DOCUMENT OF
ENVIRONMENTAL PROTECTION

ACTIVITY:
AIR EMISSIONS FROM MAJOR, SYNTHETIC MINOR, AND INDUSTRIAL BOILER STATIONARY SOURCES

CONTROL NUMBER DEP-11-001.2

FEBRUARY 2013
EFFECTIVE DATE: 23 August 2013
Modified: August 2019

U.S. ARMY KWAJALEIN ATOLL
IN THE
REPUBLIC OF THE MARSHALL ISLANDS

PREPARED BY TELEDYNE BROWN ENGINEERING, INC.
HUNTSVILLE, ALABAMA

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(DEP)
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DEP EXPIRES: Five Years After Final Signature
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REFERENCES

- J. W. Morrow. *Air Quality Impact Report (AQIR)*, U.S. Army Kwajalein Atoll (USAKA), Kwajalein, August 12, 2012
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- U.S. Army Space and Missile Defense Command. *Environmental Standards and Procedures for United States Army Kwajalein Atoll (USAKA) Activities in the Republic of the Marshall Islands (UES)*. Fifteenth Edition. September 2018. Section 2-17.3, Section 3-1
- U.S. Environmental Protection Agency (USEPA). 40 Code of Federal Regulations (CFR) Parts 50, 53, 58, 60 and 63
- U.S. Army Garrison – Kwajalein Atoll, (USAG-KA). *Document of Environmental Protection: Construction and Operation of Space Fence Radar System* (Control Number DEP-13-002.0). September 2014, Modified July 2015 and June 2016.
- AECOM, *Air Quality Impact Report (AQIR) Kwajalein, Roi-Namur and Meck Islands*, February 2018

LOCATION OF ACTIVITY

The USAKA controlled islands of Kwajalein, Roi-Namur, and Meck.

COMPLIANCE STATUS

USAKA is in compliance with this DEP. Since the previous DEP-05-001.1, new 1-hour ambient air quality standards (AAQS) for nitrogen oxides (NO_x) and sulfur dioxide (SO_2), and annual and 24-hour particulate matter of 2.5 microns or less ($PM_{2.5}$) have come into effect in the United States. Achieving compliance with these standards is discussed in Section 2.1.5 of the DEP and incorporated into applicable permit conditions.

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APPENDICES

ABBREVIATIONS AND ACRONYMS

AAQS	Ambient Air Quality Standards
AQIR	Air Quality Impact Report
BGENs	Portable Backup Generators
CFR	Code of Federal Regulations
DEP	Document of Environmental Protection
gal	Gallon
Gensets	Diesel- And Gasoline-Fueled Generator Sets
GRMI	Government of the Republic of the Marshall Islands
KMR	Kwajalein Missile Range
KPP	Kwajalein Power Plant
kW	Kilowatt
lbs/hr	Pounds Per Hour
MMBtu/hr	One Million British Thermal Units Per Hour
MOGAS	Mobility or Motor Gas
MSW	Municipal Solid Waste
NCA	Notice of Continuing Activity
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
$PM_{2.5}$	Particulate Matter (2.5 microns or less)
PM_{10}	Particulate Matter (10 microns or less)
PTE	Potential to Emit
PPA	Power Plant Annex
RICE	Reciprocating Internal Combustion Engine
SO_2	Sulfur Dioxide
Synthetic Minor	A source that is rendered a minor source when its PTE is based on limits contained in this DEP
UES	USAKA Environmental Standards
U.S.	United States
USAG-KA	U.S. Army Garrison – Kwajalein Atoll
USAKA	U.S. Army Kwajalein Atoll
USEPA	U.S. Environmental Protection Agency
VPPF	Vehicle Paint and Preparation Facility

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1.0 TECHNICAL DESCRIPTION OF ACTIVITY

The Document of Environmental Protection (DEP-11-001.0) provides renewal and update of the activities covered by DEP-05-001.1, *Air Emissions from Major Stationary Sources* and two minor modifications. This DEP provides for the continuing operation of those major, synthetic minor, and industrial boiler emission units that are in operation on the U.S. Army Garrison - Kwajalein Atoll (USAG-KA) controlled islands of Kwajalein, Roi-Namur, and Meck. Major sources on Ennylabegan and Omelek are no longer in service and, therefore, are not included in this DEP. Emission sources on Gagan, Legan, and Illeginni have been replaced with smaller generators (80 kW Tier 3 Kohler units) that render them minor sources. Moreover, Gagan, Legan, and Illeginni have no residential population and are only occasionally visited for short durations by personnel for maintenance and repairs. These islands are closed for visitation under the Military Use and Operating Rights Agreement (MUORA) between the US and the Government of the Republic of the Marshall Islands (GRMI). Accordingly, air at the island(s) and immediate, surrounding reef areas is not considered as ambient air within the meaning of the USAKA Environmental Standards (UES). Consequently, the DEP does not include emission sources on Gagan, Legan or Illeginni. As a matter of good practice and worker safety, USAG-KA has made improvements in the stack configuration on these islands by heightening them to no less than 10 feet and orienting the discharges to vertical.

