehicle Class	Model Year	Emission Factors in grams per Mile[a]								
		PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs	CO2	Fugitive PM_{10}	Fugitive $PM_{2.5}$
HDDV8A*	2005	0.2	0.19	2.8	5.47	0.01	0.48	1544.1	0.05	0.01
HDDV8B**	2005	0.2	0.19	3.33	6.23	0.02	0.58	1615.2	0.05	0.01

* Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8a

**Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8b

a) Emission factors from Appendix A of Air Emissions Factor Guide to Air Force Mobile Sources, AFCEE, December 2009

Greenhouse Gas Emission Factors for Calendar Year 2015

Vehicle Class	CH_4 (g/mile)	N_2O (g/mile)
HDDV	0.0051	0.0048

g/mile = grams per mile

CH_4 = Methane; N_2O = Nitrous Oxide

b) Emission Factors from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf).

Emission Calculations - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 1 - Implementation Phase (Saipan)

Miles for Commuter Emissions for 8 week training exercises

Vehicle Class	Speed Miles/hour	Miles/Trip	Total Trips/Day	Hours/Day	Total Days	Total Miles
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	---	40	24	---	56	53,760
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	55	---	---	10	56	30,800

Criteria and VOC Emissions for Commuters

Vehicle Class	Model Year	Annual Miles	Criteria Pollutant Emissions (tons/year)					
			PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	2005	53,760	0.015	0.012	0.166	0.324	0.001	0.028
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	2005	30,800	0.008	0.007	0.113	0.212	0.001	0.020
Total			**0.023**	**0.019**	**0.279**	**0.536**	**0.001**	**0.048**

Particulate emissions include exhaust, brake wear, tire wear. Assume paved road.

Greenhouse Gas Emissions for Commuters

Vehicle Class	Annual Miles	CO_2 (lb/year)	CH_4 (lb/year)	N_2O (lb/year)	CH_4 GWP Multiplier	N_2O GWP Multiplier	CO_2 Equivalent (lb/year)	CO_2 Equivalent (metric tonnes/year)
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	53,760	183,004.44	0.60	0.57	25	298	183,189.08	83.09
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	30,800	109,674.07	0.35	0.33	25	298	109,779.86	49.80
Total		**292,678.52**	**0.95**	**0.89**	---	---	**292,968.94**	**132.89**

GWP = Global Warming Potential; 100-year GWP values obtained from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf)

Emission Calculations Method - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 1 - Implementation Phase (Saipan)

Calculation Method: Equation 4-1 , AFCEE 2009, Mobile Emissions Guide

EP = VMTVehCat * EFPolVehCat * 0.002205

Where,
EP = Emissions of each individual pollutant (lb/yr)
VMTVehCat = Annual vehicle miles traveled by each vehicle category (LDGV, LDGT1, LDDV, etc.) (mi/yr)
EFPolVehCat = Emission factor of each pollutant for each vehicle category (g/mi)
0.002205 = Factor for converting grams to pounds (g/lb).

DATA - Fuel Loading Emissions for Modified Alternative 1 - Implementation Phase (Saipan)

Given:

Total Exercise Days (8 weeks)	56
Initial Fuel Fill Days	14
Remaining Fuel Fill Days	42
Total # of Fuel Trucks	6
Total Gallons per Fuel Truck	10,000
Trips per day per Fuel Truck	5
1 bbl conversion to gallons	42
Total Fuel (gal) during Initial Fill	4,200,000
Total Fuel (gal) during Remaining Exercise	12,600,000
Total Fuel (gal) during Exercise (8 Weeks)	16,800,000

Proposed Action Fuel Loading Operations

Location	Description	Fuel Type	Fuel Transferred (gal)	Category
Flightline	Loading Aircraft from Hydrants	JP-8	16,800,000.0	Loading
Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8400000	Loading
Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8400000	Loading

Emission Factors - Fuel Loading Emissions for Modified Alternative 1 - Implementation Phase (Saipan)

JP-8 emission factors (lb/Mgal)	Dispensing Splash	Loading Bottom fill	
Molecular Weight =	130		AP-42 Table 7.1-2 dated 11/06
True Vapor Pressure (psia) =	0.011		AP-42 Table 7.1-2 dated 11/06 @ 70F (annual avg.)
Dispensing Displacement losses =	0.0487	0.020	AP-42 Section 5.2 dated 6/08 Equation (1)
Spillage =	0.7		AP-42 Table 5.2-7 dated 6/08
Total =	0.749		

Emission Calculations - Fuel Loading Emissions for Modified Alternative 1 - Implementation Phase (Saipan)

Location	Description	Fuel Type	Fuel Transferred (gal)	Displaced Vapor (lb)	Spillage (lb)	Total VOC (lb)	Total VOC (ton)
Flightline	Loading Aircraft from Hydrants	JP-8	16,800,000	338.9	0	338.9	0.17
Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Total			**33,600,000**	**678**	**0**	**678**	**0.34**

Emission Calculations Method - Fuel Loading Emissions for Modified Alternative 1 - Implementation Phase (Saipan)

Displacement emissions for Diesel and JP-8 were estimated using Equation (1) from AP-42 Section 5.2, Transportation and Marketing of Petroleum Liquids, dated 6/08

$$L_L = 12.46\ (SPM)/T$$

Where

L_L = Loading loss in lb/10^3 gal

S = Saturation Factor 1.45 for splash loading, 0.6 for bottom loading

M = molecular weight,

T = temperature of bulk liquid (assume average annual ambient temperature)

DATA - Fuel Storage Tank Emissions for Modified Alternative 1 - Implementation Phase (Saipan)

Fuel storage tank emissions were estimated using the U.S. EPA TANKS storage tank emissions calculation software (Version 4.0.9d). The emissions calculations algorithms in the TANKS program are based on Chapter 7 of EPA's AP-42. Honolulu, Hawaii was used as a surrogate location for the tanks as meteorological data does not exist in TANKS for CNMI. Jet Kerosene fuel was used as the surrogate for JP-8 in the TANKS model as it is the closet in characteristics to JP-8.

Emission Calculations Summary from TANKS*

Tank Type	Throughput (gal.)	Working Loss (lbs)	Breathing Loss (lbs)	VOC Total (lbs)	VOC Total (tons)
Tank 1 (Seaport)- 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 2 (Seaport)- 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 3 (Airport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 4 (Airport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Total		**1713.68**	**950.24**	**2663.92**	**1.33**

*See the following references for TANKS printouts. (SM11 - TANKS) & (SM12 - TANKS)

Summary	Summarizes total emissions by calendar year for Modified Alternative 2A - Construction Phase (Tinian North).
Combustion	Estimates emissions from non-road equipment exhaust.
Fugitive	Estimates particulate emissions from construction activities including earthmoving, vehicle traffic, and windblown dust.
Grading	Estimates the number of days of site preparation, to be used for estimating heavy equipment exhaust and earthmoving dust emissions.
Construction Commuter	Estimates emissions for construction workers commuting to the site.
Haul Truck On-Road	Estimates emissions from hauling construction materials to the project site.

Summary of Air Quality Emissions from Divert EIS - Modified Alternative 2A - Construction Phase (Tinian North)

	NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Construction Combustion	19.668	2.119	8.316	0.956	1.306	1.266	2,329.220
Construction Fugitive Dust	-	-	-	-	230.883	21.912	-
Construction Commuter	5.778	6.370	58.954	0.1028	0.889	0.577	10,578.512
Haul Truck On-Road	9.815	0.914	5.246	0.032	0.315	0.299	2,544.627
TOTAL	***35.26***	***9.40***	***72.52***	***1.09***	***233.39***	***24.06***	***15,452.36***

Annual Summary of Air Quality Emissions from Divert EIS - Modified Alternative 2A - Construction Phase (Tinian North)*

	Point and Area Sources Combined						
	NO_x (tpy)	VOC (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CO_2 (metric tons)
CY 01	11.75	3.13	24.17	0.36	77.80	8.02	4,672.72
CY 02	11.75	3.13	24.17	0.36	77.80	8.02	4,672.72
CY 03	11.75	3.13	24.17	0.36	77.80	8.02	4,672.72

* Construction duration is estimated to be 36 months and the emissions are assumed to be distributed evenly over the construction period.

Combustion Emissions - Modified Alternative 2A - Construction Phase (Tinian North)
Combustion Emissions of VOC, NO_x, SO_2, CO, $PM_{2.5}$, PM_{10}, and CO_2 due to Construction

Assumptions
When multiple options exist under the general construction activites the most conservative value will be used to quantify air emission.

General Construction Activities	**Area Disturbed (ft^2)**
Construct Taxiway	1,385,300 ft^2
Construct Road Re-Route	40,585 ft^2
Construct New Access Roads	128,924 ft^2
Construct Maintenance Facility	7,570 ft^2
Construct Jet Fuel System and Fire Pump System (Operational, Bulk and at the Port of Tinian)	891,266 ft^2
Construct Hazardous Cargo Pad	299,754 ft^2
Construct Parking Apron	1,729,805 ft^2

Total General Construction Area:	898,836	ft^2	
	20.6	acres	
Total Demolition Area:	0	ft^2	
	0.0	acres	
Total Pavement Area:	3,584,368	ft^2	
	82.3	acres	
Total Disturbed Area:	4,483,204	ft^2	
	102.9	acres	
Construction Duration:	36	months	
1 Yr Project Construction Activity:	240	days/yr	Assume 12 months, 4 weeks per month, 5 days per week.

Emission Factors Used for Construction Equipment

References: Guide to Air Quality Assessment, SMAQMD, 2004; and U.S. EPA NONROAD Emissions Model, Version 2005.0.0
Emission factors are taken from the NONROAD model and were provided to e²M by Larry Landman of the Air Quality and Modeling Center (Landman.Larry@epamail.epa.gov) on 12/14/07. Factors provided are for the weighted average US fleet for CY2007.
Assumptions regarding the type and number of equipment are from SMAQMD Table 3-1 unless otherwise noted.

Grading

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Bulldozer	1	13.60	0.96	5.50	1.02	0.89	0.87	1456.90
Motor Grader	1	9.69	0.73	3.20	0.80	0.66	0.64	1141.65
Water Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	3	41.64	2.58	15.71	0.83	2.55	2.47	4941.53

Paving

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Paver	1	3.83	0.37	2.06	0.28	0.35	0.34	401.93
Roller	1	4.82	0.44	2.51	0.37	0.43	0.42	536.07
Truck	2	36.71	1.79	14.01	3.27	1.99	1.93	4685.95
Total per 10 acres of activity	4	45.37	2.61	18.58	0.91	2.78	2.69	5623.96

Demolition

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Loader	1	13.45	0.99	5.58	0.95	0.93	0.90	1360.10
Haul Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	2	31.81	1.89	12.58	0.64	1.92	1.87	3703.07

Building Construction

Equipment[d]	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Stationary								
Generator Set	1	2.38	0.32	1.18	0.15	0.23	0.22	213.06
Industrial Saw	1	2.62	0.32	1.97	0.20	0.32	0.31	291.92
Welder	1	1.12	0.38	1.50	0.08	0.23	0.22	112.39
Mobile (non-road)								
Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Forklift	1	5.34	0.56	3.33	0.40	0.55	0.54	572.24
Crane	1	9.57	0.66	2.39	0.65	0.50	0.49	931.93
Total per 10 acres of activity	6	39.40	3.13	17.38	3.12	2.83	2.74	4464.51

Architectural Coatings

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c]	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Air Compressor	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77
Total per 10 acres of activity	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77

a) The SMAQMD 2004 guidance suggests a default equipment fleet for each activity, assuming 10 acres of that activity, (e.g., 10 acres of grading, 10 acres of paving, etc.). The default equipment fleet is increased for each 10 acre increment in the size of the construction project. That is, a 26 acre project would round to 30 acres and the fleet size would be three times the default fleet for a 10 acre project.
b) The SMAQMD 2004 reference lists emission factors for reactive organic gas (ROG). For the purposes of this worksheet ROG = VOC. The NONROAD model contains emissions factors for total HC and for VOC. The factors used here are the VOC factors.
c) The NONROAD emission factors assume that the average fuel burned in nonroad trucks is 1100 ppm sulfur. Trucks that would be used for the Proposed Actions will all be fueled by highway grade diesel fuel which cannot exceed 500 ppm sulfur. These estimates therefore over-estimate SO2 emissions by more than a factor of two.
d) Typical equipment fleet for building construction was not itemized in SMAQMD 2004 guidance. The equipment list above was assumed based on SMAQMD 1994 guidance.

PROJECT-SPECIFIC EMISSION FACTOR SUMMARY

Source	Equipment Multiplier*	Project-Specific Emission Factors (lb/day)						
		NO_x	VOC	CO	SO_2**	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	10	416.412	25.770	157.099	8.328	25.455	24.691	49415.263
Paving Equipment	8	362.938	20.846	148.627	7.259	22.209	21.543	44991.655
Demolition Equipment	1	31.808	1.886	12.584	0.636	1.923	1.865	3703.074
Building Construction	2	78.793	6.260	34.765	6.233	5.658	5.488	8929.023
Air Compressor for Architectural Coating	2	7.148	0.746	3.131	0.502	0.619	0.600	719.547
Architectural Coating**			77.268					

*The equipment multiplier is an integer that represents units of 10 acres for purposes of estimating the number of equipment required for the project.
**Emission factor is from the evaporation of solvents during painting, per "Air Quality Thresholds of Significance", SMAQMD, 1994
Example: SMAQMD Emission Factor for Grading Equipment NOx = (Total Grading NOx per 10 acre)*(Equipment Multiplier)

Summary of Input Parameters

	Total Area (ft^2)	Total Area (acres)	Total Days	
Grading:	4,483,204	102.92	6	(from "Grading" worksheet)
Paving:	3,584,368	82.29	49	
Demolition:	0	0.00	0	
Building Construction:	898,836	20.63	240	
Architectural Coating	898,836	20.63	20	(per SMAQMD "Air Quality of Thresholds of Significance", 1994)

NOTE: The 'Total Days' estimate for paving is calculated by dividing the total number of acres by 0.21 acres/day, which is a factor derived from the 2005 MEANS Heavy Construction Cost Data, 19th Edition, for 'Asphaltic Concrete Pavement, Lots and Driveways - 6" stone base', which provides an estimate of square feet paved per day. There is also an estimate for 'Plain Cement Concrete Pavement', however the estimate for asphalt is used because it is more conservative. The 'Total Days' estimate for demolition is calculated by dividing the total number of acres by 0.02 acres/day, which is a factor also derived from the 2005 MEANS reference. This is calculated by averaging the demolition estimates from 'Building Demolition - Small Buildings, Concrete', assuming a height of 30 feet for a two-story building; from 'Building Footings and Foundations Demolition - 6" Thick, Plain Concrete'; and from 'Demolish, Remove Pavement and Curb - Concrete to 6" thick, rod reinforced'. Paving is double-weighted since projects typically involve more paving demolition. The 'Total Days' estimate for building construction is assumed to be 230 days, unless project-specific data is known.

Total Project Emissions by Activity (lbs)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	2,498.47	154.62	942.59	49.97	152.73	148.15	296,492
Paving	17,783.98	1,021.44	7,282.74	355.68	1,088.23	1,055.58	2,204,591
Demolition	-	-	-	-	-	-	0
Building Construction	18,910.23	1,502.31	8,343.51	1,495.85	1,357.94	1,317.20	2,142,966
Architectural Coatings	142.96	1,560.28	62.62	10.05	12.37	12.00	14,391
Total Emissions (lbs):	**39,335.65**	**4,238.65**	**16,631.46**	**1,911.54**	**2,611.27**	**2,532.94**	**4,658,439**

Results: Total Project Annual Emission Rates

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Total Project Emissions (lbs)	39,335.65	4,238.65	16,631.46	1,911.54	2,611.27	2,532.94	4,658,439
Total Project Emissions (tons)	19.67	2.12	8.32	0.96	1.31	1.27	2,329.22

Construction Fugitive Dust Emissions - Proposed Action [Modified Alternative 2A - Construction Phase (Tinian North)]

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
General Construction Activities	0.19	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.42	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006

$PM_{2.5}$ Emissions

$PM_{2.5}$ Multiplier	0.10	(10% of PM_{10} emissions assumed to be $PM_{2.5}$)	EPA 2001; EPA 2006
Control Efficiency	0.50	(assume 50% control efficiency for PM_{10} and $PM_{2.5}$ emissions)	EPA 2001; EPA 2006

Project Assumptions

New Roadway Construction (0.42 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	82.3	acres

General Construction Activities (0.19 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	20.6	acres

	Project Emissions (tons/year)			
	PM_{10} uncontrolled	**PM_{10} controlled**	**$PM_{2.5}$ uncontrolled**	**$PM_{2.5}$ controlled**
New Roadway Construction	414.72	207.36	41.47	20.74
General Construction Activities	47.05	23.52	2.35	1.18
Total	**461.77**	**230.88**	**43.82**	**21.91**

General Construction Activities Emission Factor

0.19 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM_{10}/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM_{10}/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions From Construction Operations, calculated the 0.19 ton PM_{10}/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM_{10}/acre-month) and 75% of the average emission factor (0.11 ton PM_{10}/acre-month). The 0.19 ton PM_{10}/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM_{10}/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particulate (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District as well as the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas.

New Road Construction Emission Factor

0.42 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM_{10}/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

$PM_{2.5}$ Multiplier **0.10**

$PM_{2.5}$ emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM_{10} and $PM_{2.5}$ **0.50**

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas (EPA 2006). Wetting controls will be applied during project construction.

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Grading Schedule - Proposed Action [Modified Alternative 2A - Construction Phase (Tinian North)]

Estimate of time required to grade a specified area.

Input Parameters
Construction area: 102.9 acres/yr (from Combustion Worksheet)
Qty Equipment: 31.0 (calculated based on 3 pieces of equipment for every 10 acres)

Assumptions.
Terrain is mostly flat.
An average of 6" soil is excavated from one half of the site and backfilled to the other half of the site; no soil is hauled off-site or borrowed.
200 hp bulldozers are used for site clearing.
300 hp bulldozers are used for stripping, excavation, and backfill.
Vibratory drum rollers are used for compacting.
Stripping, Excavation, Backfill and Compaction require an average of two passes each.
Excavation and Backfill are assumed to involve only half of the site.