This DEP includes the relevant operating limits and conditions for attainment of the current UES Ambient Air Quality Standards identified in Table 1.0.

The 2012 AQIRs showed widespread exceedances of the 1-hour SO_2 and NO_x standards and localized exceedances of the annual and 24-hour $PM_{2.5}$ standards on some islands (see Chapters 1-3 of the NCA).

As a result of the 2012 AQIR exceedances, this DEP required USAG-KA to develop a plan to protect public health and the environment through attainment of all AAQS (including the new 1-hour NO_x, SO_2, and annual and 24-hour $PM_{2.5}$ standards) or other measures to protect public and worker health. The plan is required to be submitted to the Appropriate Agencies as a minor modification for review no later than three years after the effective date of this DEP.

A minor modification proposing an AAQS Attainment Plan was submitted June 23, 2016. The minor modification proposed a plan to demonstrate compliance through physical measurement of ambient air quality on Kwajalein, Roi-Namur, and Meck Islands. Ambient air sampling was proposed to be conducted on each island for the pollutants that were predicted to contravene the UES AAQS (NO_2, SO_2, and $PM_{2.5}$) in the 2012 AQIRs. This approach allowed USAG-KA to determine compliance with the AAQS by the most direct means. The plan also indicated in the event significant AAQS exceedances are confirmed through on-site monitoring, then appropriate changes to control emissions would be pursued.

On 27 July 2016, the USEPA provided formal comments to the proposed minor modification to the DEP. The USEPA indicated the modification did not meet the legal requirement set forth in the UES for minor modifications to a DEP. Additionally, the proposed modification did not meet the requirements set forth in the DEP itself, particularly the requirement for a plan and schedule to demonstrate attainment of the UES AAQS. While the proposed DEP minor modification is required to identify how USAG-KA intended to meet the UES AAQS through an attainment plan, the USEPA asserted the minor modification instead proposed a means to reassess compliance and then re-evaluate how to meet the AAQS, if needed. The USEPA expressed that further scrutiny of the proposal by the Agency was warranted, and that the proposal should either be withdrawn and revised or be rejected as a minor modification.

On 20 September 2016, USAG-KA provided a response to the comments received from the USEPA on the proposed minor modification. The response proposed a different approach by first conducting AAQS monitoring on Kwajalein, Roi-Namur, and Meck Islands to demonstrate whether the UES AAQS were exceeded. The approach also proposed conducting revised air dispersion model for USAG-KA that incorporated changes to existing emission sources, inclusion of Space Fence Power Plant Annex generators and updated appropriate model inputs. An evaluation of the results from the air dispersion modeling and the AAQS monitoring would be utilized to select appropriate controls and/or protective measures to mitigate any remaining AAQS exceedances. The selected measures would then be submitted to the Appropriate Agencies in a minor modification to address the required actions to attain AAQS.

On 18 October 2016, the USEPA concurred with the approach presented by USAG-KA to address the issues identified in the comments.

AAQS monitoring adjacent to the Kwajalein, Roi-Namur, and Meck Island Power Plants in areas of highest predicted concentration was conducted from September – December 2017. Updated air dispersion modeling associated with the Kwajalein, Roi-Namur, and Meck Island Power Plants was also performed. The results of AAQS monitoring and updated air dispersion modelling is provided in Appendix A (2018 AQIRs for Kwajalein, Roi-Namur, and Meck Islands).

Based on the results of the AAQS monitoring conducted and the updated air dispersion modeling, a minor modification to the DEP was submitted to the Appropriate Agencies in June 2019 proposing measures to protect public and worker health and meet attainment of the AAQS. The three measures were:

(1) reduction in the sulfur content limitation for fuel used by all power plants from 1% by weight to 0.08% by weight;
(2) reduction in the limitation of the annual fuel usage to each island power plant; and
(3) installation and maintenance of "No Loitering" signs in the areas adjacent to the Power Plants.

USAG-KA is currently engaged in energy performance saving projects on each island that will reduce fuel use and significantly curb air emissions from all power plants. These energy saving projects include:

(1) Replacement of select window air conditioner with high-efficiency split systems (2019).
(2) Building envelope improvements (2019).
(3) Upgrade of select interior and exterior lighting with energy efficient LED components (2020).

(4) Installation and operation of a Kwajalein Central Chiller Plant and chilled water distribution system and conversion to high-efficiency chilled water heating, ventilation, and air conditioning systems (2023).
(5) Replacement of electric water heaters with high-efficiency heat pump water systems (2023).
(6) Installation and operation of a 1.86 MW solar photovoltaic generator on Meck Island (2020).

Although these projects are not required to attain AAQS, they will reduce fuel usage and improve air quality on USAKA by reducing air emissions from the power plants.

In the event that a U.S. health-based air quality standard(s) is modified while this DEP is in effect, the modification(s) is automatically made to the USAKA Environmental Standards (UES) in accordance with UES§2-22.2, unless otherwise agreed to by the U.S. and the GRMI. A UES modification(s) of this nature shall be considered as incorporated into this DEP upon its effective date in the UES, and shall also be incorporated into this DEP through a minor modification completed in accordance with UES§2-17.3.6(e). Table 1.0 contains the primary AAQS for USAKA.

Table 1.0 UES Primary Ambient Air Quality Standards (Criteria Pollutants)

Pollutant	Averaging Period	UES Standard[1]
Sulfur Oxides ($S0_x$)	1-hour	60 ppb
Carbon Monoxide (CO)	1-hour 8-hour	28 ppm 7.2 ppm
Particle Pollution ($PM_{2.5}$)	24-hour Annual	28 µg/m3 9.6 µg/m^3
Particle Pollution (PM_{10})	24-hour	120 µg/m^3
Ozone (O_3)	8-hour	0.06 ppm
Nitrogen Dioxide (NO_2)	1-hour Annual	80 ppb 42.4 ppb
Lead (Pb)	Rolling 3-Month Average	0.12 µg/m^3

[1] Values reflect 80% of the U.S. National Ambient Air Quality Standard

1.1 Major, Synthetic Minor, and Industrial Boiler Stationary Sources

The stationary sources addressed in this DEP are:

- Abrasive blasting at various locations
- Operation of power plants: Kwajalein, Power Plant Annex, Roi-Namur, Meck,
- Operation of existing solid waste incinerators: Kwajalein, Roi-Namur, and Meck
- Bulk gasoline storage: Kwajalein, Fuel Farm Tank No. 9
- Operation of the vehicle painting and preparation facility on Kwajalein
- Operation of emergency generators at various locations constructed before June 12, 2006.

Table 1.1 Major and Synthetic Minor Stationary Sources of Air Pollution

Source ID	Type	Rating	Make/Model	Classification	Remarks
Kwajalein					
KWPP1A	Generator Sets (Gensets)	2 units @ 4,000 kilowatt (kW) each	Caterpillar C280-16	Major	---
KWPP1A	Genset	1 unit @ 1820 kW	Caterpillar C280-6	Major	Replacement, 2012
KWPP1B	Gensets	4 units@ 4,400 kW each	Caterpillar C280-16	Major	---
KWPPA	Gensets	3 units @ 3,640kW each	Caterpillar C280-12	Major	
KWIN	Municipal Solid Waste (MSW) Incinerator	1 unit@ 32 tons/day	Batch Oxidation	Major	Replaced in 2019
KWST	Motor Gasoline (MOGAS) Storage Tank#9	355,740 gal	External floating roof; AST	Major	Approx. 109K gal/yr throughput
KWVPP	Vehicle Paint & Prep Facility	NA	NA	Synthetic minor	---
Roi-Namur					
RNIN	MSW Incinerator	1 unit @ 850 lbs/hr	---	Major	---
RNPP	Gensets	9 units @ 1500 kW each	Caterpillar 3606	Major	---
Meck					
MKIN	MSW Incinerator	1 unit @ 850 lbs/hr	---	Major	---
MKPP	Gensets	5 units @ 565 kW each	Caterpillar 3508	Major	---
USAKA-Wide					
SB	Abrasive Blasting	NA	NA	Synthetic Minor	Various locations
EGENS	Emergency & Backup Generators constructed prior June 2006	Various	Various	Minor sources subject to NESHAPS	No applicable limits or controls

Notes: kW = kilowatt; gal = gallon; gal/yr = gallons per year; lbs/hr = pounds per hour; MMbtu/hr = Million British Thermal Units per hour

1.2 Individual Sources and Associated Technical Information

Technical information on existing sources is provided in NCA-11-001.0; in Appendix A and in the 2012 AQIRs (see NCA Chapters 1 through 3). Fuel oil burning source locations also are shown in the AQIRs.

2.0 REQUIREMENTS AND LIMITATIONS

All requirements and limitations stated in this DEP are based on continued operations as provided in the companion NCA. Additions and alterations to any source(s) other than those presented in this DEP and companion NCA shall require review by the Appropriate Agencies.

2.1 USAKA-Wide

2.1.1 Abrasive Blasting

2.1.1(a) Limit USAKA-wide particulate matter of 10 microns (PM_{10}) emissions to less than 15 tons per year by limiting the annual use of abrasive media at USAKA to less than 1,150 tons per 12-month rolling period.

2.1.2 Fuel Sulfur Content

2.1.2(a) USAG-KA shall limit sulfur content of fuel oil used at all the power plants to no more than 0.08 percent by weight. (USAKA-wide limit)

2.1.3 Reserved

2.1.4 Reserved

2.1.5 Plan and Schedule to Attain Ambient Air Quality Standards (AAQS)

2.1.5(a) Within three years of the effective date of this DEP, USAKA shall prepare a proposed modification to this DEP with a plan and schedule, and submit it for agency review in accordance with UES§2-17.3.6. At a minimum, the proposed plan shall:

- Address potential AAQS exceedances on Kwajalein, Roi-Namur, and Meck.