Calculation of days required for one piece of equipment to grade the specified area.

Reference: Means Heavy Construction Cost Data, 19th Ed., R. S. Means, 2005.

Means Line No.	Operation	Description	Output	Units	Acres per equip-day	equip-days per acre	Acres/yr (project-specific)	Equip-days per year
2230 200 0550	Site Clearing	Dozer & rake, medium brush	8	acre/day	8	0.13	102.92	12.87
2230 500 0300	Stripping	Topsoil & stockpiling, adverse soil	1,650	cu. yd/day	2.05	0.49	102.92	50.32
2315 432 5220	Excavation	Bulk, open site, common earth, 150' haul	800	cu. yd/day	0.99	1.01	51.46	51.89
2315 120 5220	Backfill	Structural, common earth, 150' haul	1,950	cu. yd/day	2.42	0.41	51.46	21.29
2315 310 5020	Compaction	Vibrating roller, 6 " lifts, 3 passes	2,300	cu. yd/day	2.85	0.35	102.92	36.10
TOTAL								172.45

Calculation of days required for the indicated pieces of equipment to grade the designated acreage.

(Equip)(day)/yr: 172.45
Qty Equipment: 31.00
Grading days/yr: 5.56

Construction/Staff Commuter Emissions - Modified Alternative 2A - Construction Phase (Tinian North)

Emissions from construction workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road).

Assumptions:
Passenger vehicle emission factors for scenario year 2015 are used.

The average roundtrip commute for a construction/staff worker =	40	miles
Number of construction days =	240	days
Number of construction/Staff workers (daily) =	2000	people

Note: None

Passenger Vehicle Emission Factors for Year 2015 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00060188	0.00066355	0.00614108	0.00001070	0.00009259	0.00006015	1.10192837

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Available online: <http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road)>. Accessed 18 August 2015.
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Construction Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**11,556.034**	**12,740.118**	**117,908.683**	**205.519**	**1,777.691**	**1,154.873**	**21,157,024.793**
tons	**5.778**	**6.370**	**58.954**	**0.103**	**0.889**	**0.577**	**10,578.512**

Example Calculation: NO_x emissions (lbs) = 60 miles/day * NO_x emission factor (lb/mile) * number of construction days * number of workers

No Statistical Area Available for TNI

				Point Source Emissions						Area Source Emissions (Non-Point and Mobile Sources)					
Row #	State	County	Tier-1	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
No Data Available															
Grand Total				0	0	0	0	0	0	0	0	0	0	0	0

SOURCE:
http://www.epa.gov/ttn/chief/eiinformation.html
USEPA - AirData NET Tier Report
*Net Air pollution sources (area and point) in tons per year (2002)
Site visited on 02 February 2012.

No Air Quality Control Region Identified

	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
CNMI	0	0	0	0	0	0
CNMI DEQ	0	0	0	0	0	0

Construction/Haul Truck Emissions - Modified Alternative 2A - Construction Phase (Tinian North)

Emissions from hauling construction supplies, demoliton debris, fill, and excavated material are estimated in this spreadsheet.

Emission Estimation Method: AFCEE Air Emissions Factor Guide to Air Force Mobile Sources, Dec. 2009.

Concrete Mixing and Dump Truck Assumptions:
Dump trucks carry 11 cubic yards of material per trip.
Concrete mixing trucks carry 10 cubic yards of material per trip.
The average distance from the port to Commercial Concrete Supply Company is 1.7 miles; therefore, dump trucks will travel 3.4 miles round trip.
The average distance from the Commercial Concrete Supply Company (CCSC) to the project site is 2.3 miles; therefore, concrete trucks will travel 4.6 miles round trip.

Fill Materials Assumptions:
Haul trucks carry 20 cubic yards of material per trip.
The average distance from the project site to the materials source is 20 miles; therefore, building material haul trucks will travel 40 miles round trip.
Estimated number of trips required by haul trucks = total amount of material/20 cubic yards per truck

Amount of demoltion debris =	0	cubic yards	No Demolition in the Proposed Action
Amount of cement transported from port to CCSC =	4,004	cubic yards	
Amount of concrete transported from CCSC to project site =	64,780	cubic yards	
Amount of Excavation Materials for New Structures/Buildings =	399,483	cubic yards	Construction area multiped by depth of disturbance which is assumed to be 12 feet.
Amount of Building/Structure Materials =	299,612	cubic yards	Construction area multipled by 9 feet.

Number of dump trucks required (port to CCSC) =	364	heavy duty diesel haul truck trips, Cells rounded up
Number of concrete mixing trucks required (CCSC to project site) =	6478	heavy duty diesel haul truck trips, Cells rounded up
Number of trucks required (Building Materials) =	34,955	heavy duty diesel haul truck trips
Miles per trip (port to CCSC) =	3.4	miles
Miles per trip (CCSC to project site) =	4.6	miles
Miles per trip (Building Materials) =	40.0	miles

Low Altitude Heavy Duty Diesel Vehicle 8b (HDDV8b) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV8b	**6.23**	**0.58**	**3.33**	**0.02**	**0.20**	**0.19**	**1615**

Notes:
Emission factors for all pollutants are from Appendix A - On-Raod Vehicle Emission Factors within AFCEE Air Emissions Factor Guide to Air Force Mobile Sources, Dec. 2009.
Emission factors from calendar year 2015 were used assuming the average vehicle model year is 2005.

HDDV8b Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**19,629.80**	**1,827.49**	**10,492.33**	**63.02**	**630.17**	**598.66**	**5,089,253.54**
tons	**9.81**	**0.91**	**5.25**	**0.03**	**0.32**	**0.30**	**2,544.63**

Example Calculation: NO_x emissions (lbs) = 40 miles per trip * 34,955 trips * NO_x emission factor (g/mile) * lb/453.6 g

DATA - Fuel Storage Tank Emissions for Modified Alternative 2a - Implementation Phase (Tinian North)

Fuel storage tank emissions were estimated using the U.S. EPA TANKS storage tank emissions calculation software (Version 4.0.9d). The emissions calculations algorithms in the TANKS program are based on Chapter 7 of EPA's AP-42. Honolulu, Hawaii was used as a surrogate location for the tanks as meteorological data does not exist in TANKS for CNMI. Jet Kerosene fuel was used as the surrogate for JP-8 in the TANKS model as it is the closet in characteristics to JP-8.

Emission Calculations Summary from TANKS*

Tank Type	Throughput (gal.)	Working Loss (lbs)	Breathing Loss (lbs)	VOC Total (lbs)	VOC Total (tons)
Tank 1 (Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 2 (Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 3 (Airport) - 60,000 bbl, cut and cover or AST	4,581,818	210.07	714.88	924.95	0.46
Tank 4 (Airport) - 60,000 bbl, cut and cover or AST	4,581,818	210.07	714.88	924.95	0.46
Tank 5 (Airport) - 100,000 bbl, cut and cover or AST	7,636,364	350.11	1172.01	1522.12	0.76
Total		**1,627.09**	**3,076.89**	**4,703.98**	**2.35**

*See the following references for TANKS printouts. (SM12 - TANKS) & (SM13 - TANKS)

Summary	Summarizes total emissions by calendar year for Modified Alternative 2a - Implementation Phase (Tinian North).
Airfield Operations	Aircraft operations consist of taxi, take-off and landings (sorties or LTOs), touch-and-go operations (TGOs), and low flybys (LFB) by base aircraft.
Fuel Truck and Commuter Vehicle Emissions	Estimates emissions for workers and operational vehicles commuting to the site of the Proposed Action.
Fuel Transfer Emissions	Fuel loading operations under the Proposed Action involves the loading of fuel into tanker trucks and aircraft.
Internal Combustion Engine (ICE) Emissions	Estimates Emissions from Internal Combustion Engines (e.g Generators)
Fuel Storage Tanks	Estimates emissions from Above Ground Storage Tanks.

Criteria Pollutant and VOC Emissions Summary for Modified Alternative 2a - Implementation Phase (Tinian North) (tons/year)

Source Category	PM10	PM2.5	CO	NOx	SOx	VOCs
Airfield Operations	0.05	0.05	18.67	6.77	0.98	1.25
Fuel Truck and Commuter Vehicle Emissions	0.02	0.02	0.28	0.54	0.00	0.05
Fuel Transfer	N/A	N/A	N/A	N/A	N/A	0.34
Fuel Storage Tanks	N/A	N/A	N/A	N/A	N/A	2.35
Total Criteria and VOC Pollutant Emissions (tons/year)	**0.08**	**0.07**	**18.95**	**7.31**	**0.98**	**3.98**

Greenhouse Gas (GHG) Emissions Summary for Modified Alternative 2a - Implementation Phase (Tinian North) (metric tonnes/year)

Source Category	CO_2-equivalent (lb/year)	CO_2-equivalent (kg/year)	CO_2-equivalent (metric tonne/year)
Airfield Operations*	366,634,444	166,305,384	166,305
Fuel Truck and Commuter Vehicle Emissions	292,969	132,891	133
Fuel Transfer	0	0	0
Fuel Storage Tanks	0	0	0
Total GHG Emissions	**366,927,413**	**166,438,275**	**166,438**

DATA - Airfield Operations for Modified Alternative 2a - Implementation Phase (Tinian North)

Aircraft exercises under this alternative are based on assuming 2 to 4 KC-135R aircraft operating up to 8 weeks per year for a maximum of 720 KC-135R operations per year. Each operation is equivalent to one landing or one take-off (1 LTO Cycle = 2 operations).

Landing and Takeoff (LTO) Cycles

Description	Quantity
# of KC-135R LTO's per year	360

Legend

Airfield Activity Data (Worst Case Scenario)

Aircraft Model	Aircraft Model Used to Match to Available Emission Factors	Engine Model	# Engines	APU Model	# APUs	Notes	LTO Cycles
KC-135R	KC-135-R	F108-CF-201	4	No data on APUs		See below	360
Note: F108-CF-201 is the military designation of the CFM56-2B-1 engine.							

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 2a - Implementation Phase (Tinian North)

Aircraft Criteria Pollutant Emission Factors

						Emission Factors in lb Pollutant per 1000 lb Fuel Burned						
Aircraft Model	Engine Model	# Eng.	Reference Thrust Mode	LTO/TGO Thrust Mode	Fuel Flow (lb/hr)	PM10	PM2.5	CO	NO_X	SO_2	VOCs	TIM
KC-135R	F108-CF-201	4	Idle	Idle	1016	0.06	0.06	30.70	4.00	1.06	2.10	47.7
KC-135R	F108-CF-201	4	Approach	Approach	2468	0.06	0.05	4.20	8.20	1.06	0.09	5.2
KC-135R	F108-CF-201	4	Climbout	Climbout	6500	0.05	0.05	0.90	16.00	1.06	0.06	1.6
KC-135R	F108-CF-201	4	Takeoff	Takeoff	7818	0.07	0.06	0.90	18.05	1.06	0.05	0.7

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-8

APU Emission Factors

			APU Emission Factors in lb Pollutant per hour						
Aircraft Model	# APU	APU Model	PM10	PM2.5	CO	NO_X	$S0_2$	VOCs	APU (hr)
KC-135R	No Data Available.								

Emission Factors (EFs) and Constants - Airfield Operations forModified Alternative 2a - Implementation Phase (Tinian North)

Default Time-In-Mode

	Typical Duration by Mode (minutes)					
Aircraft Type	Taxi/Idle-	Takeoff	Climbout	Approach	Taxi/Idle-in	Total
KC-135R	32.8	0.7	1.6	5.2	14.9	55.2

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-4

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 2a - Implementation Phase (Tinian North)

Greenhouse Gas Emission Factors

Units	CO_2	CH_4	N_2O
kg/gal fuel	9.80	---	---
g/gal fuel	---	0.27	0.31

Reference: Footnote 2. from Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 2a - Implementation Phase (Tinian North)
Criteria Pollutant and VOC Emissions per LTO by Aircraft Type
Calculated as the sum of the products of [(minutes) * (fuel flow/minute) * (lbs pollutant/lb fuel)] for each of the thrust modes.

			Emission in lb Pollutant per LTO						
Reported Aircraft Model	APU	Fuel (lb)	PM10 (lb)	PM2.5 (lb)	CO (lb)	NOx (lb)	SOx (lb)	VOCs (lb)	APU
KC - 135R	0	5144.6	0.3	0.3	103.7	37.6	5.5	6.9	0

Total Criteria Pollutant and VOC Emissions for maximum LTO's by Aircraft Type

Reported Aircraft Model	APU	Total LTO's	Fuel (lb)	PM10 (tons)	PM2.5 (tons)	CO (tons)	NOx (tons)	SOx (tons)	VOCs (tons)	APU
KC - 135R	0	360	1,852,065.6	0.05	0.05	18.67	6.77	0.98	1.25	0
Worst Case Scenario			**1,852,065.60**	**0.05**	**0.05**	**18.67**	**6.77**	**0.98**	**1.25**	0

Total gallons of fuel used for LTOs (277,671 gal.) is based on the 6.67 lb/gal density of JP-8 as provided in footnote 2. of Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 2a - Implementation Phase (Tinian North)

Greenhouse Gas Emissions
Assume aircraft will use 300,000 gallons of fuel per day for 56 days.

Quantity (gallons)	Fuel Type	CH_4 (kg)	N_2O (kg)	CO_2 (kg)	CO_2-equivalent (kg)	CO_2-equivalent (metric tonne)
16,800,000	JP-8	4536	5208	164,640,000	166,305,384	166,305

The CH_4 and N_2O Global Warming Potential multipliers are 25 and 298, respectively from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014.

DATA - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 2a - Implementation Phase (Tinian North)

Given: Six 10,000 gal Fuel Trucks will take 30 days at 10hrs/day to provide initial fill from Tinian seaport to Tinian Airport (Site of Proposed Action). The six 10,000 gallon Fuel trucks will operate 10hrs/day for the duration of the exercises. The total exercise time is 8 weeks (56 days), therefore the fuel trucks will operate an additional 26 days after the initial fill.

Under the commercial lodging option six busses will transport a total of 256 personnel 4 roundtrips/day for a total of 24 roundtrips/day for 8 weeks.

Assumptions: A Gross Vehicle Weight (GVW) of 36,200 lbs will be used, based off of an 84 passenger Blue Bird bus.

Assume fuel truck GVW > 60,000 lbs since fuel load alone is 83,400 lbs.

Assume fuel trucks travel at 55 miles per hour

Assume 40 miles per roundtrip for busses.

Vehicle Weight Classes for Which Emission Factors are Published

Vehicle Category	Description	SCC
LDGV	Light-Duty Gasoline Vehicles (i.e., passenger cars) does not include SUVs, vans or pickups	A2201001000
LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs GVW - includes pickup trucks, sport utility vehicles and vans)	A2201020000
LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVW - includes pickup trucks, sport utility vehicles and vans)	A2201040000
HDGV2B	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs GVW)	A2201070000
HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs GVW)	A2201070000
HDGV8A	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs GVW)	A2201070000
LDDV	Light-Duty Diesel Vehicles (Passenger Cars)	
LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs GVW)	A2230002000
HDDV2B	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs GVW – includes pickup trucks)	A2230070000
HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs GVW)	A2230070000
HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	A2230070000
HDDV8B	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	A2230070000
MC	Motorcycles	A2201080000

Emission Factors - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 2a - Implementation Phase (Tinian North)

Emission Factors for Calendar Year 2015

Vehicle Class	Model Year	Emission Factors in grams per Mile[a]								
		PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs	CO2	Fugitive PM_{10}	Fugitive $PM_{2.5}$
HDDV8A*	2005	0.2	0.19	2.8	5.47	0.01	0.48	1544.1	0.05	0.01
HDDV8B**	2005	0.2	0.19	3.33	6.23	0.02	0.58	1615.2	0.05	0.01

* Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8a

**Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8b

a) Emission factors from Appendix A of Air Emissions Factor Guide to Air Force Mobile Sources, AFCEE, December 2009

Greenhouse Gas Emission Factors for Calendar Year 2015

Vehicle Class	CH_4 (g/mile)	N_2O (g/mile)
HDDV	0.0051	0.0048

g/mile = grams per mile

CH_4 = Methane; N_2O = Nitrous Oxide

b) Emission Factors from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf).

Emission Calculations - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 2a - Implementation Phase (Tinian North)

Miles for Commuter Emissions for 8 week training exercises

Vehicle Class	Speed Miles/hour	Miles/Trip	Total Trips/Day	Hours/Day	Total Days	Total Miles
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)		40	24		56	53,760
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	55			10	56	30,800

Criteria and VOC Emissions for Commuters

Vehicle Class	Model Year	Annual Miles	Criteria Pollutant Emissions (tons/year)					
			PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	2005	53,760	0.015	0.012	0.166	0.324	0.001	0.028
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	2005	30,800	0.008	0.007	0.113	0.212	0.001	0.020
Total			**0.023**	**0.019**	**0.279**	**0.536**	**0.001**	**0.048**

Particulate emissions include exhaust, brake wear, tire wear. Assume paved road.

Greenhouse Gas Emissions for Commuters

Vehicle Class	Annual Miles	CO_2 (lb/year)	CH_4 (lb/year)	N_2O (lb/year)	CH_4 GWP Multiplier	N_2O GWP Multiplier	CO_2 Equivalent (lb/year)	CO_2 Equivalent (metric tonnes/year)
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	53,760	183,004.44	0.60	0.57	25	298	183,189.08	83.09
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	30,800	109,674.07	0.35	0.33	25	298	109,779.86	49.80
Total		**292,678.52**	**0.95**	**0.89**	---	---	**292,968.94**	**132.89**

GWP = Global Warming Potential; 100-year GWP values obtained from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf)

Emission Calculations Method - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 2a - Implementation Phase (Tinian North)

Calculation Method: Equation 4-1 , AFCEE 2009, Mobile Emissions Guide

EP = VMTVehCat * EFPolVehCat * 0.002205

Where,
EP = Emissions of each individual pollutant (lb/yr)
VMTVehCat = Annual vehicle miles traveled by each vehicle category (LDGV, LDGT1, LDDV, etc.) (mi/yr)
EFPolVehCat = Emission factor of each pollutant for each vehicle category (g/mi)
0.002205 = Factor for converting grams to pounds (g/lb).