- Demonstrate that AAQS attainment and/or other measures to protect public and worker health shall be achieved within five years of the effective date of the revised DEP. If a longer period is required, the plan shall justify the longer period. In no event shall attainment and/or other protective measures be achieved later than ten years from the effective date of the revised DEP.

- Describe specific actions that will be taken and any necessary requirements to attain all AAQS and/or protect public and worker health along with an associated implementation schedule. Those actions that may occur after the expiration date of this DEP shall be included in the NCA that will be submitted 90 days prior to the expiration date of this DEP.

- As necessary, revise conditions and requirements that will be superseded by the planned actions to meet AAQS or otherwise not needed due to new developments.

- Describe the procedures that shall be followed to mitigate the impacts of any new, major sources of air pollutants that may begin operations prior to the attainment of all AAQS. Such procedures may include requirements to ensure there is no net increase in emissions. In no case shall a new source jeopardize attainment of AAQS in accordance with the established schedule.

- Include reporting and notifications to the Appropriate Agencies of sufficient frequency and content to enable monitoring implementation of actions to attain AAQS.

- Include a reassessment of compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPs) at 40 CFR Part 63, Subpart ZZZZ. The reassessment shall take into account the actions scheduled to attain AAQS.

2.1.5(b) The proposed DEP modification plan and schedule required by §2-1.5(a) above shall be processed in accordance with the actions and timeframes in UES §2-17.3.6.

2.2 Kwajalein

2.2.1 Power Plants 1A and 1B

Based on the air quality analysis in Appendix A, the following limitations on operation of Power Plants 1A and 1B is necessary to ensure compliance with the UES AAQS:

2.2.1(a) Limit the 12-month rolling total fuel consumption of Power Plants 1A and 1B combined to less than 7.122 million gallons.
2.2.1(b) Install in 2019 and maintain “No Loitering” signs in English and Marshallese in the area identified in Appendix A where modeling results indicated an exceedance of the UES AAQS.

2.2.2 MSW Incinerator

2.2.2(a) Incinerator shall combust only non-hazardous solid waste and other waste as provided for in the DEP for solid waste disposal (DEP-10.003.0).
2.2.2(b) Incinerator may be fired with a combination of fuel oil and used oil;
2.2.2(c) Used oil shall meet the criteria set forth in UES §3-6.5.7(b)(4)(iii), AND
2.2.2(d) To the extent practical incinerator operators shall minimize startups and shut-downs of the incinerator.

2.2.3 Fuel Farm

2.2.3(a) When any tank greater than 39,800 gallons storing a product with a true vapor pressure greater than 3.5 kilopascals or any tank with a capacity between 19,800 ($71m^3$) and 39,800 ($151m^3$) gallons storing a product with a true vapor pressure greater than 15.0 kilopascals is replaced or rehabilitated, consideration shall be given to the standards given in 40 CFR Part 60, Subpart Kb (New Source Performance Standards - Volatile Organic Liquid Storage Vessels).

2.2.4 Vehicle Paint and Preparation Facility

2.2.4(a) Each booth of the Vehicle Paint and Preparation Facility (VPPF) (including the paint/rhino booth, abrasive blast booth and metallization booth) shall be equipped with ventilation and a high efficiency filter system to capture particulate matter;
AND,

2.2.4(b) Operating hours for the paint/rhino booth and for the metallization booth shall be limited to less than 4,190 hours each per 12-month rolling period (approximately 11 hours per day each) to ensure the sources are operated below the thresholds set forth in UES §3-1.5.2.

2.2.5 Power Plant Annex (PPA)

2.2.5(a) Limit the 12-month rolling total fuel consumption of the PPA to less than 4.273 million gallons.

2.3 Roi-Namur

2.3.1 Power Plant

Based upon the air quality analysis in Appendix A, the following limitation on operation of the Roi-Namur Power Plant is necessary to ensure compliance with the UES AAQS:

2.3.1(a) Limit the 12-month rolling total fuel consumption to less than 3.274 million gallons.

2.3.1(b) Install in 2019 and maintain “No Loitering” signs in English and Marshallese in the area identified in Appendix A where modeling results indicated an exceedance of the UES AAQS.

2.3.2 MSW Incinerator

2.3.2(a) Incinerator shall combust only non-hazardous solid waste and other waste as provided for in the DEP for solid waste disposal (DEP-10.003.0).

2.4 Meck

2.4.1 Power Plant

Based upon the air quality analysis in Appendix A, the following limitations on operations of the Meck Power Plant are necessary to ensure compliance with the UES AAQS:

2.4.1(a) Limit the 12-month rolling total fuel consumption to less than 0.585 million gallons.

2.4.1(b) Install in 2019 and maintain "No Loitering" signs in English and Marshallese in the area identified in Appendix A where monitoring results indicated an exceedance of the UES AAQS.

2.4.2 MSW Incinerator

2.4.2(a) Incinerator shall combust only non-hazardous solid waste and other waste as provided for in the DEP for solid waste disposal (DEP-10.003.0).