DATA - Fuel Loading Emissions for Modified Alternative 2a - Implementation Phase (Tinian North)

Given:

Total Exercise Days (8 weeks)	56
Initial Fuel Fill Days	30
Remaining Fuel Fill Days	26
Total # of Fuel Trucks	6
Total Gallons per Fuel Truck	10,000
Trips per day per Fuel Truck	5
1 bbl conversion to gallons	42
Total Fuel (gal) during Initial Fill	9,000,000
Total Fuel (gal) during Remaining Exercise	7,800,000
Total Fuel (gal) during Exercise (8 Weeks)	16,800,000

Proposed Action Fuel Loading Operations

Location	Description	Fuel Type	Fuel Transferred (gal)	Category
Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	Loading
Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	Loading
Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	Loading

Emission Factors - Fuel Loading Emissions for Modified Alternative 2a - Implementation Phase (Tinian North)

JP-8 emission factors (lb/Mgal)	Dispensing Splash	Loading Bottom fill	
Molecular Weight =	130		AP-42 Table 7.1-2 dated 11/06
True Vapor Pressure (psia) =	0.011		AP-42 Table 7.1-2 dated 11/06 @ 70F (annual avg.)
Dispensing Displacement losses =	0.0487	0.020	AP-42 Section 5.2 dated 6/08 Equation (1)
Spillage =	0.7		AP-42 Table 5.2-7 dated 6/08
Total =	0.749		

Emission Calculations - Fuel Loading Emissions for Modified Alternative 2a - Implementation Phase (Tinian North)

Location	Description	Fuel Type	Fuel Transferred (gal)	Displaced Vapor (lb)	Spillage (lb)	Total VOC (lb)	Total VOC (tons)
Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	338.9	0	338.9	0.169
Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.085
Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.085
Total			**33,600,000**	**678**	**0**	**677.75**	**0.34**

Emission Calculations Method - Fuel Loading Emissions for Modified Alternative 2a - Implementation Phase (Tinian North)

Displacement emissions for Diesel and JP-8 were estimated using Equation (1) from AP-42 Section 5.2, Transportation and Marketing of Petroleum Liquids, dated 6/08

$$L_L = 12.46\ (SPM)/T$$

Where

L_L = Loading loss in lb/10^3 gal

S = Saturation Factor 1.45 for splash loading, 0.6 for bottom loading

M = molecular weight,

T = temperature of bulk liquid (assume average annual ambient temperature)

Summary	Summarizes total emissions by calendar year for Modified Alternative 2B - Construction Phase (Tinian South).
Combustion	Estimates emissions from non-road equipment exhaust.
Fugitive	Estimates particulate emissions from construction activities including earthmoving, vehicle traffic, and windblown dust.
Grading	Estimates the number of days of site preparation, to be used for estimating heavy equipment exhaust and earthmoving dust emissions.
Construction Commuter	Estimates emissions for construction workers commuting to the site.
Haul Truck On-Road	Estimates emissions from hauling construction materials to the project site.

Summary of Air Quality Emissions from Divert EIS - Modified Alternative 2B - Construction Phase (Tinian South)

	NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Construction Combustion	13.236	1.755	5.702	0.827	0.912	0.885	1,535.230
Construction Fugitive Dust	-	-	-	-	95.708	8.371	-
Construction Commuter	5.778	6.370	58.954	0.1028	0.889	0.577	10,578.512
Haul Truck On-Road	9.929	0.924	5.307	0.032	0.319	0.303	2,574.326
TOTAL	***28.94***	***9.05***	***69.96***	***0.96***	***97.83***	***10.14***	***14,688.07***

Annual Summary of Air Quality Emissions from Divert EIS - Modified Alternative 2B - Construction Phase (Tinian South)*

	Point and Area Sources Combined						
	NO_x (tpy)	VOC (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CO_2 (metric tons)
CY 01	9.65	3.02	23.32	0.32	32.61	3.38	4,441.60
CY 02	9.65	3.02	23.32	0.32	32.61	3.38	4,441.60
CY 03	9.65	3.02	23.32	0.32	32.61	3.38	4,441.60

* Construction duration is estimated to be 36 months and the emissions are assumed to be distributed evenly over the construction period.

Combustion Emissions - Modified Alternative 2B - Construction Phase (Tinian South)
Combustion Emissions of VOC, NO_x, SO_2, CO, $PM_{2.5}$, PM_{10}, and CO_2 due to Construction

Assumptions
When multiple options exist under the general construction activites the most conservative value will be used to quantify air emissions.

General Construction Activities	**Area Disturbed (ft^2)**
Construct New Access Roads	177,294 ft^2
Construct Maintenance Facility	7,972 ft^2
Construct Jet Fuel System and Fire Pump System (Operational, Bulk and at the Port of Tinian)	908,933 ft^2
Construct Hazardous Cargo Pad	230,165 ft^2
Construct Parking Apron	832,128 ft^2

Total General Construction Area:	916,905	ft^2	
	21.0	acres	
Total Demolition Area:	0	ft^2	
	0.0	acres	
Total Pavement Area:	1,239,587	ft^2	
	28.5	acres	
Total Disturbed Area:	2,156,492	ft^2	
	49.5	acres	
Construction Duration:	36	months	
1 Yr Project Construction Activity:	240	days/yr	Assume 12 months, 4 weeks per month, 5 days per week.

Emission Factors Used for Construction Equipment

References: Guide to Air Quality Assessment, SMAQMD, 2004; and U.S. EPA NONROAD Emissions Model, Version 2005.0.0
Emission factors are taken from the NONROAD model and were provided to e²M by Larry Landman of the Air Quality and Modeling Center (Landman.Larry@epamail.epa.gov) on 12/14/07. Factors provided are for the weighted average US fleet for CY2007.
Assumptions regarding the type and number of equipment are from SMAQMD Table 3-1 unless otherwise noted.

Grading

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Bulldozer	1	13.60	0.96	5.50	1.02	0.89	0.87	1456.90
Motor Grader	1	9.69	0.73	3.20	0.80	0.66	0.64	1141.65
Water Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	3	41.64	2.58	15.71	0.83	2.55	2.47	4941.53

Paving

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Paver	1	3.83	0.37	2.06	0.28	0.35	0.34	401.93
Roller	1	4.82	0.44	2.51	0.37	0.43	0.42	536.07
Truck	2	36.71	1.79	14.01	3.27	1.99	1.93	4685.95
Total per 10 acres of activity	4	45.37	2.61	18.58	0.91	2.78	2.69	5623.96

Demolition

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Loader	1	13.45	0.99	5.58	0.95	0.93	0.90	1360.10
Haul Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	2	31.81	1.89	12.58	0.64	1.92	1.87	3703.07

Building Construction

Equipment[d]	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Stationary								
Generator Set	1	2.38	0.32	1.18	0.15	0.23	0.22	213.06
Industrial Saw	1	2.62	0.32	1.97	0.20	0.32	0.31	291.92
Welder	1	1.12	0.38	1.50	0.08	0.23	0.22	112.39
Mobile (non-road)								
Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Forklift	1	5.34	0.56	3.33	0.40	0.55	0.54	572.24
Crane	1	9.57	0.66	2.39	0.65	0.50	0.49	931.93
Total per 10 acres of activity	6	39.40	3.13	17.38	3.12	2.83	2.74	4464.51

Architectural Coatings

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c]	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Air Compressor	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77
Total per 10 acres of activity	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77

a) The SMAQMD 2004 guidance suggests a default equipment fleet for each activity, assuming 10 acres of that activity, (e.g., 10 acres of grading, 10 acres of paving, etc.). The default equipment fleet is increased for each 10 acre increment in the size of the construction project. That is, a 26 acre project would round to 30 acres and the fleet size would be three times the default fleet for a 10 acre project.
b) The SMAQMD 2004 reference lists emission factors for reactive organic gas (ROG). For the purposes of this worksheet ROG = VOC. The NONROAD model contains emissions factors for total HC and for VOC. The factors used here are the VOC factors.
c) The NONROAD emission factors assume that the average fuel burned in nonroad trucks is 1100 ppm sulfur. Trucks that would be used for the Proposed Actions will all be fueled by highway grade diesel fuel which cannot exceed 500 ppm sulfur. These estimates therefore over-estimate SO2 emissions by more than a factor of two.
d) Typical equipment fleet for building construction was not itemized in SMAQMD 2004 guidance. The equipment list above was assumed based on SMAQMD 1994 guidance.

PROJECT-SPECIFIC EMISSION FACTOR SUMMARY

Source	Equipment Multiplier*	Project-Specific Emission Factors (lb/day)						
		NO_x	VOC	CO	SO_2**	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	5	208.206	12.885	78.549	4.164	12.728	12.346	24707.632
Paving Equipment	3	136.102	7.817	55.735	2.722	8.328	8.078	16871.871
Demolition Equipment	1	31.808	1.886	12.584	0.636	1.923	1.865	3703.074
Building Construction	2	78.793	6.260	34.765	6.233	5.658	5.488	8929.023
Air Compressor for Architectural Coating	2	7.148	0.746	3.131	0.502	0.619	0.600	719.547
Architectural Coating**			78.040					

*The equipment multiplier is an integer that represents units of 10 acres for purposes of estimating the number of equipment required for the project.
**Emission factor is from the evaporation of solvents during painting, per "Air Quality Thresholds of Significance", SMAQMD, 1994
Example: SMAQMD Emission Factor for Grading Equipment NOx = (Total Grading NOx per 10 acre)*(Equipment Multiplier)

Summary of Input Parameters

	Total Area (ft^2)	Total Area (acres)	Total Days	
Grading:	2,156,492	49.51	6	(from "Grading" worksheet)
Paving:	1,239,587	28.46	45	
Demolition:	0	0.00	0	
Building Construction:	916,905	21.05	240	
Architectural Coating	916,905	21.05	20	(per SMAQMD "Air Quality of Thresholds of Significance", 1994)

NOTE: The 'Total Days' estimate for paving is calculated by dividing the total number of acres by 0.21 acres/day, which is a factor derived from the 2005 MEANS Heavy Construction Cost Data, 19th Edition, for 'Asphaltic Concrete Pavement, Lots and Driveways - 6" stone base', which provides an estimate of square feet paved per day. There is also an estimate for 'Plain Cement Concrete Pavement', however the estimate for asphalt is used because it is more conservative. The 'Total Days' estimate for demolition is calculated by dividing the total number of acres by 0.02 acres/day, which is a factor also derived from the 2005 MEANS reference. This is calculated by averaging the demolition estimates from 'Building Demolition - Small Buildings, Concrete', assuming a height of 30 feet for a two-story building; from 'Building Footings and Foundations Demolition - 6" Thick, Plain Concrete'; and from 'Demolish, Remove Pavement and Curb - Concrete to 6" thick, rod reinforced'. Paving is double-weighted since projects typically involve more paving demolition. The 'Total Days' estimate for building construction is assumed to be 230 days, unless project-specific data is known.

Total Project Emissions by Activity (lbs)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	1,249.24	77.31	471.30	24.98	76.37	74.07	148,246
Paving	6,169.95	354.38	2,526.67	123.40	377.55	366.22	764,858
Demolition	-	-	-	-	-	-	0
Building Construction	18,910.23	1,502.31	8,343.51	1,495.85	1,357.94	1,317.20	2,142,966
Architectural Coatings	142.96	1,575.74	62.62	10.05	12.37	12.00	14,391
Total Emissions (lbs):	**26,472.38**	**3,509.73**	**11,404.09**	**1,654.28**	**1,824.23**	**1,769.50**	**3,070,460**

Results: Total Project Annual Emission Rates

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Total Project Emissions (lbs)	26,472.38	3,509.73	11,404.09	1,654.28	1,824.23	1,769.50	3,070,460
Total Project Emissions (tons)	13.24	1.75	5.70	0.83	0.91	0.88	1,535.23

Construction Fugitive Dust Emissions - Proposed Action [Modified Alternative 2B - Construction Phase (Tinian South)]

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
General Construction Activities	0.19	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.42	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006

$PM_{2.5}$ Emissions

$PM_{2.5}$ Multiplier	0.10	(10% of PM_{10} emissions assumed to be $PM_{2.5}$)	EPA 2001; EPA 2006
Control Efficiency	0.50	(assume 50% control efficiency for PM_{10} and $PM_{2.5}$ emissions)	EPA 2001; EPA 2006

Project Assumptions

New Roadway Construction (0.42 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	28.5	acres

General Construction Activities (0.19 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	21.0	acres

	Project Emissions (tons/year)			
	PM_{10} uncontrolled	**PM_{10} controlled**	**$PM_{2.5}$ uncontrolled**	**$PM_{2.5}$ controlled**
New Roadway Construction	143.42	71.71	14.34	7.17
General Construction Activities	47.99	24.00	2.40	1.20
Total	**191.42**	**95.71**	**16.74**	**8.37**

General Construction Activities Emission Factor

0.19 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM_{10}/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM_{10}/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions From Construction Operations, calculated the 0.19 ton PM_{10}/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM_{10}/acre-month) and 75% of the average emission factor (0.11 ton PM_{10}/acre-month). The 0.19 ton PM_{10}/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM_{10}/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particulate (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District as well as the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas.

New Road Construction Emission Factor

0.42 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM_{10}/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

$PM_{2.5}$ Multiplier **0.10**

$PM_{2.5}$ emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM_{10} and $PM_{2.5}$ **0.50**

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas (EPA 2006). Wetting controls will be applied during project construction.

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Grading Schedule - Proposed Action [Modified Alternative 2B - Construction Phase (Tinian South)]

Estimate of time required to grade a specified area.

Input Parameters
Construction area: 49.5 acres/yr (from Combustion Worksheet)
Qty Equipment: 15.0 (calculated based on 3 pieces of equipment for every 10 acres)

Assumptions.
Terrain is mostly flat.
An average of 6" soil is excavated from one half of the site and backfilled to the other half of the site; no soil is hauled off-site or borrowed.
200 hp bulldozers are used for site clearing.
300 hp bulldozers are used for stripping, excavation, and backfill.
Vibratory drum rollers are used for compacting.
Stripping, Excavation, Backfill and Compaction require an average of two passes each.
Excavation and Backfill are assumed to involve only half of the site.

Calculation of days required for one piece of equipment to grade the specified area.

Reference: Means Heavy Construction Cost Data, 19th Ed., R. S. Means, 2005.

Means Line No.	Operation	Description	Output	Units	Acres per equip-day	equip-days per acre	Acres/yr (project-specific)	Equip-days per year
2230 200 0550	Site Clearing	Dozer & rake, medium brush	8	acre/day	8	0.13	49.51	6.19
2230 500 0300	Stripping	Topsoil & stockpiling, adverse soil	1,650	cu. yd/day	2.05	0.49	49.51	24.20
2315 432 5220	Excavation	Bulk, open site, common earth, 150' haul	800	cu. yd/day	0.99	1.01	24.75	24.96
2315 120 5220	Backfill	Structural, common earth, 150' haul	1,950	cu. yd/day	2.42	0.41	24.75	10.24
2315 310 5020	Compaction	Vibrating roller, 6 " lifts, 3 passes	2,300	cu. yd/day	2.85	0.35	49.51	17.36
TOTAL								82.95

Calculation of days required for the indicated pieces of equipment to grade the designated acreage.

(Equip)(day)/yr: 82.95
Qty Equipment: 15.00
Grading days/yr: 5.53

Construction/Staff Commuter Emissions - Modified Alternative 2B - Construction Phase (Tinian South)

Emissions from construction workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road).

Assumptions:
Passenger vehicle emission factors for scenario year 2015 are used.

The average roundtrip commute for a construction/staff worker =	40	miles
Number of construction days =	240	days
Number of construction/Staff workers (daily) =	2000	people

Note: None

Passenger Vehicle Emission Factors for Year 2015 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00060188	0.00066355	0.00614108	0.00001070	0.00009259	0.00006015	1.10192837

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Available online: <http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road)>. Accessed 18 August 2015.
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Construction Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**11,556.034**	**12,740.118**	**117,908.683**	**205.519**	**1,777.691**	**1,154.873**	**21,157,024.793**
tons	**5.778**	**6.370**	**58.954**	**0.103**	**0.889**	**0.577**	**10,578.512**

Example Calculation: NO_x emissions (lbs) = 60 miles/day * NO_x emission factor (lb/mile) * number of construction days * number of workers

No Statistical Area Available for TNI

				Point Source Emissions						Area Source Emissions (Non-Point and Mobile Sources)					
Row #	State	County	Tier-1	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
No Data Available															
Grand Total				0	0	0	0	0	0	0	0	0	0	0	0

SOURCE:

http://www.epa.gov/ttn/chief/eiinformation.html

USEPA - AirData NET Tier Report

*Net Air pollution sources (area and point) in tons per year (2002)

Site visited on 02 February 2012.

No Air Quality Control Region Identified

	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
CNMI	0	0	0	0	0	0
CNMI DEQ	0	0	0	0	0	0

Construction/Haul Truck Emissions - Modified Alternative 2B - Construction Phase (Tinian South)

Emissions from hauling construction supplies, demoliton debris, fill, and excavated material are estimated in this spreadsheet.

Emission Estimation Method: United States Air Force (USAF) Institute for Environment, Safety and Occupational Health Risk Analysis (IERA) Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations (Revised December 2003).

Concrete Mixing and Dump Truck Assumptions:
Dump trucks carry 11 cubic yards of material per trip.
Concrete mixing trucks carry 10 cubic yards of material per trip.
The average distance from the port to Commercial Concrete Supply Company is 1.7 miles; therefore, dump trucks will travel 3.4 miles round trip.
The average distance from the Commercial Concrete Supply Company (CCSC) to the project site is 2.3 miles; therefore, concrete trucks will travel 4.6 miles round trip.

Fill Materials Assumptions:
Haul trucks carry 20 cubic yards of material per trip.
The average distance from the project site to the materials source is 20 miles; therefore, building material haul trucks will travel 40 miles round trip.
Estimated number of trips required by haul trucks = total amount of material/20 cubic yards per truck

Amount of demoltion debris =	0	cubic yards	No Demolition in the Proposed Action
Amount of cement transported from port to CCSC =	2,530	cubic yards	
Amount of concrete transported from CCSC to project site =	40,930	cubic yards	
Amount of Excavation Materials for New Structures/Buildings =	407,513	cubic yards	Construction area multiped by depth of disturbance which is assumed to be 12 feet.
Amount of Building/Structure Materials =	305,635	cubic yards	Construction area multipled by 9 feet.

Number of dump trucks required (port to CCSC) =	230	heavy duty diesel haul truck trips, Cells rounded up
Number of concrete mixing trucks required (CCSC to project site) =	4093	heavy duty diesel haul truck trips, Cells rounded up
Number of trucks required (Building Materials) =	35,657	heavy duty diesel haul truck trips
Miles per trip (port to CCSC) =	3.4	miles
Miles per trip (CCSC to project site) =	4.6	miles
Miles per trip (Building Materials) =	40.0	miles

Low Altitude Heavy Duty Diesel Vehicle 8b (HDDV8b) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV8b	**6.23**	**0.58**	**3.33**	**0.02**	**0.20**	**0.19**	**1615**

Notes:
Emission factors for all pollutants are from Appendix A - On-Raod Vehicle Emission Factors within AFCEE Air Emissions Factor Guide to Air Force Mobile Sources, Dec. 2009.
Emission factors from calendar year 2015 were used assuming the average vehicle model year is 2005.

HDDV8b Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**19,858.90**	**1,848.82**	**10,614.79**	**63.75**	**637.52**	**605.65**	**5,148,651.07**
tons	**9.93**	**0.92**	**5.31**	**0.03**	**0.32**	**0.30**	**2,574.33**

Example Calculation: NO_x emissions (lbs) = 40 miles per trip * 35,657 trips * NO_x emission factor (g/mile) * lb/453.6 g

Summary	Summarizes total emissions by calendar year for Modified Alternative 2b - Implementation Phase (Tinian South).
Airfield Operations	Aircraft operations consist of taxi, take-off and landings (sorties or LTOs), touch-and-go operations (TGOs), and low flybys (LFB) by base aircraft.
Fuel Truck and Commuter Vehicle Emissions	Estimates emissions for workers and operational vehicles commuting to the site of the Proposed Action.
Fuel Transfer Emissions	Fuel loading operations under the Proposed Action involves the loading of fuel into tanker trucks and aircraft.
Internal Combustion Engine (ICE) Emissions	Estimates Emissions from Internal Combustion Engines (e.g Generators)
Fuel Storage Tanks	Estimates emissions from Above Ground Storage Tanks.

Criteria Pollutant and VOC Emissions Summary for Modified Alternative 2b - Implementation Phase (Tinian South) (tons/year)

Source Category	PM10	PM2.5	CO	NOx	SOx	VOCs
Airfield Operations	0.05	0.05	18.67	6.77	0.98	1.25
Fuel Truck and Commuter Vehicle Emissions	0.02	0.02	0.28	0.54	0.00	0.05
Fuel Transfer	N/A	N/A	N/A	N/A	N/A	0.34
Fuel Storage Tanks	N/A	N/A	N/A	N/A	N/A	2.35
Total Criteria and VOC Pollutant Emissions (tons/year)	**0.08**	**0.07**	**18.95**	**7.31**	**0.98**	**3.98**

Greenhouse Gas (GHG) Emissions Summary for Modified Alternative 2b - Implementation Phase (Tinian South) (metric tonnes/year)

Source Category	CO_2-equivalent (lb/year)	CO_2-equivalent (kg/year)	CO_2-equivalent (metric tonne/year)
Airfield Operations*	366,634,444	166,305,384	166,305
Fuel Truck and Commuter Vehicle Emissions	292,969	132,891	133
Fuel Transfer	0	0	0
Fuel Storage Tanks	0	0	0
Total GHG Emissions	**366,927,413**	**166,438,275**	**166,438**

DATA - Airfield Operations for Modified Alternative 2b - Implementation Phase (Tinian South)

Aircraft exercises under this alternative are based on assuming 2 to 4 KC-135R aircraft operating up to 8 weeks per year for a maximum of 720 KC-135R operations per year. Each operation is equivalent to one landing or one take-off (1 LTO cycle = 2 operations).

Landing and Takeoff (LTO) Cycles

Description	Quantity
# of KC-135R LTO's per year	360

Legend

Airfield Activity Data (Worst Case Scenario)

Aircraft Model	Aircraft Model Used to Match to Available Emission Factors	Engine Model	# Engines	APU Model	# APUs	Notes	LTO Cycles
KC-135R	KC-135-R	F108-CF-201	4	No data on APUs		See below	360
Note: F108-CF-201 is the military designation of the CFM56-2B-1 engine.							

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 2b - Implementation Phase (Tinian South)

Aircraft Criteria Pollutant Emission Factors

						Emission Factors in lb Pollutant per 1000 lb Fuel Burned						
Aircraft Model	Engine Model	# Eng.	Reference Thrust Mode	LTO/TGO Thrust Mode	Fuel Flow (lb/hr)	PM10	PM2.5	CO	NO_X	SO_2	VOCs	TIM
KC-135R	F108-CF-201	4	Idle	Idle	1016	0.06	0.06	30.70	4.00	1.06	2.10	47.7
KC-135R	F108-CF-201	4	Approach	Approach	2468	0.06	0.05	4.20	8.20	1.06	0.09	5.2
KC-135R	F108-CF-201	4	Climbout	Climbout	6500	0.05	0.05	0.90	16.00	1.06	0.06	1.6
KC-135R	F108-CF-201	4	Takeoff	Takeoff	7818	0.07	0.06	0.90	18.05	1.06	0.05	0.7

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-8

APU Emission Factors

			APU Emission Factors in lb Pollutant per hour						
Aircraft Model	# APU	APU Model	PM10	PM2.5	CO	NO_X	$S0_2$	VOCs	APU (hr)
KC-135R	No Data Available.								

Emission Factors (EFs) and Constants - Airfield Operations forModified Alternative 2b - Implementation Phase (Tinian South)

Default Time-In-Mode

	Typical Duration by Mode (minutes)					
Aircraft Type	Taxi/Idle-	Takeoff	Climbout	Approach	Taxi/Idle-in	Total
KC-135R	32.8	0.7	1.6	5.2	14.9	55.2

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-4

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 2b - Implementation Phase (Tinian South)

Greenhouse Gas Emission Factors

Units	CO_2	CH_4	N_2O
kg/gal fuel	9.80	---	---
g/gal fuel	---	0.27	0.31

Reference: Footnote 2. from Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 2a - Implementation Phase (Tinian North)
Criteria Pollutant and VOC Emissions per LTO by Aircraft Type
Calculated as the sum of the products of [(minutes) * (fuel flow/minute) * (lbs pollutant/lb fuel)] for each of the thrust modes.

			Emission in lb Pollutant per LTO						
Reported Aircraft Model	APU	Fuel (lb)	PM10 (lb)	PM2.5 (lb)	CO (lb)	NOx (lb)	SOx (lb)	VOCs (lb)	APU
KC - 135R	0	5144.6	0.3	0.3	103.7	37.6	5.5	6.9	0

Total Criteria Pollutant and VOC Emissions for maximum LTO's by Aircraft Type

Reported Aircraft Model	APU	Total LTO's	Fuel (lb)	PM10 (tons)	PM2.5 (tons)	CO (tons)	NOx (tons)	SOx (tons)	VOCs (tons)	APU
KC - 135R	0	360	1,852,065.6	0.05	0.05	18.67	6.77	0.98	1.25	0
Worst Case Scenario			**1,852,065.60**	**0.05**	**0.05**	**18.67**	**6.77**	**0.98**	**1.25**	0

Total gallons of fuel used for LTOs (277,671 gal.) is based on the 6.67 lb/gal density of JP-8 as provided in footnote 2. of Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 2a - Implementation Phase (Tinian North)

Greenhouse Gas Emissions
Assume aircraft will use 300,000 gallons of fuel per day for 56 days.

Quantity (gallons)	Fuel Type	CH_4 (kg)	N_2O (kg)	CO_2 (kg)	CO_2-equivalent (kg)	CO_2-equivalent (metric tonne)
16,800,000	JP-8	4536	5208	164,640,000	166,305,384	166,305

The CH_4 and N_2O Global Warming Potential multipliers are 25 and 298, respectively from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014.

DATA - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 2b - Implementation Phase (Tinian South)

Given: Six 10,000 gal Fuel Trucks will take 30 days at 10hrs/day to provide initial fill from Tinian seaport to Tinian Airport (Site of Proposed Action). The six 10,000 gallon Fuel trucks will operate 10hrs/day for the duration of the exercises. The total exercise time is 8 weeks (56 days), therefore the fuel trucks will operate an additional 26 days after the initial fill.

Under the commercial lodging option six busses will transport a total of 256 personnel 4 roundtrips/day for a total of 24 roundtrips/day for 8 weeks.

Assumptions: A Gross Vehicle Weight (GVW) of 36,200 lbs will be used, based off of an 84 passenger Blue Bird bus.

Assume fuel truck GVW > 60,000 lbs since fuel load alone is 83,400 lbs.

Assume fuel trucks travel at 55 miles per hour

Assume 40 miles per roundtrip for busses.

Vehicle Weight Classes for Which Emission Factors are Published

Vehicle Category	Description	SCC
LDGV	Light-Duty Gasoline Vehicles (i.e., passenger cars) does not include SUVs, vans or pickups	A2201001000
LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs GVW - includes pickup trucks, sport utility vehicles and vans)	A2201020000
LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVW - includes pickup trucks, sport utility vehicles and vans)	A2201040000
HDGV2B	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs GVW)	A2201070000
HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs GVW)	A2201070000
HDGV8A	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs GVW)	A2201070000
LDDV	Light-Duty Diesel Vehicles (Passenger Cars)	
LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs GVW)	A2230002000
HDDV2B	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs GVW – includes pickup trucks)	A2230070000
HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs GVW)	A2230070000
HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	A2230070000
HDDV8B	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	A2230070000
MC	Motorcycles	A2201080000

Emission Factors - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 2b - Implementation Phase (Tinian South)

Emission Factors for Calendar Year 2015

Vehicle Class	Model Year	Emission Factors in grams per Mile[a]								
		PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs	CO2	Fugitive PM_{10}	Fugitive $PM_{2.5}$
HDDV8A*	2005	0.2	0.19	2.8	5.47	0.01	0.48	1544.1	0.05	0.01
HDDV8B**	2005	0.2	0.19	3.33	6.23	0.02	0.58	1615.2	0.05	0.01

* Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8a

**Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8b

a) Emission factors from Appendix A of Air Emissions Factor Guide to Air Force Mobile Sources, AFCEE, December 2009

Greenhouse Gas Emission Factors for Calendar Year 2015

Vehicle Class	CH_4 (g/mile)	N_2O (g/mile)
HDDV	0.0051	0.0048

g/mile = grams per mile

CH_4 = Methane; N_2O = Nitrous Oxide

b) Emission Factors from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf).

Emission Calculations - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 2b - Implementation Phase (Tinian South)

Miles for Commuter Emissions for 8 week training exercises

Vehicle Class	Speed Miles/hour	Miles/Trip	Total Trips/Day	Hours/Day	Total Days	Total Miles
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)		40	24		56	53,760
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	55			10	56	30,800

Criteria and VOC Emissions for Commuters

Vehicle Class	Model Year	Annual Miles	Criteria Pollutant Emissions (tons/year)					
			PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	2005	53,760	0.015	0.012	0.166	0.324	0.001	0.028
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	2005	30,800	0.008	0.007	0.113	0.212	0.001	0.020
Total			**0.023**	**0.019**	**0.279**	**0.536**	**0.001**	**0.048**

Particulate emissions include exhaust, brake wear, tire wear. Assume paved road.

Greenhouse Gas Emissions for Commuters

Vehicle Class	Annual Miles	CO_2 (lb/year)	CH_4 (lb/year)	N_2O (lb/year)	CH_4 GWP Multiplier	N_2O GWP Multiplier	CO_2 Equivalent (lb/year)	CO_2 Equivalent (metric tonnes/year)
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	53,760	183,004.44	0.60	0.57	25	298	183,189.08	83.09
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	30,800	109,674.07	0.35	0.33	25	298	109,779.86	49.80
Total		**292,678.52**	**0.95**	**0.89**	---	---	**292,968.94**	**132.89**

GWP = Global Warming Potential; 100-year GWP values obtained from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf)

Emission Calculations Method - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 2b - Implementation Phase (Tinian South)

Calculation Method: Equation 4-1 , AFCEE 2009, Mobile Emissions Guide

EP = VMTVehCat * EFPolVehCat * 0.002205

Where,
EP = Emissions of each individual pollutant (lb/yr)
VMTVehCat = Annual vehicle miles traveled by each vehicle category (LDGV, LDGT1, LDDV, etc.) (mi/yr)
EFPolVehCat = Emission factor of each pollutant for each vehicle category (g/mi)
0.002205 = Factor for converting grams to pounds (g/lb).

DATA - Fuel Loading Emissions for Modified Alternative 2b - Implementation Phase (Tinian South)

Given:

Total Exercise Days (8 weeks)	56
Initial Fuel Fill Days	30
Remaining Fuel Fill Days	26
Total # of Fuel Trucks	6
Total Gallons per Fuel Truck	10,000
Trips per day per Fuel Truck	5
1 bbl conversion to gallons	42
Total Fuel (gal) during Initial Fill	9,000,000
Total Fuel (gal) during Remaining Exercise	7,800,000
Total Fuel (gal) during Exercise (8 Weeks)	16,800,000

Proposed Action Fuel Loading Operations

Location	Description	Fuel Type	Fuel Transferred (gal)	Category
Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	Loading
Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	Loading
Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	Loading

Emission Factors - Fuel Loading Emissions for Modified Alternative 2b - Implementation Phase (Tinian South)

JP-8 emission factors (lb/Mgal)	Dispensing Splash	Loading Bottom fill	
Molecular Weight =	130		AP-42 Table 7.1-2 dated 11/06
True Vapor Pressure (psia) =	0.011		AP-42 Table 7.1-2 dated 11/06 @ 70F (annual avg.)
Dispensing Displacement losses =	0.0487	0.020	AP-42 Section 5.2 dated 6/08 Equation (1)
Spillage =	0.7		AP-42 Table 5.2-7 dated 6/08
Total =	0.749		

Emission Calculations - Fuel Loading Emissions for Modified Alternative 2b - Implementation Phase (Tinian South)

Location	Description	Fuel Type	Fuel Transferred (gal)	Displaced Vapor (lb)	Spillage (lb)	Total VOC (lb)	Total VOC (tons)
Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	338.9	0	338.9	0.17
Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Total			**33,600,000**	**678**	**0**	**677.75**	**0.34**

Emission Calculations Method - Fuel Loading Emissions for Modified Alternative 2b - Implementation Phase (Tinian South)

Displacement emissions for Diesel and JP-8 were estimated using Equation (1) from AP-42 Section 5.2, Transportation and Marketing of Petroleum Liquids, dated 6/08

$$L_L = 12.46\ (SPM)/T$$

Where

L_L = Loading loss in lb/10^3 gal

S = Saturation Factor 1.45 for splash loading, 0.6 for bottom loading

M = molecular weight,

T = temperature of bulk liquid (assume average annual ambient temperature)

DATA - Fuel Storage Tank Emissions for Modified Alternative 2b - Implementation Phase (Tinian South)

Fuel storage tank emissions were estimated using the U.S. EPA TANKS storage tank emissions calculation software (Version 4.0.9d). The emissions calculations algorithms in the TANKS program are based on Chapter 7 of EPA's AP-42. Honolulu, Hawaii was used as a surrogate location for the tanks as meteorological data does not exist in TANKS for CNMI. Jet Kerosene fuel was used as the surrogate for JP-8 in the TANKS model as it is the closet in characteristics to JP-8.

Emission Calculations Summary from TANKS*

Tank Type	Throughput (gal.)	Working Loss (lbs)	Breathing Loss (lbs)	VOC Total (lbs)	VOC Total (tons)
Tank 1 (Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 2 (Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 3 (Airport) - 60,000 bbl, cut and cover or AST	4,581,818	210.07	714.88	924.95	0.46
Tank 4 (Airport) - 60,000 bbl, cut and cover or AST	4,581,818	210.07	714.88	924.95	0.46
Tank 5 (Airport) - 100,000 bbl, cut and cover or AST	7,636,364	350.11	1172.01	1522.12	0.76
Total		**1,627.09**	**3,076.89**	**4,703.98**	**2.35**

*See the following references for TANKS printouts. (SM12 - TANKS) & (SM13 - TANKS)

Construction/Haul Truck Emissions - Modified Alternative 3A - Construction Phase (Hybrid Saipan/Tinian North)

Emissions from hauling construction supplies, demoliton debris, fill, and excavated material are estimated in this spreadsheet.

Emission Estimation Method: AFCEE Air Emissions Factor Guide to Air Force Mobile Sources, Dec. 2009.

Concrete Mixing and Dump Truck Assumptions:
Dump trucks carry 11 cubic yards of material per trip.
Concrete mixing trucks carry 10 cubic yards of material per trip.
Saipan
The average distance from the port to Commercial Concrete Supply Company is 7 miles; therefore, dump trucks will travel 14 miles round trip.
The average distance from the Commercial Concrete Supply Company (CCSC) to the project site is 2 miles; therefore, concrete trucks will travel 4 miles round trip.
Tinian N.
The average distance from the port to Commercial Concrete Supply Company is 1.7 miles; therefore, dump trucks will travel 3.4 miles round trip.
The average distance from the Commercial Concrete Supply Company (CCSC) to the project site is 2.3 miles; therefore, concrete trucks will travel 4.6 miles round trip.