3.0 MINOR DEP MODIFICATIONS

Minor modifications to this DEP may be accomplished under the provisions of UES §2-17.3.6(e).

4.0 NOTIFICATION

4.1 Emergency Notifications

USAG-KA will notify the Appropriate Agencies and the public of any release or anticipated release of air pollutants that could result in an exposure of the public representing a significant public health threat.

4.2 Air Quality Notifications

4.2.1 Notify the Appropriate Agencies of any changes to the emission unit inventory contained in the DEP.

4.2.2 Notify the Appropriate Agencies of any operational changes, malfunctions, or other circumstances that either have, or potentially will result in an exceedance of a limitation or non-compliance with a requirement stated in the DEP.

4.2.3 Notify the Appropriate Agencies of any authorizations, or proposed authorizations, for open burning under UES §§3-1.7.1(a) or (b).

4.2.4 Notify the Appropriate Agencies if any fuel oil with sulfur content exceeding 0.08 percent by weight is used at any of the power plants.

5.0 RECORD-KEEPING

5.1 Record Retention and Availability

All records specified in this DEP shall be retained in accordance with UES §2-13. The records shall be available for examination by the Appropriate Agencies upon request.

5.2 Fuel Sulfur Content

USAG-KA shall maintain a record of the sulfur content of fuel received at the fuel farm.

5.3 Abrasive Blast Media

USAG-KA shall determine and record the annual use of abrasive blast media at USAKA.

5.4 Power Plants

USAG-KA shall monitor and record the monthly fuel consumption and maintain a record showing the 12-month rolling total fuel consumption at the following Power Plants: Kwajalein, Power Plant Annex, Roi-Namur, and Meck.

5.5 Kwajalein Vehicle Paint and Preparation Facility

USAG-KA shall monitor and record the monthly operating hours of the paint/rhino and metallization booths and maintain a record showing the 12-month rolling total hours of operation for each booth.

6.0 REPORTING

Reporting requirements are noted in the individual sections and notification requirements of this DEP. Of particular importance is the submission of the DEP modification required in §2.1.5.

7.0 RESOLUTION OF NON-COMPLIANT AREAS

USAKA is in substantive compliance with the requirements and limitations of DEP-11-001.0. However, new AAQS and NESHAPs have been promulgated in the U.S. Compliance with these new standards is addressed in §§1.0 and 2.1.5 of this DEP.

8.0 ENVIRONMENTAL COMMENTS AND RECOMMENDATIONS RECEIVED ON THE DRAFT DEP AND USAKA RESPONSES

U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT

COMMENT: Draft DEP and NCA do not affect resources within the jurisdiction of this agency. No comments are provided.

USAKA Response: Comment noted.

U.S. ENVIRONMENTAL PROTECTION AGENCY

COMMENT: Draft DEP and NCA may affect resources within the jurisdiction of this agency. Agree with proposed environmental controls. No comments provided.

USAKA Response: Comment noted.

U.S. FISH AND WILDLIFE SERVICE

COMMENT: Draft DEP and NCA do not affect resources within the jurisdiction of this agency. Comments are provided.

COMMENT 1: The Service commends USAKA in its continuing efforts to reduce air emissions from these sources, which have included downsizing, purchase and installation of new equipment to reduce pollution, and developing plans for long-term reductions in air emissions. USAKA is aware of the emissions exceedances, and has a reasonable plan to bring the emissions into compliance. The current emissions do not appear to be adversely affecting wildlife resources, as the emissions are almost immediately carried off-island, and rapidly diluted with winds over the lagoon or open sea. Depositions of emissions into the ocean over a wide area are at such low levels that marine wildlife will not be affected. The Service concurs with the plans outlined, and requests to be kept informed of future actions.

USAKA RESPONSE: Comment noted.

NATIONAL MARINE FISHERIES SERVICE, PACIFIC ISLANDS REGIONAL OFFICE, PROTECTED RESOURCES DIVISION

COMMENT: Draft DEP and NCA may affect resources within the jurisdiction of this agency. Agree with proposed environmental controls. No comments provided.

USAKA RESPONSE: Comment noted.

REPUBLIC OF THE MARSHALL ISLANDS ENVIRONMENTAL PROTECTION AUTHORITY

COMMENT: None received.

APPENDIX A

2018 AIR QUALITY IMPACT REPORT (AQIR) FOR KWAJALEIN, ROI-NAMUR AND MECK ISLANDS

Air Quality Impact Report (AQIR)

Kwajalein, Roi-Namur and Meck Islands

Kwajalein Atoll, Republic of the Marshall Islands

Kwajalein Range Services, LLC

Project Number: 60546992

February 2018

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Revision	Revision date	Details	Authorized	Name	Position

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# Hard Copies	PDF Required	Association / Company Name
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Figures

Tables

1. Introduction

1.1 Background

The United States Army Kwajalein Atoll (USAKA) Environmental Standards (UES) includes specific processes for addressing activities with potential environmental impacts. Sources with the potential to emit regulated air pollutants above thresholds specified in the UES, or sources regulated by the National Emission Standards for Hazardous Air Pollutants (NESHAPS), require preparation of various documents. An air quality impact analysis that includes an assessment based on air quality modeling of existing emission sources and the predicted change in ambient air quality resulting from the operation of any new sources is required by the UES. Notice of Continuing Activity NCA-11-001.0 included Air Quality Impact Reports (AQIRs) for Kwajalein, Roi-Namur and Meck islands prepared in 2012 (see **Figure 1-1** for locations of these islands). These AQIRs were applicable to the United States Army Garrison – Kwajalein Atoll (USAG-KA) air pollutant emission source inventory at the time of preparation of those reports (CY 2012). Document of Environmental Protection (DEP) DEP-13-002.0, *Construction and Operation of Space Fence Radar System*, documented addition of new sources of regulated air pollutants to provide power for the Space Fence radar at USAG-KA. These emission sources were not included in the 2012 AQIRs.

Updated air dispersion modeling, ambient air sampling and updated AQIRs are needed to analyze the impact of adding the new emission units to the USAG-KA air emission source inventory. To address this requirement, AECOM has conducted ambient air sampling, updated air dispersion modeling and updated the AQIR to address addition of the Space Fence power plant (Power Plant Annex) generators (Kwajalein Island only) and other changes to the air emission source inventories at USAG-KA.

USAG-KA is required by DEP-11-001.0, Air Emissions from Major, Synthetic Minor, and Industrial Boiler Stationary Sources, to attain Ambient Air Quality Standards (AAQS) which are set at 80 percent (%) of the United States Environmental Protection Agency (USEPA) National Ambient Air Quality Standards (NAAQS). The updated AQIR is intended provide an updated status of AAQS compliance and be responsive to specific comments received from the USEPA on the Ambient Air Quality Attainment Plan.

The NAAQS and AAQS for the criteria pollutants and averaging periods evaluated for this analysis are included in **Table 1-1**. Footnotes to **Table 1-1** explain how compliance with each NAAQS is assessed.

Table 1-1: Ambient Air Quality Standards

Pollutant	NAAQS Primary Standards		NAAQS Secondary Standards	UES AAQS – [80% NAAQS] (µg/m^3)		Averaging Times
	(µg/m^3)	(ppb)	(µg/m^3)	(µg/m^3)	(ppb)	
Carbon Monoxide	40,000	35,000	---	32,000	28,000	1-Hour[1]
	10,000	9,000	---	8,000	7,200	8-Hour[1]
Nitrogen Dioxide	188	100	--	150.4	80	1-hour[3]
Particulate Matter ($PM_{2.5}$)	35	---	35	28	---	24-Hour[5]
	12	---	15	9.6	---	Annual[4]
Sulfur Oxides	196	75	--	156.8	60	1-Hour[2]

Source: http://www.epa.gov/air/criteria.html.

1 Not to be exceeded more than once per year.

2 Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 parts per billion (“ppb”).

3 To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).

4 To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 12.0 micrograms per cubic meter (“µg/m^3”).

5 To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).

1.2 Overview of Ambient Monitoring and Dispersion Modeling

This AQIR documents the 2017 ambient air monitoring and updated air dispersion modeling analyses conducted for the Kwajalein, Roi-Namur and Meck power plants (see **Figures 1-2**, **1-3** and **1-4**, respectively, for their locations). The purpose of the monitoring and updated dispersion modeling was to evaluate the revised USAG-KA air emission source inventory to account for the addition of the Power Plant Annex generators (Kwajalein), upgrades to the power plant engines, and use of ultra-low sulfur fuel oil at each island.

Air sampling of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter with aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$) was conducted for the following periods on each island:

- Kwajalein - August 30, 2017 through December 13, 2017;
- Roi-Namur - September 12, 2017 through December 15, 2017; and
- Meck - September 02, 2017 through December 14, 2017.

The ambient air monitoring program was designed to meet the requirements of USEPA 40 CFR 53 *Ambient Air Monitoring Reference and Equivalent Methods*, 40 CFR 58 Ambient Air Quality Surveillance and *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II* guidelines. Dispersion modeling was initially conducted for the existing island power plant engines to site the air sampling stations on each island. The monitoring stations were located near the dispersion model-predicted point of maximum air quality impact near each power plant (see **Figures 1-2**, **1-3** and **1-4**, respectively), generally downwind of the predominant wind direction (winds from the NE or ENE).

Air dispersion modeling was also conducted for air emissions of $PM_{2.5}$, SO_2, NO_2 and carbon monoxide (CO) to evaluate the maximum modeled concentrations relative to the UES AAQS, which are set at 80% of the USEPA’s NAAQS. As noted, the modeling included the three new Power Plant Annex engines, recent upgrades to the Kwajalein Island power plant engines and use of ultra-low sulfur fuel oil.

Dispersion modeling was also conducted for formaldehyde and acrolein air emissions from the power plant engines and evaluated relative to the ambient air Regional Screening Levels (RSLs) prescribed by USEPA[1] to determine the potential health risk.