Building Materials Assumptions:
Haul trucks carry 20 cubic yards of material per trip.
The average distance from the project site to the materials source is 20 miles; therefore, building material haul trucks will travel 40 miles round trip.
Estimated number of trips required by haul trucks = total amount of material/20 cubic yards per truck

Amount of demoltion debris =	0	cubic yards	No Demolition in the Proposed Action
Amount of cement transported from port to CCSC (Saipan)=	396	cubic yards	
Amount of cement transported from port to CCSC (Tinian N.)=	3,190	cubic yards	
Amount of concrete transported from CCSC to project site (Saipan) =	5,610	cubic yards	
Amount of concrete transported from CCSC to project site (Tinian N.) =	51,580	cubic yards	
Amount of Excavation Materials for New Structures/Buildings (Saipan) =	61,372	cubic yards	Construction area multiped by depth of disturbance which is assumed to be 12 feet.
Amount of Excavation Materials for New Structures/Buildings (Tinian N.) =	306,257	cubic yards	Construction area multiped by depth of disturbance which is assumed to be 12 feet.
Amount of Building/Structure Materials (Saipan) =	46,029	cubic yards	Construction area multipled by 9 feet.
Amount of Building/Structure Materials (Tinian N.) =	229,693	cubic yards	Construction area multipled by 9 feet.
Number of dump trucks required (port to CCSC) (Saipan) =	36	heavy duty diesel haul truck trips, Cells rounded up	
Number of dump trucks required (port to CCSC) (Tinian N.) =	290	heavy duty diesel haul truck trips, Cells rounded up	
Number of concrete mixing trucks required (CCSC to project site) (Saipan) =	561	heavy duty diesel haul truck trips, Cells rounded up	
Number of concrete mixing trucks required (CCSC to project site) (Tinian N.) =	5158	heavy duty diesel haul truck trips, Cells rounded up	
Number of trucks required (Building Materials) (Saipan) =	5,370	heavy duty diesel haul truck trips	
Number of trucks required (Building Materials) (Tinian N.) =	26,798	heavy duty diesel haul truck trips	
Miles per roundtrip (port to CCSC) (Saipan) =	14	miles	
Miles per roundtrip (port to CCSC) (Tinain N.) =	3.4	miles	
Miles per roundtrip (CCSC to project site) (Saipan) =	4	miles	
Miles per roundtrip (CCSC to project site) (Tinian N.) =	4.6	miles	
Miles per roundtrip (Building Materials) (Saipan) =	40.0	miles	
Miles per roundtrip (Building Materials) (Tinaina N.) =	40.0	miles	

Low Altitude Heavy Duty Diesel Vehicle 8b (HDDV8b) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV8b	**6.23**	**0.58**	**3.33**	**0.02**	**0.20**	**0.19**	**1615**

Notes:
Emission factors for all pollutants are from Appendix A - On-Raod Vehicle Emission Factors within AFCEE Air Emissions Factor Guide to Air Force Mobile Sources, Dec. 2009.
Emission factors from calendar year 2015 were used assuming the average vehicle model year is 2005.

HDDV8b Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**18,049.47**	**1,680.31**	**9,647.30**	**57.94**	**579.42**	**550.45**	**4,679,374.22**
tons	**9.02**	**0.84**	**4.82**	**0.03**	**0.29**	**0.28**	**2,339.69**

Example Calculation: NO_x emissions (lbs) = 40 miles per trip * 34,955 trips * NO_x emission factor (g/mile) * lb/453.6 g

Summary	Summarizes total emissions by calendar year for Modified Alternative 3A - Construction Phase (Hybrid Saipan/Tinian North).
Combustion	Estimates emissions from non-road equipment exhaust.
Fugitive	Estimates particulate emissions from construction activities including earthmoving, vehicle traffic, and windblown dust.
Grading	Estimates the number of days of site preparation, to be used for estimating heavy equipment exhaust and earthmoving dust emissions.
Construction Commuter	Estimates emissions for construction workers commuting to the site.
Haul Truck On-Road	Estimates emissions from hauling construction materials to the project site.

Summary of Air Quality Emissions from Divert EIS - Modified Alternative 3A - Construction Phase (Hybrid Saipan/Tinian North)

	NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Construction Combustion	18.431	2.016	7.813	0.931	1.230	1.193	2,176.608
Construction Fugitive Dust	-	-	-	-	202.801	19.198	-
Construction Commuter	5.778	6.370	58.954	0.1028	0.889	0.577	10,578.512
Haul Truck On-Road	9.025	0.840	4.824	0.029	0.290	0.275	2,339.687
TOTAL	***33.23***	***9.23***	***71.59***	***1.06***	***205.21***	***21.24***	***15,094.81***

Annual Summary of Air Quality Emissions from Divert EIS - Modified Alternative 3A - Construction Phase (Hybrid Saipan/Tinian North)*

	Point and Area Sources Combined						
	NO_x (tpy)	VOC (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CO_2 (metric tons)
CY 01	11.08	3.08	23.86	0.35	68.40	7.08	4,564.59
CY 02	11.08	3.08	23.86	0.35	68.40	7.08	4,564.59
CY 03	11.08	3.08	23.86	0.35	68.40	7.08	4,564.59

* Construction duration is estimated to be 36 months and the emissions are assumed to be distributed evenly over the construction period.

Combustion Emissions - Modified Alternative 3A - Construction Phase (Hybrid Saipan/Tinian North)
Combustion Emissions of VOC, NO_x, SO_2, CO, $PM_{2.5}$, PM_{10} and CO_2 due to Construction

Assumptions
When multiple options exist under the general construction activites the most conservative value will be used to quantify air emission.

General Construction Activities	Area Disturbed (ft^2)	
Construct Taxiway (Tinian N.)	1,385,300	ft^2
Construct Road Re-Route (Tinian N.)	40,585	ft^2
Construct New Access Roads (Tinian N.)	128,924	ft^2
Construct Maintenance Facility (Saipan)	6,100	ft^2
Construct Maintenance Facility (Tinian N.)	7,570	ft^2
Construct Jet Fuel System and Fire Pump System (Operational, Bulk and at the Port of Tinian) (Saipan/Tinian N.)	813,496	ft^2
Construct Hazardous Cargo Pad (Saipan)	250,470	ft^2
Construct Hazardous Cargo Pad (Tinian N.)	299,754	ft^2
Construct Parking Apron (Tinian N.)	1,026,340	ft^2

Total General Construction Area:	827,166	ft^2	
	19.0	acres	
Total Demolition Area:	0	ft^2	
	0.0	acres	
Total Pavement Area:	3,131,373	ft^2	
	71.9	acres	
Total Disturbed Area:	3,958,539	ft^2	
	90.9	acres	
Construction Duration:	36	months	
1 Yr Project Construction Activity:	240	days/yr	Assume 12 months, 4 weeks per month, 5 days per week.

Emission Factors Used for Construction Equipment

References: Guide to Air Quality Assessment, SMAQMD, 2004; and U.S. EPA NONROAD Emissions Model, Version 2005.0.0
Emission factors are taken from the NONROAD model and were provided to e²M by Larry Landman of the Air Quality and Modeling Center (Landman.Larry@epamail.epa.gov) on 12/14/07. Factors provided are for the weighted average US fleet for CY2007.
Assumptions regarding the type and number of equipment are from SMAQMD Table 3-1 unless otherwise noted.

Grading

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Bulldozer	1	13.60	0.96	5.50	1.02	0.89	0.87	1456.90
Motor Grader	1	9.69	0.73	3.20	0.80	0.66	0.64	1141.65
Water Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	3	41.64	2.58	15.71	0.83	2.55	2.47	4941.53

Paving

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Paver	1	3.83	0.37	2.06	0.28	0.35	0.34	401.93
Roller	1	4.82	0.44	2.51	0.37	0.43	0.42	536.07
Truck	2	36.71	1.79	14.01	3.27	1.99	1.93	4685.95
Total per 10 acres of activity	4	45.37	2.61	18.58	0.91	2.78	2.69	5623.96

Demolition

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Loader	1	13.45	0.99	5.58	0.95	0.93	0.90	1360.10
Haul Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	2	31.81	1.89	12.58	0.64	1.92	1.87	3703.07

Building Construction

Equipment[d]	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Stationary								
Generator Set	1	2.38	0.32	1.18	0.15	0.23	0.22	213.06
Industrial Saw	1	2.62	0.32	1.97	0.20	0.32	0.31	291.92
Welder	1	1.12	0.38	1.50	0.08	0.23	0.22	112.39
Mobile (non-road)								
Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Forklift	1	5.34	0.56	3.33	0.40	0.55	0.54	572.24
Crane	1	9.57	0.66	2.39	0.65	0.50	0.49	931.93
Total per 10 acres of activity	6	39.40	3.13	17.38	3.12	2.83	2.74	4464.51

Architectural Coatings

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c]	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Air Compressor	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77
Total per 10 acres of activity	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77

a) The SMAQMD 2004 guidance suggests a default equipment fleet for each activity, assuming 10 acres of that activity, (e.g., 10 acres of grading, 10 acres of paving, etc.). The default equipment fleet is increased for each 10 acre increment in the size of the construction project. That is, a 26 acre project would round to 30 acres and the fleet size would be three times the default fleet for a 10 acre project.
b) The SMAQMD 2004 reference lists emission factors for reactive organic gas (ROG). For the purposes of this worksheet ROG = VOC. The NONROAD model contains emissions factors for total HC and for VOC. The factors used here are the VOC factors.
c) The NONROAD emission factors assume that the average fuel burned in nonroad trucks is 1100 ppm sulfur. Trucks that would be used for the Proposed Actions will all be fueled by highway grade diesel fuel which cannot exceed 500 ppm sulfur. These estimates therefore over-estimate SO2 emissions by more than a factor of two.
d) Typical equipment fleet for building construction was not itemized in SMAQMD 2004 guidance. The equipment list above was assumed based on SMAQMD 1994 guidance.

PROJECT-SPECIFIC EMISSION FACTOR SUMMARY

Source	Equipment Multiplier*	Project-Specific Emission Factors (lb/day)						
		NO_x	VOC	CO	SO_2**	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	9	374.771	23.193	141.389	7.495	22.910	22.222	44473.737
Paving Equipment	7	317.571	18.240	130.049	6.351	19.433	18.850	39367.698
Demolition Equipment	1	31.808	1.886	12.584	0.636	1.923	1.865	3703.074
Building Construction	2	78.793	6.260	34.765	6.233	5.658	5.488	8929.023
Air Compressor for Architectural Coating	2	7.148	0.746	3.131	0.502	0.619	0.600	719.547
Architectural Coating**			74.123					

*The equipment multiplier is an integer that represents units of 10 acres for purposes of estimating the number of equipment required for the project.
**Emission factor is from the evaporation of solvents during painting, per "Air Quality Thresholds of Significance", SMAQMD, 1994
Example: SMAQMD Emission Factor for Grading Equipment NOx = (Total Grading NOx per 10 acre)*(Equipment Multiplier)

Summary of Input Parameters

	Total Area (ft^2)	Total Area (acres)	Total Days	
Grading:	3,958,539	90.88	6	(from "Grading" worksheet)
Paving:	3,131,373	71.89	49	
Demolition:	0	0.00	0	
Building Construction:	827,166	18.99	240	
Architectural Coating	827,166	18.99	20	(per SMAQMD "Air Quality of Thresholds of Significance", 1994)

NOTE: The 'Total Days' estimate for paving is calculated by dividing the total number of acres by 0.21 acres/day, which is a factor derived from the 2005 MEANS Heavy Construction Cost Data, 19th Edition, for 'Asphaltic Concrete Pavement, Lots and Driveways - 6" stone base', which provides an estimate of square feet paved per day. There is also an estimate for 'Plain Cement Concrete Pavement', however the estimate for asphalt is used because it is more conservative. The 'Total Days' estimate for demolition is calculated by dividing the total number of acres by 0.02 acres/day, which is a factor also derived from the 2005 MEANS reference. This is calculated by averaging the demolition estimates from 'Building Demolition - Small Buildings, Concrete', assuming a height of 30 feet for a two-story building; from 'Building Footings and Foundations Demolition - 6" Thick, Plain Concrete'; and from 'Demolish, Remove Pavement and Curb - Concrete to 6" thick, rod reinforced'. Paving is double-weighted since projects typically involve more paving demolition. The 'Total Days' estimate for building construction is assumed to be 230 days, unless project-specific data is known.

Total Project Emissions by Activity (lbs)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	2,248.63	139.16	848.33	44.97	137.46	133.33	266,842
Paving	15,560.98	893.76	6,372.40	311.22	952.20	923.63	1,929,017
Demolition	-	-	-	-	-	-	0
Building Construction	18,910.23	1,502.31	8,343.51	1,495.85	1,357.94	1,317.20	2,142,966
Architectural Coatings	142.96	1,497.39	62.62	10.05	12.37	12.00	14,391
Total Emissions (lbs):	**36,862.80**	**4,032.62**	**15,626.86**	**1,862.09**	**2,459.97**	**2,386.17**	**4,353,216**

Results: Total Project Annual Emission Rates

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Total Project Emissions (lbs)	36,862.80	4,032.62	15,626.86	1,862.09	2,459.97	2,386.17	4,353,216
Total Project Emissions (tons)	18.43	2.02	7.81	0.93	1.23	1.19	2,176.61

Construction Fugitive Dust Emissions - Proposed Action [Modified Alternative 3A - Construction Phase (Hybrid Saipan/Tinian North)]

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
General Construction Activities	0.19	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.42	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006

$PM_{2.5}$ Emissions

$PM_{2.5}$ Multiplier	0.10	(10% of PM_{10} emissions assumed to be $PM_{2.5}$)	EPA 2001; EPA 2006
Control Efficiency	0.50	(assume 50% control efficiency for PM_{10} and $PM_{2.5}$ emissions)	EPA 2001; EPA 2006

Project Assumptions

New Roadway Construction (0.42 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	71.9	acres

General Construction Activities (0.19 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	19.0	acres

	Project Emissions (tons/year)			
	PM_{10} uncontrolled	**PM_{10} controlled**	**$PM_{2.5}$ uncontrolled**	**$PM_{2.5}$ controlled**
New Roadway Construction	362.31	181.15	36.23	18.12
General Construction Activities	43.30	21.65	2.16	1.08
Total	**405.60**	**202.80**	**38.40**	**19.20**

General Construction Activities Emission Factor

0.19 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM_{10}/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM_{10}/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions From Construction Operations, calculated the 0.19 ton PM_{10}/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM_{10}/acre-month) and 75% of the average emission factor (0.11 ton PM_{10}/acre-month). The 0.19 ton PM_{10}/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM_{10}/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particulate (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District as well as the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas.

New Road Construction Emission Factor

0.42 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM_{10}/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

$PM_{2.5}$ Multiplier **0.10**

$PM_{2.5}$ emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM_{10} and $PM_{2.5}$ **0.50**

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas (EPA 2006). Wetting controls will be applied during project construction.

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Grading Schedule - Proposed Action [Modified Alternative 3A - Construction Phase (Hybrid Saipan/Tinian North)]

Estimate of time required to grade a specified area.

Input Parameters
Construction area: 90.9 acres/yr (from Combustion Worksheet)
Qty Equipment: 28.0 (calculated based on 3 pieces of equipment for every 10 acres)

Assumptions.
Terrain is mostly flat.
An average of 6" soil is excavated from one half of the site and backfilled to the other half of the site; no soil is hauled off-site or borrowed.
200 hp bulldozers are used for site clearing.
300 hp bulldozers are used for stripping, excavation, and backfill.
Vibratory drum rollers are used for compacting.
Stripping, Excavation, Backfill and Compaction require an average of two passes each.
Excavation and Backfill are assumed to involve only half of the site.

Calculation of days required for one piece of equipment to grade the specified area.

Reference: Means Heavy Construction Cost Data, 19th Ed., R. S. Means, 2005.

Means Line No.	Operation	Description	Output	Units	Acres per equip-day	equip-days per acre	Acres/yr (project-specific)	Equip-days per year
2230 200 0550	Site Clearing	Dozer & rake, medium brush	8	acre/day	8	0.13	90.88	11.36
2230 500 0300	Stripping	Topsoil & stockpiling, adverse soil	1,650	cu. yd/day	2.05	0.49	90.88	44.43
2315 432 5220	Excavation	Bulk, open site, common earth, 150' haul	800	cu. yd/day	0.99	1.01	45.44	45.82
2315 120 5220	Backfill	Structural, common earth, 150' haul	1,950	cu. yd/day	2.42	0.41	45.44	18.80
2315 310 5020	Compaction	Vibrating roller, 6 " lifts, 3 passes	2,300	cu. yd/day	2.85	0.35	90.88	31.87
TOTAL								152.27

Calculation of days required for the indicated pieces of equipment to grade the designated acreage.

(Equip)(day)/yr: 152.27
Qty Equipment: 28.00
Grading days/yr: 5.44

Construction/Staff Commuter Emissions - Modified Alternative 3A - Construction Phase (Hybrid Saipan/Tinian North)

Emissions from construction workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road).

Assumptions:
Passenger vehicle emission factors for scenario year 2015 are used.

The average roundtrip commute for a construction/staff worker =	40	miles
Number of construction days =	240	days
Number of construction/Staff workers (daily) =	2000	people

Note: None

Passenger Vehicle Emission Factors for Year 2015 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00060188	0.00066355	0.00614108	0.00001070	0.00009259	0.00006015	1.10192837

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Available online: <http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road)>. Accessed 18 August 2015.
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Construction Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**11,556.034**	**12,740.118**	**117,908.683**	**205.519**	**1,777.691**	**1,154.873**	**21,157,024.793**
tons	**5.778**	**6.370**	**58.954**	**0.103**	**0.889**	**0.577**	**10,578.512**

Example Calculation: NO_x emissions (lbs) = 60 miles/day * NO_x emission factor (lb/mile) * number of construction days * number of workers

No Statistical Area Available for TNI

				Point Source Emissions						Area Source Emissions (Non-Point and Mobile Sources)					
Row #	State	County	Tier-1	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
No Data Available															
Grand Total				0	0	0	0	0	0	0	0	0	0	0	0

SOURCE:
http://www.epa.gov/ttn/chief/eiinformation.html
USEPA - AirData NET Tier Report
*Net Air pollution sources (area and point) in tons per year (2002)
Site visited on 02 February 2012.