The air dispersion modeling was conducted in accordance with USEPA guidance provided in *40 CFR 51, Appendix W, Guideline on Air Quality Models* (GAQM, Revised 2016)[2]. The modeling was conducted with the latest version of AERMOD (Version 16216r) dispersion model and five recent years (2012 – 2016) of Kwajalein meteorological data processed with AERMET (the AERMOD meteorological data processor). AECOM acquired pre-processed meteorological data from the National Climatic Data Center (*ftp://ftp.ncdc.noaa.gov/pub/data/noaa/*). AERMOD is the USEPA’s state-of-the-art model designed to assess air quality impacts from stack sources in rural or urban environments involving both flat and hilly terrain features. AERMOD is recognized internationally and it is routinely applied in the United States and around the world for air quality compliance demonstrations.

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[1] https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2017

[2] https://www3.epa.gov/ttn/scram/appendix_w-2016.htm

The following emission scenarios were evaluated in the modeling for each island power plant:

- Representative maximum load case for the power plant engines;
- Nominal operations (including the three (3) new engines for the Power Plant Annex on Kwajalein Island); and
- Future reduced emissions scenario to simulate air quality benefits of energy savings measures.

Further details on these operational scenarios and source data are provided in **Section 5**.

The ambient measurements served to establish current existing ambient concentrations and were also used to support an analysis to evaluate AERMOD model performance. The model evaluation utilized several statistical tests and graphical displays used in recent evaluations[3], such as time series plots, quantile-quantile plots ("Q-Q plots"), and analyses of concentrations vs. model inputs such as wind direction and wind speed. The analysis included a review of modeled concentrations, monitored concentrations, concurrent meteorological data from Kwajalein, and power plant operating conditions/emissions information.

The remainder of this report is organized as follows:

- Section 2 – Ambient Monitoring Program;
- Section 3 – Model Selection and Application;
- Section 4 – Ambient Impact Criteria;
- Section 5 – Source Data;
- Section 6 – Modeling Results;
- Section 7 – Review of Monitoring and Modeling Results/Model Evaluation Analysis;
- Section 8 – Conclusions
- Appendix A – Air Quality Monitoring Results
- Appendix B – Wind Roses
- Appendix C – Pollution Roses
- Appendix D – Elevated Hourly NO_2 Concentrations
- Appendix E – Quality Assurance Quality Control Documentation
- Appendix F – Power Plant Annex Engine Specification Comparison

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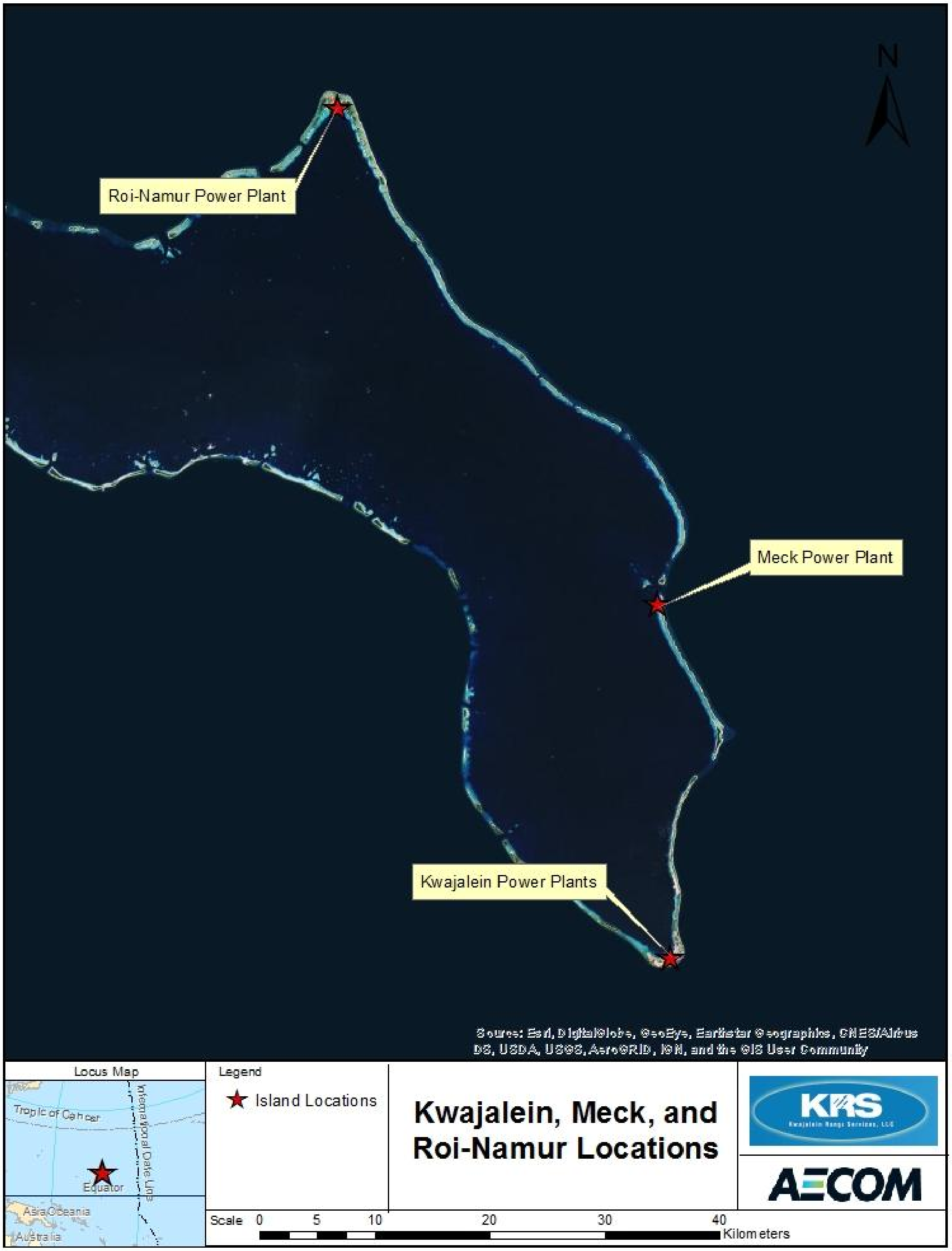
[3] For example, see Paine, R., O. Samani, M. Kaplan, E. Knipping and N. Kumar (2015) Evaluation of low wind modeling approaches for two tall-stack databases, Journal of the Air & Waste Management Association, 65:11, 1341-1353, DOI: 10.1080/10962247.2015.1085924.