No Air Quality Control Region Identified

	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
CNMI	0	0	0	0	0	0
CNMI DEQ	0	0	0	0	0	0

DATA - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Given:

Saipan

Six 10,000 gal Fuel Trucks will take 14 days at 10hrs/day to provide initial fill from Saipan seaport to Saipan Airport (Site of Proposed Action). The six 10,000 gallon Fuel trucks will operate 10hrs/day for the duration of the exercises. The total exercise time is 8 weeks (56 days), therefore the fuel trucks will operate an additional 42 days after the initial fill.

Tinian North

Six 10,000 gal Fuel Trucks will take 17 days at 10hrs/day to provide initial fill from Tinian seaport to Tinian Airport (Site of Proposed Action). The six 10,000 gallon Fuel trucks will operate 10hrs/day for the duration of the exercises. The total exercise time is 8 weeks (56 days), therefore the fuel trucks will operate an additional 39 days after the initial fill.

Under the commercial lodging option at Saipan, six busses will transport a total of 256 personnel 4 roundtrips/day for a total of 24 roundtrips/day for 8 weeks. This same number of personnel, busses, and roundtrips could alernatively occur at Tinian.

Assumptions:

A Gross Vehicle Weight (GVW) of 36,200 lbs will be used, based off of an 84 passenger Blue Bird bus.

Assume fuel truck GVW > 60,000 lbs since fuel load alone is 83,400 lbs.

Assume fuel trucks travel at 55 miles per hour

Assume 40 miles per roundtrip for busses.

Vehicle Weight Classes for Which Emission Factors are Published

Vehicle Category	Description	SCC
LDGV	Light-Duty Gasoline Vehicles (i.e., passenger cars) does not include SUVs, vans or pickups	A2201001000
LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs GVW - includes pickup trucks, sport utility vehicles and vans)	A2201020000
LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVW - includes pickup trucks, sport utility vehicles and vans)	A2201040000
HDGV2B	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs GVW)	A2201070000
HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs GVW)	A2201070000
HDGV8A	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs GVW)	A2201070000
LDDV	Light-Duty Diesel Vehicles (Passenger Cars)	
LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs GVW)	A2230002000
HDDV2B	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs GVW – includes pickup trucks)	A2230070000
HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs GVW)	A2230070000
HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	A2230070000
HDDV8B	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	A2230070000
MC	Motorcycles	A2201080000

Emission Factors - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Emission Factors for Calendar Year 2015

Vehicle Class	Model Year	Emission Factors in grams per Mile[a]								
		PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs	CO2	Fugitive PM_{10}	Fugitive $PM_{2.5}$
HDDV8A*	2005	0.2	0.19	2.8	5.47	0.01	0.48	1544.1	0.05	0.01
HDDV8B**	2005	0.2	0.19	3.33	6.23	0.02	0.58	1615.2	0.05	0.01

* Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8a

**Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8b

a) Emission factors from Appendix A of Air Emissions Factor Guide to Air Force Mobile Sources, AFCEE, December 2009

Greenhouse Gas Emission Factors for Calendar Year 2015

Vehicle Class	CH_4 (g/mile)	N_2O (g/mile)
HDDV	0.0051	0.0048

g/mile = grams per mile

CH_4 = Methane; N_2O = Nitrous Oxide

b) Emission Factors from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf).

Emission Calculations - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Miles for Commuter Emissions for 8 week training exercises

Vehicle Class	Speed Miles/hour	Miles/Trip	Total Trips/Day	Hours/Day	Total Days	Total Miles
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)		40	24		56	53,760
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	55			10	56	30,800

Criteria and VOC Emissions for Commuters

Vehicle Class	Model Year	Annual Miles	Criteria Pollutant Emissions (tons/year)					
			PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	2005	53,760	0.015	0.012	0.166	0.324	0.001	0.028
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	2005	30,800	0.008	0.007	0.113	0.212	0.001	0.020
Total			**0.023**	**0.019**	**0.279**	**0.536**	**0.001**	**0.048**

Particulate emissions include exhaust, brake wear, tire wear. Assume paved road.

Greenhouse Gas Emissions for Commuters

Vehicle Class	Annual Miles	CO_2 (lb/year)	CH_4 (lb/year)	N_2O (lb/year)	CH_4 GWP Multiplier	N_2O GWP Multiplier	CO_2 Equivalent (lb/year)	CO_2 Equivalent (metric tonnes/year)
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	53,760	183,004.44	0.60	0.57	25	298	183,189.08	83.09
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	30,800	109,674.07	0.35	0.33	25	298	109,779.86	49.80
Total		**292,678.52**	**0.95**	**0.89**	---	---	**292,968.94**	**132.89**

GWP = Global Warming Potential; 100-year GWP values obtained from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf)

Emission Calculations Method - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Calculation Method: Equation 4-1 , AFCEE 2009, Mobile Emissions Guide

EP = VMTVehCat * EFPolVehCat * 0.002205

Where,
EP = Emissions of each individual pollutant (lb/yr)
VMTVehCat = Annual vehicle miles traveled by each vehicle category (LDGV, LDGT1, LDDV, etc.) (mi/yr)
EFPolVehCat = Emission factor of each pollutant for each vehicle category (g/mi)
0.002205 = Factor for converting grams to pounds (g/lb).

Summary	Summarizes total emissions by calendar year for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North).
Airfield Operations	Aircraft operations consist of taxi, take-off and landings (sorties or LTOs), touch-and-go operations (TGOs), and low flybys (LFB) by base aircraft.
Fuel Truck and Commuter Vehicle Emissions	Estimates emissions for workers and operational vehicles commuting to the site of the Proposed Action.
Fuel Transfer Emissions	Fuel loading operations under the Proposed Action involves the loading of fuel into tanker trucks and aircraft.
Internal Combustion Engine (ICE) Emissions	Estimates Emissions from Internal Combustion Engines (e.g Generators)
Fuel Storage Tanks	Estimates emissions from Above Ground Storage Tanks.

Criteria Pollutant and VOC Emissions Summary for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North) (tons/year)

Source Category	PM10	PM2.5	CO	NOx	SOx	VOCs
Airfield Operations	0.05	0.05	18.67	6.77	0.98	1.25
Fuel Truck and Commuter Vehicle Emissions	0.02	0.02	0.28	0.54	0.00	0.05
Fuel Transfer	N/A	N/A	N/A	N/A	N/A	0.34
Fuel Storage Tanks	N/A	N/A	N/A	N/A	N/A	1.77
Total Criteria and VOC Pollutant Emissions (tons/year)	**0.08**	**0.07**	**18.95**	**7.31**	**0.98**	**3.40**

Greenhouse Gas (GHG) Emissions Summary for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North) (metric tonnes/year)

Source Category	CO_2-equivalent (lb/year)	CO_2-equivalent (kg/year)	CO_2-equivalent (metric tonne/year)
Airfield Operations*	366,634,444	166,305,384	166,305
Fuel Truck and Commuter Vehicle Emissions	292,969	132,891	133
Fuel Transfer	0	0	0
Fuel Storage Tanks	0	0	0
Total GHG Emissions	**366,927,413**	**166,438,275**	**166,438**

DATA - Airfield Operations for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Aircraft exercises under this alternative are based on assuming 2 to 4 KC-135R aircraft operating up to 8 weeks per year for a maximum of 720 KC-135R operations per year. Each operation is equivalent to one landing or one take-off (1 LTO Cycle = 2 operations). These 720 total operations could occur at either Saipan or Tinian North.

Landing and Takeoff (LTO) Cycles

Description	Quantity
# of KC-135R LTO's per year	360

Legend

Airfield Activity Data (Worst Case Scenario)

Aircraft Model	Aircraft Model Used to Match to Available Emission Factors	Engine Model	# Engines	APU Model	# APUs	Notes	LTO Cycles
KC-135R	KC-135-R	F108-CF-201	4	No data on APUs		See below	360
Note: F108-CF-201 is the military designation of the CFM56-2B-1 engine.							

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Aircraft Criteria Pollutant Emission Factors

						Emission Factors in lb Pollutant per 1000 lb Fuel Burned						
Aircraft Model	Engine Model	# Eng.	Reference Thrust Mode	LTO/TGO Thrust Mode	Fuel Flow (lb/hr)	PM10	PM2.5	CO	NO_X	SO_2	VOCs	TIM
KC-135R	F108-CF-201	4	Idle	Idle	1016	0.06	0.06	30.70	4.00	1.06	2.10	47.7
KC-135R	F108-CF-201	4	Approach	Approach	2468	0.06	0.05	4.20	8.20	1.06	0.09	5.2
KC-135R	F108-CF-201	4	Climbout	Climbout	6500	0.05	0.05	0.90	16.00	1.06	0.06	1.6
KC-135R	F108-CF-201	4	Takeoff	Takeoff	7818	0.07	0.06	0.90	18.05	1.06	0.05	0.7

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-8

APU Emission Factors

			APU Emission Factors in lb Pollutant per hour						
Aircraft Model	# APU	APU Model	PM10	PM2.5	CO	NO_X	$S0_2$	VOCs	APU (hr)
KC-135R	No Data Available.								

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Default Time-In-Mode

	Typical Duration by Mode (minutes)					
Aircraft Type	Taxi/Idle-	Takeoff	Climbout	Approach	Taxi/Idle-in	Total
KC-135R	32.8	0.7	1.6	5.2	14.9	55.2

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-4

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Greenhouse Gas Emission Factors

Units	CO_2	CH_4	N_2O
kg/gal fuel	9.80	---	---
g/gal fuel	---	0.27	0.31

Reference: Footnote 2. from Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)
Criteria Pollutant and VOC Emissions per LTO by Aircraft Type
Calculated as the sum of the products of [(minutes) * (fuel flow/minute) * (lbs pollutant/lb fuel)] for each of the thrust modes.

			Emission in lb Pollutant per LTO						
Reported Aircraft Model	APU	Fuel (lb)	PM10 (lb)	PM2.5 (lb)	CO (lb)	NOx (lb)	SOx (lb)	VOCs (lb)	APU
KC - 135R	0	5144.6	0.3	0.3	103.7	37.6	5.5	6.9	0

Total Criteria Pollutant and VOC Emissions for maximum LTO's by Aircraft Type

Reported Aircraft Model	APU	Total LTO's	Fuel (lb)	PM10 (tons)	PM2.5 (tons)	CO (tons)	NOx (tons)	SOx (tons)	VOCs (tons)	APU
KC - 135R	0	360	1,852,065.6	0.05	0.05	18.67	6.77	0.98	1.25	0
Worst Case Scenario			**1,852,065.60**	**0.05**	**0.05**	**18.67**	**6.77**	**0.98**	**1.25**	0

Total gallons of fuel used for LTOs (555,342 gal.) is based on the 6.67 lb/gal density of JP-8 as provided in footnote 2. of Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Greenhouse Gas Emissions
Assume aircraft will use 300,000 gallons of fuel per day for 56 days at either Saipan or Tinian.

Quantity (gallons)	Fuel Type	CH_4 (kg)	N_2O (kg)	CO_2 (kg)	CO_2-equivalent (kg)	CO_2-equivalent (metric tonne)
16,800,000	JP-8	4536	5208	164,640,000	166,305,384	166,305

The CH_4 and N_2O Global Warming Potential multipliers are 25 and 298, respectively from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014.

DATA - Fuel Loading Emissions for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Given:	Saipan
Total Exercise Days (8 weeks)	56
Initial Fuel Fill Days	14
Remaining Fuel Fill Days	42
Total # of Fuel Trucks	6
Total Gallons per Fuel Truck	10,000
Trips per day per Fuel Truck	5
1 bbl conversion to gallons	42
Total Fuel (gal) during Initial Fill	4,200,000
Total Fuel (gal) during Remaining Exercise	12,600,000
Total Fuel (gal) during Exercise (8 Weeks)	16,800,000

Proposed Action Fuel Loading Operations

Location	Description	Fuel Type	Fuel Transferred (gal)	Category
Saipan Airport Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	Loading
Saipan Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	Loading
Saipan Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	Loading

Given:	Tinian North
Total Exercise Days (8 weeks)	56
Initial Fuel Fill Days	17
Remaining Fuel Fill Days	39
Total # of Fuel Trucks	6
Total Gallons per Fuel Truck	10,000
Trips per day per Fuel Truck	5
1 bbl conversion to gallons	42
Total Fuel (gal) during Initial Fill	5,100,000
Total Fuel (gal) during Remaining Exercise	11,700,000
Total Fuel (gal) during Exercise (8 Weeks)	16,800,000

Proposed Action Fuel Loading Operations

Location	Description	Fuel Type	Fuel Transferred (gal)	Category
Tinian North Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	Loading
Tinian Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	Loading
Tinian Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	Loading

Emission Factors - Fuel Loading Emissions for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

JP-8 emission factors (lb/Mgal)	Dispensing Splash	Loading Bottom fill	
Molecular Weight =	130		AP-42 Table 7.1-2 dated 11/06
True Vapor Pressure (psia) =	0.011		AP-42 Table 7.1-2 dated 11/06 @ 70F (annual avg.)
Dispensing Displacement losses =	0.0487	0.020	AP-42 Section 5.2 dated 6/08 Equation (1)
Spillage =	0.7		AP-42 Table 5.2-7 dated 6/08
Total =	0.749		

Emission Calculations - Fuel Loading Emissions for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Saipan

Location	Description	Fuel Type	Fuel Transferred (gal)	Displaced Vapor (lb)	Spillage (lb)	Total VOC (lb)	Total VOC (tons)
Saipan Airport Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	338.9	0	338.9	0.17
Saipan Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Saipan Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Total			**33,600,000**	**678**	**0**	**677.75**	**0.34**

Tinian

Location	Description	Fuel Type	Fuel Transferred (gal)	Displaced Vapor (lb)	Spillage (lb)	Total VOC (lb)	Total VOC (tons)
Tinian North Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	338.9	0	338.9	0.17
Tinian Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Tinian Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Total			**33,600,000**	**678**	**0**	**677.75**	**0.34**

Maximum Emissions	**677.75**	**0.34**

Emission Calculations Method - Fuel Loading Emissions for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Displacement emissions for Diesel and JP-8 were estimated using Equation (1) from AP-42 Section 5.2, Transportation and Marketing of Petroleum Liquids, dated 6/08

$$L_L = 12.46\ (SPM)/T$$

Where

L_L = Loading loss in lb/10^3 gal

S = Saturation Factor 1.45 for splash loading, 0.6 for bottom loading

M = molecular weight,

T = temperature of bulk liquid (assume average annual ambient temperature)

DATA - Fuel Storage Tank Emissions for Modified Alternative 3a - Implementation Phase (Hybrid Saipan/Tinian North)

Fuel storage tank emissions were estimated using the U.S. EPA TANKS storage tank emissions calculation software (Version 4.0.9d). The emissions calculations algorithms in the TANKS program are based on Chapter 7 of EPA's AP-42. Honolulu, Hawaii was used as a surrogate location for the tanks as meteorological data does not exist in TANKS for CNMI. Jet Kerosene fuel was used as the surrogate for JP-8 in the TANKS model as it is the closet in characteristics to JP-8.

Emission Calculations Summary from TANKS* - Saipan

Tank Type	Throughput (gal.)	Working Loss (lbs)	Breathing Loss (lbs)	VOC Total (lbs)	VOC Total (tons)
Tank 1 (Saipan Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 2 (Saipan Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 3 (Saipan Airport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 4 (Saipan Airport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Total		**1,713.68**	**950.24**	**2,663.92**	**1.33**

*See the following references for TANKS printouts. (SM12 - TANKS) & (SM13 - TANKS)

Emission Calculations Summary from TANKS* - Tinian North

Tank Type	Throughput (gal.)	Working Loss (lbs)	Breathing Loss (lbs)	VOC Total (lbs)	VOC Total (tons)
Tank 1 (Tinian Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 2 (Tinian Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 3 (Tinian Airport) - 60,000 bbl, cut and cover or AST	8,400,000	385.12	714.88	1100	0.55
Tank 4 (Tinian Airport) - 60,000 bbl, cut and cover or AST	8,400,000	385.12	714.88	1100	0.55
Total		**1,627.08**	**1,904.88**	**3,531.96**	**1.77**

*See the following references for TANKS printouts. (SM12 - TANKS) & (SM13 - TANKS)

Maximum Emissions	**3,531.96**	**1.77**

Summary	Summarizes total emissions by calendar year for Modified Alternative 3B - Construction Phase (Hybrid Saipan/Tinian South).
Combustion	Estimates emissions from non-road equipment exhaust.
Fugitive	Estimates particulate emissions from construction activities including earthmoving, vehicle traffic, and windblown dust.
Grading	Estimates the number of days of site preparation, to be used for estimating heavy equipment exhaust and earthmoving dust emissions.
Construction Commuter	Estimates emissions for construction workers commuting to the site.
Haul Truck On-Road	Estimates emissions from hauling construction materials to the project site.

Summary of Air Quality Emissions from Divert EIS - Modified Alternative 3B - Construction Phase (Hybrid Saipan/Tinian South)

	NO_x (ton)	VOC (ton)	CO (ton)	SO_2 (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO_2 (ton)
Construction Combustion	15.777	1.866	6.735	0.878	1.068	1.036	1,848.889
Construction Fugitive Dust	-	-	-	-	147.150	13.623	-
Construction Commuter	5.778	6.370	58.954	0.1028	0.889	0.577	10,578.512
Haul Truck On-Road	9.023	0.840	4.823	0.029	0.290	0.275	2,339.226
TOTAL	***30.58***	***9.08***	***70.51***	***1.01***	***149.40***	***15.51***	***14,766.63***

Annual Summary of Air Quality Emissions from Divert EIS - Modified Alternative 3B - Construction Phase (Hybrid Saipan/Tinian South)*

	Point and Area Sources Combined						
	NO_x (tpy)	VOC (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CO_2 (metric tons)
CY 01	10.19	3.03	23.50	0.34	49.80	5.17	4,465.35
CY 02	10.19	3.03	23.50	0.34	49.80	5.17	4,465.35
CY 03	10.19	3.03	23.50	0.34	49.80	5.17	4,465.35

* Construction duration is estimated to be 36 months and the emissions are assumed to be distributed evenly over the construction period.

Combustion Emissions - Modified Alternative 3B - Construction Phase (Hybrid Saipan/Tinian South)
Combustion Emissions of VOC, NO_x, SO_2, CO, $PM_{2.5}$, PM_{10}, and CO_2 due to Construction

Assumptions
When multiple options exist under the general construction activites the most conservative value will be used to quantify air emissions.

General Construction Activities	**Area Disturbed (ft^2)**
Construct New Access Roads (Tinian South)	177,294 ft^2
Construct Maintenance Facility (Saipan)	6,100 ft^2
Construct Maintenance Facility (Tinian South)	7,972 ft^2
Construct Jet Fuel System and Fire Pump System (Operational, Bulk and at the Port of Tinian) (Saipan/Tinian South)	820,200 ft^2
Construct Hazardous Cargo Pad (Saipan)	250,470 ft^2
Construct Hazardous Cargo Pad (Tinian South)	230,165 ft^2
Construct Parking Apron (Tinian South)	1,508,251 ft^2

Total General Construction Area:	834,272	ft^2	
	19.2	acres	
Total Demolition Area:	0	ft^2	
	0.0	acres	
Total Pavement Area:	2,166,180	ft^2	
	49.7	acres	
Total Disturbed Area:	3,000,452	ft^2	
	68.9	acres	
Construction Duration:	36	months	
1 Yr Project Construction Activity:	240	days/yr	Assume 12 months, 4 weeks per month, 5 days per week.

Emission Factors Used for Construction Equipment

References: Guide to Air Quality Assessment, SMAQMD, 2004; and U.S. EPA NONROAD Emissions Model, Version 2005.0.0
Emission factors are taken from the NONROAD model and were provided to e²M by Larry Landman of the Air Quality and Modeling Center (Landman.Larry@epamail.epa.gov) on 12/14/07. Factors provided are for the weighted average US fleet for CY2007.
Assumptions regarding the type and number of equipment are from SMAQMD Table 3-1 unless otherwise noted.

Grading

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Bulldozer	1	13.60	0.96	5.50	1.02	0.89	0.87	1456.90
Motor Grader	1	9.69	0.73	3.20	0.80	0.66	0.64	1141.65
Water Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	3	41.64	2.58	15.71	0.83	2.55	2.47	4941.53

Paving

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Paver	1	3.83	0.37	2.06	0.28	0.35	0.34	401.93
Roller	1	4.82	0.44	2.51	0.37	0.43	0.42	536.07
Truck	2	36.71	1.79	14.01	3.27	1.99	1.93	4685.95
Total per 10 acres of activity	4	45.37	2.61	18.58	0.91	2.78	2.69	5623.96

Demolition

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Loader	1	13.45	0.99	5.58	0.95	0.93	0.90	1360.10
Haul Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Total per 10 acres of activity	2	31.81	1.89	12.58	0.64	1.92	1.87	3703.07

Building Construction

Equipment[d]	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c] (lb/day)	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Stationary								
Generator Set	1	2.38	0.32	1.18	0.15	0.23	0.22	213.06
Industrial Saw	1	2.62	0.32	1.97	0.20	0.32	0.31	291.92
Welder	1	1.12	0.38	1.50	0.08	0.23	0.22	112.39
Mobile (non-road)								
Truck	1	18.36	0.89	7.00	1.64	1.00	0.97	2342.98
Forklift	1	5.34	0.56	3.33	0.40	0.55	0.54	572.24
Crane	1	9.57	0.66	2.39	0.65	0.50	0.49	931.93
Total per 10 acres of activity	6	39.40	3.13	17.38	3.12	2.83	2.74	4464.51

Architectural Coatings

Equipment	No. Reqd.[a] per 10 acres	NO_x (lb/day)	VOC[b] (lb/day)	CO (lb/day)	SO_2[c]	PM_{10} (lb/day)	$PM_{2.5}$ (lb/day)	CO_2 (lb/day)
Air Compressor	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77
Total per 10 acres of activity	1	3.57	0.37	1.57	0.25	0.31	0.30	359.77

a) The SMAQMD 2004 guidance suggests a default equipment fleet for each activity, assuming 10 acres of that activity, (e.g., 10 acres of grading, 10 acres of paving, etc.). The default equipment fleet is increased for each 10 acre increment in the size of the construction project. That is, a 26 acre project would round to 30 acres and the fleet size would be three times the default fleet for a 10 acre project.
b) The SMAQMD 2004 reference lists emission factors for reactive organic gas (ROG). For the purposes of this worksheet ROG = VOC. The NONROAD model contains emissions factors for total HC and for VOC. The factors used here are the VOC factors.
c) The NONROAD emission factors assume that the average fuel burned in nonroad trucks is 1100 ppm sulfur. Trucks that would be used for the Proposed Actions will all be fueled by highway grade diesel fuel which cannot exceed 500 ppm sulfur. These estimates therefore over-estimate SO2 emissions by more than a factor of two.
d) Typical equipment fleet for building construction was not itemized in SMAQMD 2004 guidance. The equipment list above was assumed based on SMAQMD 1994 guidance.

PROJECT-SPECIFIC EMISSION FACTOR SUMMARY

Source	Equipment Multiplier*	Project-Specific Emission Factors (lb/day)						
		NO_x	VOC	CO	SO_2**	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	7	291.489	18.039	109.969	5.830	17.819	17.284	34590.684
Paving Equipment	5	226.836	13.029	92.892	4.537	13.880	13.464	28119.784
Demolition Equipment	1	31.808	1.886	12.584	0.636	1.923	1.865	3703.074
Building Construction	2	78.793	6.260	34.765	6.233	5.658	5.488	8929.023
Air Compressor for Architectural Coating	2	7.148	0.746	3.131	0.502	0.619	0.600	719.547
Architectural Coating**			74.441					

*The equipment multiplier is an integer that represents units of 10 acres for purposes of estimating the number of equipment required for the project.
**Emission factor is from the evaporation of solvents during painting, per "Air Quality Thresholds of Significance", SMAQMD, 1994
Example: SMAQMD Emission Factor for Grading Equipment NOx = (Total Grading NOx per 10 acre)*(Equipment Multiplier)

Summary of Input Parameters

	Total Area (ft^2)	Total Area (acres)	Total Days	
Grading:	3,000,452	68.88	6	(from "Grading" worksheet)
Paving:	2,166,180	49.73	47	
Demolition:	0	0.00	0	
Building Construction:	834,272	19.15	240	
Architectural Coating	834,272	19.15	20	(per SMAQMD "Air Quality of Thresholds of Significance", 1994)

NOTE: The 'Total Days' estimate for paving is calculated by dividing the total number of acres by 0.21 acres/day, which is a factor derived from the 2005 MEANS Heavy Construction Cost Data, 19th Edition, for 'Asphaltic Concrete Pavement, Lots and Driveways - 6" stone base', which provides an estimate of square feet paved per day. There is also an estimate for 'Plain Cement Concrete Pavement', however the estimate for asphalt is used because it is more conservative. The 'Total Days' estimate for demolition is calculated by dividing the total number of acres by 0.02 acres/day, which is a factor also derived from the 2005 MEANS reference. This is calculated by averaging the demolition estimates from 'Building Demolition - Small Buildings, Concrete', assuming a height of 30 feet for a two-story building; from 'Building Footings and Foundations Demolition - 6" Thick, Plain Concrete'; and from 'Demolish, Remove Pavement and Curb - Concrete to 6" thick, rod reinforced'. Paving is double-weighted since projects typically involve more paving demolition. The 'Total Days' estimate for building construction is assumed to be 230 days, unless project-specific data is known.

Total Project Emissions by Activity (lbs)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Grading Equipment	1,748.93	108.23	659.82	34.98	106.91	103.70	207,544
Paving	10,752.05	617.56	4,403.09	215.04	657.93	638.20	1,332,878
Demolition	-	-	-	-	-	-	0
Building Construction	18,910.23	1,502.31	8,343.51	1,495.85	1,357.94	1,317.20	2,142,966
Architectural Coatings	142.96	1,503.74	62.62	10.05	12.37	12.00	14,391
Total Emissions (lbs):	**31,554.17**	**3,731.84**	**13,469.03**	**1,755.91**	**2,135.16**	**2,071.11**	**3,697,778**

Results: Total Project Annual Emission Rates

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Total Project Emissions (lbs)	31,554.17	3,731.84	13,469.03	1,755.91	2,135.16	2,071.11	3,697,778
Total Project Emissions (tons)	15.78	1.87	6.73	0.88	1.07	1.04	1,848.89

Construction Fugitive Dust Emissions - Proposed Action [Modified Alternative 3B - Construction Phase (Hybrid Saipan/Tinian South)]

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
General Construction Activities	0.19	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.42	ton PM_{10}/acre-month	MRI 1996; EPA 2001; EPA 2006

$PM_{2.5}$ Emissions

$PM_{2.5}$ Multiplier	0.10	(10% of PM_{10} emissions assumed to be $PM_{2.5}$)	EPA 2001; EPA 2006
Control Efficiency	0.50	(assume 50% control efficiency for PM_{10} and $PM_{2.5}$ emissions)	EPA 2001; EPA 2006

Project Assumptions

New Roadway Construction (0.42 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	49.7	acres

General Construction Activities (0.19 ton PM_{10}/acre-month)

Duration of Construction Project	12	months
Area	19.2	acres

	Project Emissions (tons/year)			
	PM_{10} uncontrolled	**PM_{10} controlled**	**$PM_{2.5}$ uncontrolled**	**$PM_{2.5}$ controlled**
New Roadway Construction	250.63	125.32	25.06	12.53
General Construction Activities	43.67	21.83	2.18	1.09
Total	**294.30**	**147.15**	**27.25**	**13.62**

General Construction Activities Emission Factor

0.19 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM_{10}/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM_{10}/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions From Construction Operations, calculated the 0.19 ton PM_{10}/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM_{10}/acre-month) and 75% of the average emission factor (0.11 ton PM_{10}/acre-month). The 0.19 ton PM_{10}/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM_{10}/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particulate (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District as well as the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas.

New Road Construction Emission Factor

0.42 ton PM_{10}/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM_{10}/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

$PM_{2.5}$ Multiplier **0.10**

$PM_{2.5}$ emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM_{10} and $PM_{2.5}$ **0.50**

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM_{10} and $PM_{2.5}$ in PM nonattainment areas (EPA 2006). Wetting controls will be applied during project construction.

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Grading Schedule - Proposed Action [Modified Alternative 3B - Construction Phase (Hybrid Saipan/Tinian South)]

Estimate of time required to grade a specified area.

Input Parameters
Construction area: 68.9 acres/yr (from Combustion Worksheet)
Qty Equipment: 21.0 (calculated based on 3 pieces of equipment for every 10 acres)

Assumptions.
Terrain is mostly flat.
An average of 6" soil is excavated from one half of the site and backfilled to the other half of the site; no soil is hauled off-site or borrowed.
200 hp bulldozers are used for site clearing.
300 hp bulldozers are used for stripping, excavation, and backfill.
Vibratory drum rollers are used for compacting.
Stripping, Excavation, Backfill and Compaction require an average of two passes each.
Excavation and Backfill are assumed to involve only half of the site.

Calculation of days required for one piece of equipment to grade the specified area.

Reference: Means Heavy Construction Cost Data, 19th Ed., R. S. Means, 2005.

Means Line No.	Operation	Description	Output	Units	Acres per equip-day	equip-days per acre	Acres/yr (project-specific)	Equip-days per year
2230 200 0550	Site Clearing	Dozer & rake, medium brush	8	acre/day	8	0.13	68.88	8.61
2230 500 0300	Stripping	Topsoil & stockpiling, adverse soil	1,650	cu. yd/day	2.05	0.49	68.88	33.68
2315 432 5220	Excavation	Bulk, open site, common earth, 150' haul	800	cu. yd/day	0.99	1.01	34.44	34.73
2315 120 5220	Backfill	Structural, common earth, 150' haul	1,950	cu. yd/day	2.42	0.41	34.44	14.25
2315 310 5020	Compaction	Vibrating roller, 6 " lifts, 3 passes	2,300	cu. yd/day	2.85	0.35	68.88	24.16
TOTAL								115.42

Calculation of days required for the indicated pieces of equipment to grade the designated acreage.

(Equip)(day)/yr: 115.42
Qty Equipment: 21.00
Grading days/yr: 5.50

Construction/Staff Commuter Emissions - Modified Alternative 3B - Construction Phase (Hybrid Saipan/Tinian South)

Emissions from construction workers commuting to the job site are estimated in this spreadsheet.

Emission Estimation Method: Emission factors from the South Coast Air Quality Management District (SCAQMD) EMFAC 2007 (v 2.3) Model (on-road) were used. These emission factors are available online at http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road).

Assumptions:
Passenger vehicle emission factors for scenario year 2015 are used.

The average roundtrip commute for a construction/staff worker =	40	miles
Number of construction days =	240	days
Number of construction/Staff workers (daily) =	2000	people

Note: None

Passenger Vehicle Emission Factors for Year 2015 (lbs/mile)

NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
0.00060188	0.00066355	0.00614108	0.00001070	0.00009259	0.00006015	1.10192837

Source: South Coast Air Quality Management District. EMFAC 2007 (ver 2.3) On-Road Emissions Factors. Available online: <http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/emfac-2007-(v2-3)-emission-factors-(on-road)>. Accessed 18 August 2015.
Notes:
The SMAQMD 2007 reference lists emission factors for reactive organic gas (ROG). For purposes of this worksheet ROG = VOC.

Construction Commuter Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**11,556.034**	**12,740.118**	**117,908.683**	**205.519**	**1,777.691**	**1,154.873**	**21,157,024.793**
tons	**5.778**	**6.370**	**58.954**	**0.103**	**0.889**	**0.577**	**10,578.512**

Example Calculation: NO_x emissions (lbs) = 60 miles/day * NO_x emission factor (lb/mile) * number of construction days * number of workers

No Statistical Area Available for TNI

				Point Source Emissions						Area Source Emissions (Non-Point and Mobile Sources)					
Row #	State	County	Tier-1	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
No Data Available															
Grand Total				0	0	0	0	0	0	0	0	0	0	0	0

SOURCE:

http://www.epa.gov/ttn/chief/eiinformation.html

USEPA - AirData NET Tier Report

*Net Air pollution sources (area and point) in tons per year (2002)

Site visited on 02 February 2012.

No Air Quality Control Region Identified

	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
CNMI	0	0	0	0	0	0
CNMI DEQ	0	0	0	0	0	0

Construction/Haul Truck Emissions - Modified Alternative 3B - Construction Phase (Hybrid Saipan/Tinian South)

Emissions from hauling construction supplies, demoliton debris, fill, and excavated material are estimated in this spreadsheet.

Emission Estimation Method: AFCEE Air Emissions Factor Guide to Air Force Mobile Sources, Dec. 2009.

Concrete Mixing and Dump Truck Assumptions:
Dump trucks carry 11 cubic yards of material per trip.
Concrete mixing trucks carry 10 cubic yards of material per trip.
Saipan
The average distance from the port to Commercial Concrete Supply Company is 7 miles; therefore, dump trucks will travel 14 miles round trip.
The average distance from the Commercial Concrete Supply Company (CCSC) to the project site is 2 miles; therefore, concrete trucks will travel 4 miles round trip.
Tinian N.
The average distance from the port to Commercial Concrete Supply Company is 1.7 miles; therefore, dump trucks will travel 3.4 miles round trip.
The average distance from the Commercial Concrete Supply Company (CCSC) to the project site is 2.3 miles; therefore, concrete trucks will travel 4.6 miles round trip.

Building Materials Assumptions:
Haul trucks carry 20 cubic yards of material per trip.
The average distance from the project site to the materials source is 20 miles; therefore, building material haul trucks will travel 40 miles round trip.
Estimated number of trips required by haul trucks = total amount of material/20 cubic yards per truck

Amount of demoltion debris =	0	cubic yards	No Demolition in the Proposed Action
Amount of cement transported from port to CCSC (Saipan)=	396	cubic yards	
Amount of cement transported from port to CCSC (Tinian N.)=	1,727	cubic yards	
Amount of concrete transported from CCSC to project site (Saipan) =	5,610	cubic yards	
Amount of concrete transported from CCSC to project site (Tinian N.) =	27,970	cubic yards	
Amount of Excavation Materials for New Structures/Buildings (Saipan) =	61,372	cubic yards	Construction area multiped by depth of disturbance which is assumed to be 12 feet.
Amount of Excavation Materials for New Structures/Buildings (Tinian N.) =	309,416	cubic yards	Construction area multiped by depth of disturbance which is assumed to be 12 feet.
Amount of Building/Structure Materials (Saipan) =	46,029	cubic yards	Construction area multipled by 9 feet.
Amount of Building/Structure Materials (Tinian N.) =	232,062	cubic yards	Construction area multipled by 9 feet.

Number of dump trucks required (port to CCSC) (Saipan) =	36	heavy duty diesel haul truck trips, Cells rounded up
Number of dump trucks required (port to CCSC) (Tinian N.) =	157	heavy duty diesel haul truck trips, Cells rounded up
Number of concrete mixing trucks required (CCSC to project site) (Saipan) =	561	heavy duty diesel haul truck trips, Cells rounded up
Number of concrete mixing trucks required (CCSC to project site) (Tinian N.)	2797	heavy duty diesel haul truck trips, Cells rounded up
Number of trucks required (Building Materials) (Saipan) =	5,370	heavy duty diesel haul truck trips
Number of trucks required (Building Materials) (Tinian N.) =	27,074	heavy duty diesel haul truck trips
Miles per roundtrip (port to CCSC) (Saipan) =	14	miles
Miles per roundtrip (port to CCSC) (Tinain N.) =	3.4	miles
Miles per roundtrip (CCSC to project site) (Saipan) =	4	miles
Miles per roundtrip (CCSC to project site) (Tinian N.) =	4.6	miles
Miles per roundtrip (Building Materials) (Saipan) =	40.0	miles
Miles per roundtrip (Building Materials) (Tinaina N.) =	40.0	miles

Low Altitude Heavy Duty Diesel Vehicle 8b (HDDV8b) Average Emission Factors (grams/mile)

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
HDDV8b	**6.23**	**0.58**	**3.33**	**0.02**	**0.20**	**0.19**	**1615**

Notes:
Emission factors for all pollutants are from Appendix A - On-Raod Vehicle Emission Factors within AFCEE Air Emissions Factor Guide to Air Force Mobile Sources, Dec. 2009.
Emission factors from calendar year 2015 were used assuming the average vehicle model year is 2005.

HDDV8b Haul Truck Emissions

	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
lbs	**18,045.91**	**1,679.98**	**9,645.40**	**57.93**	**579.30**	**550.34**	**4,678,451.88**
tons	**9.02**	**0.84**	**4.82**	**0.03**	**0.29**	**0.28**	**2,339.23**

Example Calculation: NO_x emissions (lbs) = 40 miles per trip * 27,074 trips * NO_x emission factor (g/mile) * lb/453.6 g

Summary	Summarizes total emissions by calendar year for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South).
Airfield Operations	Aircraft operations consist of taxi, take-off and landings (sorties or LTOs), touch-and-go operations (TGOs), and low flybys (LFB) by base aircraft.
Fuel Truck and Commuter Vehicle Emissions	Estimates emissions for workers and operational vehicles commuting to the site of the Proposed Action.
Fuel Transfer Emissions	Fuel loading operations under the Proposed Action involves the loading of fuel into tanker trucks and aircraft.
Internal Combustion Engine (ICE) Emissions	Estimates Emissions from Internal Combustion Engines (e.g Generators)
Fuel Storage Tanks	Estimates emissions from Above Ground Storage Tanks.

Criteria Pollutant and VOC Emissions Summary for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South) (tons/year)

Source Category	PM10	PM2.5	CO	NOx	SOx	VOCs
Airfield Operations	0.05	0.05	18.67	6.77	0.98	1.25
Fuel Truck and Commuter Vehicle Emissions	0.02	0.02	0.28	0.54	0.00	0.05
Fuel Transfer	N/A	N/A	N/A	N/A	N/A	0.34
Fuel Storage Tanks	N/A	N/A	N/A	N/A	N/A	1.77
Total Criteria and VOC Pollutant Emissions (tons/year)	**0.08**	**0.07**	**18.95**	**7.31**	**0.98**	**3.40**

Greenhouse Gas (GHG) Emissions Summary for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South) (metric tonnes/year)

Source Category	CO_2-equivalent (lb/year)	CO_2-equivalent (kg/year)	CO_2-equivalent (metric tonne/year)
Airfield Operations*	366,634,444	166,305,384	166,305
Fuel Truck and Commuter Vehicle Emissions	292,969	132,891	133
Fuel Transfer	0	0	0
Fuel Storage Tanks	0	0	0
Total GHG Emissions	**366,927,413**	**166,438,275**	**166,438**

DATA - Airfield Operations for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Aircraft exercises under this alternative are based on assuming 2 to 4 KC-135R aircraft operating up to 8 weeks per year for a maximum of 720 KC-135R operations per year. Each operation is equivalent to one landing or one take-off (1 LTO Cycle = 2 operations). These 720 operations could occur at either Saipan or Tinian.

Landing and Takeoff (LTO) Cycles

Description	Quantity
# of KC-135R LTO's per year	360

Legend

Airfield Activity Data (Worst Case Scenario)

Aircraft Model	Aircraft Model Used to Match to Available Emission Factors	Engine Model	# Engines	APU Model	# APUs	Notes	LTO Cycles
KC-135R	KC-135-R	F108-CF-201	4	No data on APUs		See below	360
Note: F108-CF-201 is the military designation of the CFM56-2B-1 engine.							

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Aircraft Criteria Pollutant Emission Factors

						Emission Factors in lb Pollutant per 1000 lb Fuel Burned						
Aircraft Model	Engine Model	# Eng.	Reference Thrust Mode	LTO/TGO Thrust Mode	Fuel Flow (lb/hr)	PM10	PM2.5	CO	NO_X	SO_2	VOCs	TIM
KC-135R	F108-CF-201	4	Idle	Idle	1016	0.06	0.06	30.70	4.00	1.06	2.10	47.7
KC-135R	F108-CF-201	4	Approach	Approach	2468	0.06	0.05	4.20	8.20	1.06	0.09	5.2
KC-135R	F108-CF-201	4	Climbout	Climbout	6500	0.05	0.05	0.90	16.00	1.06	0.06	1.6
KC-135R	F108-CF-201	4	Takeoff	Takeoff	7818	0.07	0.06	0.90	18.05	1.06	0.05	0.7

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-8

APU Emission Factors

			APU Emission Factors in lb Pollutant per hour						
Aircraft Model	# APU	APU Model	PM10	PM2.5	CO	NO_X	$S0_2$	VOCs	APU (hr)
KC-135R	No Data Available.								

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Default Time-In-Mode

	Typical Duration by Mode (minutes)					
Aircraft Type	Taxi/Idle-	Takeoff	Climbout	Approach	Taxi/Idle-in	Total
KC-135R	32.8	0.7	1.6	5.2	14.9	55.2

Emission factors from AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources, Table 2-4

Emission Factors (EFs) and Constants - Airfield Operations for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Greenhouse Gas Emission Factors

Units	CO_2	CH_4	N_2O
kg/gal fuel	9.80	---	---
g/gal fuel	---	0.27	0.31

Reference: Footnote 2. from Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 2a - Implementation Phase (Tinian North)
Criteria Pollutant and VOC Emissions per LTO by Aircraft Type
Calculated as the sum of the products of [(minutes) * (fuel flow/minute) * (lbs pollutant/lb fuel)] for each of the thrust modes.

		Emission in lb Pollutant per LTO							
Reported Aircraft Model	APU	Fuel (lb)	PM10 (lb)	PM2.5 (lb)	CO (lb)	NOx (lb)	SOx (lb)	VOCs (lb)	APU
KC - 135R	0	5144.6	0.3	0.3	103.7	37.6	5.5	6.9	0

Total Criteria Pollutant and VOC Emissions for maximum LTO's by Aircraft Type

Reported Aircraft Model	APU	Total LTO's	Fuel (lb)	PM10 (tons)	PM2.5 (tons)	CO (tons)	NOx (tons)	SOx (tons)	VOCs (tons)	APU
KC - 135R	0	360	1,852,065.6	0.05	0.05	18.67	6.77	0.98	1.25	0
Worst Case Scenario			**1,852,065.60**	**0.05**	**0.05**	**18.67**	**6.77**	**0.98**	**1.25**	0

Total gallons of fuel used for LTOs (555,342 gal.) is based on the 6.67 lb/gal density of JP-8 as provided in footnote 2. of Table 2-8 of the AFCEC August 2013 Air Emissions Guide for Air Force Mobile Sources.

Calculations - Airfield Operations for Modified Alternative 2a - Implementation Phase (Tinian North)

Greenhouse Gas Emissions
Assume aircraft will use 300,000 gallons of fuel per day for 56 days at either Saipan or Tinian.

Quantity (gallons)	Fuel Type	CH_4 (kg)	N_2O (kg)	CO_2 (kg)	CO_2-equivalent (kg)	CO_2-equivalent (metric tonne)
16,800,000	JP-8	4536	5208	164,640,000	166,305,384	166,305

The CH_4 and N_2O Global Warming Potential multipliers are 25 and 298, respectively from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014.

DATA - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Given:

Saipan

Six 10,000 gal Fuel Trucks will take 14 days at 10hrs/day to provide initial fill from Saipan seaport to Saipan Airport (Site of Proposed Action). The six 10,000 gallon Fuel trucks will operate 10hrs/day for the duration of the exercises. The total exercise time is 8 weeks (56 days), therefore the fuel trucks will operate an additional 42 days after the initial fill.

Tinian North

Six 10,000 gal Fuel Trucks will take 17 days at 10hrs/day to provide initial fill from Tinian seaport to Tinian Airport (Site of Proposed Action). The six 10,000 gallon Fuel trucks will operate 10hrs/day for the duration of the exercises. The total exercise time is 8 weeks (56 days), therefore the fuel trucks will operate an additional 39 days after the initial fill.

Under the commercial lodging option at Saipan, six busses will transport a total of 256 personnel 4 roundtrips/day for a total of 24 roundtrips/day for 8 weeks. This same number of personnel, busses, and roundtrips could also occur at Tinian.

Assumptions:

A Gross Vehicle Weight (GVW) of 36,200 lbs will be used, based off of an 84 passenger Blue Bird bus.

Assume fuel truck GVW > 60,000 lbs since fuel load alone is 83,400 lbs.

Assume fuel trucks travel at 55 miles per hour

Assume 40 miles per roundtrip for busses.

Vehicle Weight Classes for Which Emission Factors are Published

Vehicle Category	Description	SCC
LDGV	Light-Duty Gasoline Vehicles (i.e., passenger cars) does not include SUVs, vans or pickups	A2201001000
LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs GVW - includes pickup trucks, sport utility vehicles and vans)	A2201020000
LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVW - includes pickup trucks, sport utility vehicles and vans)	A2201040000
HDGV2B	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs GVW)	A2201070000
HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs GVW)	A2201070000
HDGV8A	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs GVW)	A2201070000
LDDV	Light-Duty Diesel Vehicles (Passenger Cars)	
LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs GVW)	A2230002000
HDDV2B	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs GVW – includes pickup trucks)	A2230070000
HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs GVW)	A2230070000
HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	A2230070000
HDDV8B	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	A2230070000
MC	Motorcycles	A2201080000

Emission Factors - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Emission Factors for Calendar Year 2015

Vehicle Class	Model Year	Emission Factors in grams per Mile[a]								
		PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs	CO2	Fugitive PM_{10}	Fugitive $PM_{2.5}$
HDDV8A*	2005	0.2	0.19	2.8	5.47	0.01	0.48	1544.1	0.05	0.01
HDDV8B**	2005	0.2	0.19	3.33	6.23	0.02	0.58	1615.2	0.05	0.01

* Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8a

**Low Altitude Emission Factors for Heavy Duty Diesel Vehicles Class 8b

a) Emission factors from Appendix A of Air Emissions Factor Guide to Air Force Mobile Sources, AFCEE, December 2009

Greenhouse Gas Emission Factors for Calendar Year 2015

Vehicle Class	CH_4 (g/mile)	N_2O (g/mile)
HDDV	0.0051	0.0048

g/mile = grams per mile

CH_4 = Methane; N_2O = Nitrous Oxide

b) Emission Factors from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf).

Emission Calculations - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Miles for Commuter Emissions for 8 week training exercises

Vehicle Class	Speed Miles/hour	Miles/Trip	Total Trips/Day	Hours/Day	Total Days	Total Miles
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)		40	24		56	53,760
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	55			10	56	30,800

Criteria and VOC Emissions for Commuters

Vehicle Class	Model Year	Annual Miles	Criteria Pollutant Emissions (tons/year)					
			PM_{10}	$PM_{2.5}$	CO	NOx	SOx	VOCs
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	2005	53,760	0.015	0.012	0.166	0.324	0.001	0.028
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	2005	30,800	0.008	0.007	0.113	0.212	0.001	0.020
Total			**0.023**	**0.019**	**0.279**	**0.536**	**0.001**	**0.048**

Particulate emissions include exhaust, brake wear, tire wear. Assume paved road.

Greenhouse Gas Emissions for Commuters

Vehicle Class	Annual Miles	CO_2 (lb/year)	CH_4 (lb/year)	N_2O (lb/year)	CH_4 GWP Multiplier	N_2O GWP Multiplier	CO_2 Equivalent (lb/year)	CO_2 Equivalent (metric tonnes/year)
HDDV8A - Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVW)	53,760	183,004.44	0.60	0.57	25	298	183,189.08	83.09
HDDV8B - Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVW)	30,800	109,674.07	0.35	0.33	25	298	109,779.86	49.80
Total		**292,678.52**	**0.95**	**0.89**	---	---	**292,968.94**	**132.89**

GWP = Global Warming Potential; 100-year GWP values obtained from EPA's Climate Leadership, Emission Factors for Greenhouse Gas Inventories, Last Modified 4 April 2014 (http://www.epa.gov/climateleadership/documents/emission-factors.pdf)

Emission Calculations Method - Fuel Truck and Commuter Vehicle Emissions for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Calculation Method: Equation 4-1 , AFCEE 2009, Mobile Emissions Guide

EP = VMTVehCat * EFPolVehCat * 0.002205

Where,
EP = Emissions of each individual pollutant (lb/yr)
VMTVehCat = Annual vehicle miles traveled by each vehicle category (LDGV, LDGT1, LDDV, etc.) (mi/yr)
EFPolVehCat = Emission factor of each pollutant for each vehicle category (g/mi)
0.002205 = Factor for converting grams to pounds (g/lb).

DATA - Fuel Loading Emissions for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Given:	Saipan
Total Exercise Days (8 weeks)	56
Initial Fuel Fill Days	14
Remaining Fuel Fill Days	42
Total # of Fuel Trucks	6
Total Gallons per Fuel Truck	10,000
Trips per day per Fuel Truck	5
1 bbl conversion to gallons	42
Total Fuel (gal) during Initial Fill	4,200,000
Total Fuel (gal) during Remaining Exercise	12,600,000
Total Fuel (gal) during Exercise (8 Weeks)	16,800,000

Proposed Action Fuel Loading Operations

Location	Description	Fuel Type	Fuel Transferred (gal)	Category
Saipan Airport Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	Loading
Saipan Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	Loading
Saipan Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	Loading

Given:	Tinian North
Total Exercise Days (8 weeks)	56
Initial Fuel Fill Days	17
Remaining Fuel Fill Days	39
Total # of Fuel Trucks	6
Total Gallons per Fuel Truck	10,000
Trips per day per Fuel Truck	5
1 bbl conversion to gallons	42
Total Fuel (gal) during Initial Fill	5,100,000
Total Fuel (gal) during Remaining Exercise	11,700,000
Total Fuel (gal) during Exercise (8 Weeks)	16,800,000

Proposed Action Fuel Loading Operations

Location	Description	Fuel Type	Fuel Transferred (gal)	Category
Tinian North Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	Loading
Tinian Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	Loading
Tinian Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	Loading

Emission Factors - Fuel Loading Emissions for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

JP-8 emission factors (lb/Mgal)	Dispensing Splash	Loading Bottom fill	
Molecular Weight =	130		AP-42 Table 7.1-2 dated 11/06
True Vapor Pressure (psia) =	0.011		AP-42 Table 7.1-2 dated 11/06 @ 70F (annual avg.)
Dispensing Displacement losses =	0.0487	0.020	AP-42 Section 5.2 dated 6/08 Equation (1)
Spillage =	0.7		AP-42 Table 5.2-7 dated 6/08
Total =	0.749		

Emission Calculations - Fuel Loading Emissions for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Saipan

Location	Description	Fuel Type	Fuel Transferred (gal)	Displaced Vapor (lb)	Spillage (lb)	Total VOC (lb)	Total VOC (tons)
Saipan Airport Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	338.9	0	338.9	0.17
Saipan Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Saipan Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Total			**33,600,000**	**678**	**0**	**677.75**	**0.34**

Tinian

Location	Description	Fuel Type	Fuel Transferred (gal)	Displaced Vapor (lb)	Spillage (lb)	Total VOC (lb)	Total VOC (tons)
Tinian North Flightline	Loading Aircraft from Truck Fill Stands	JP-8	16,800,000	338.9	0	338.9	0.17
Tinian Seaport, Loading Racks (50,000 bbl tank 1)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Tinian Seaport, Loading Racks (50,000 bbl tank 2)	Loading Refueler Trucks	JP-8	8,400,000	169.4	0	169.4	0.08
Total			**33,600,000**	**678**	**0**	**677.75**	**0.34**

Maximum Emissions	**677.75**	**0.34**

Emission Calculations Method - Fuel Loading Emissions for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Displacement emissions for Diesel and JP-8 were estimated using Equation (1) from AP-42 Section 5.2, Transportation and Marketing of Petroleum Liquids, dated 6/08

$$L_L = 12.46\ (SPM)/T$$

Where

L_L = Loading loss in lb/10^3 gal

S = Saturation Factor 1.45 for splash loading, 0.6 for bottom loading

M = molecular weight,

T = temperature of bulk liquid (assume average annual ambient temperature)

DATA - Fuel Storage Tank Emissions for Modified Alternative 3b - Implementation Phase (Hybrid Saipan/Tinian South)

Fuel storage tank emissions were estimated using the U.S. EPA TANKS storage tank emissions calculation software (Version 4.0.9d). The emissions calculations algorithms in the TANKS program are based on Chapter 7 of EPA's AP-42. Honolulu, Hawaii was used as a surrogate location for the tanks as meteorological data does not exist in TANKS for CNMI. Jet Kerosene fuel was used as the surrogate for JP-8 in the TANKS model as it is the closet in characteristics to JP-8.

Emission Calculations Summary from TANKS* - Saipan

Tank Type	Throughput (gal.)	Working Loss (lbs)	Breathing Loss (lbs)	VOC Total (lbs)	VOC Total (tons)
Tank 1 (Saipan Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 2 (Saipan Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 3 (Saipan Airport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 4 (Saipan Airport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Total		**1,713.68**	**950.24**	**2,663.92**	**1.33**

*See the following references for TANKS printouts. (SM12 - TANKS) & (SM13 - TANKS)

Emission Calculations Summary from TANKS* - Tinian North

Tank Type	Throughput (gal.)	Working Loss (lbs)	Breathing Loss (lbs)	VOC Total (lbs)	VOC Total (tons)
Tank 1 (Tinian Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 2 (Tinian Seaport) - 50,000 bbl, cut and cover or AST	8,400,000	428.42	237.56	665.98	0.33
Tank 3 (Tinian Airport) - 60,000 bbl, cut and cover or AST	8,400,000	385.12	714.88	1100	0.55
Tank 4 (Tinian Airport) - 60,000 bbl, cut and cover or AST	8,400,000	385.12	714.88	1100	0.55
Total		**1,627.08**	**1,904.88**	**3,531.96**	**1.77**

*See the following references for TANKS printouts. (SM12 - TANKS) & (SM13 - TANKS)

Maximum Emissions	**3,531.96**	**1.77**

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX F

Aeronautical Study in the Commonwealth of the Northern Mariana Islands (Placeholder)

Aeronautical Study

The USAF is revising the Aeronautical Study in accordance with the Modified Alternatives presented in this Revised Draft EIS. The Revised Aeronautical Study will be completed before the Final EIS is published.

THIS PAGE INTENTIONALLY LEFT BLANK