Figure 1-1: Location of the Kwajalein, Meck, and Roi-Namur Islands



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 1-2: Location of the Kwajalein Power Plant and Ambient Monitoring Station

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 1-3: Location of the Roi-Namur Power Plant and Ambient Monitoring Station

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 1-4: Location of the Meck Power Plant and Ambient Monitoring Station

2. Ambient Air Measurements

2.1 Introduction

This final ambient air monitoring summary has been developed by AECOM on behalf of Kwajalein Range Services, LLC (KRS) to summarize the ambient air quality (AQ) data collected at USAG-KA in the Republic of the Marshall Islands. Measurements were collected in accordance with the project-specific Ambient Air Monitoring Plan (AAMP) generated by AECOM, dated August 2017 and AAMP Amendment 01, dated December 2017. A total of three AQ sites were installed in the vicinity of the power plants on Kwajalein, Meck, and Roi-Namur islands. The location of each monitor was chosen based on the location of the highest modeled SO_2, NO_2, and $PM_{2.5}$ concentrations and consideration of the prevailing winds (see **Figures 1-2**, **1-3** and **1-4** above).

2.2 Air Quality Monitoring

AECOM arrived at the atoll in late August 2017 to install and operate the three air monitoring stations on the islands of Kwajalein, Meck and Roi-Namur. Installations at the individual islands were completed in series between August 29 and September 12, 2017. The operational start and end dates for each station are documented in **Table 2-1**.

Table 2-1: Monitoring Location Start and End Dates

Station	**Start Date**	**End Date[1]**
Kwajalein	August 30, 2017	December 13, 2017
Meck	September 2, 2017	December 14,2017
Roi-Namur	September 12, 2017	December 15, 2017
[1] End dates for the $PM_{2.5}$ samplers vary due to the 72-hour zero checks performed prior to shut down.		

Air monitoring and data validation was conducted in accordance with AAMP and applicable amendments referenced herein. The monitoring equipment installed in the USAG-KA ambient air quality monitoring network was selected to meet the requirements of *EPA 40 CFR 53 Ambient Air Monitoring Reference and Equivalent Methods, 40 CFR 58 Ambient Air Quality Surveillance,* and Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II guidelines. Instrumentation used during the program is listed in **Table 2-2**.

Table 2-2: Monitoring Instrumentation

Instrument	**Model**
SO_2 Analyzer	Thermo Fisher Scientific Model 43A Pulsed Fluorescence SO_2 Analyzers (EPA Designated Equivalent Method No. EQSA-0486-060)
$NO/NO_2/NO_x$ Analyzer	Thermo Fisher Scientific Model 42 Chemiluminescence $NO-NO_2-NO_x$ Analyzers (EPA Designated Reference Method No. RFNA-1289-074)
SO_2, $NO/NO_2/NO_x$ In-station Calibrator	Valco Instruments Co. Inc. Dynacalibrator, Model 230 Calibration System
SO_2, $NO/NO_2/NO_x$ Audit Calibrator	Thermo Fisher Scientific Model 143 Permeation Calibrator
$PM_{2.5}$ Analyzer	MetOne Beta Attenuation Monitor (BAM) Model 1020 measurement system configured with a $PM_{2.5}$ sample inlet cyclone

2.2.1 Air Monitoring Results Summary

Monthly data listings of the hourly air monitoring results for SO_2, NO_2 and $PM_{2.5}$ for each air monitoring station are included in **Appendix A**.

Summaries of the air monitoring data collected at each site are presented in the tables identified below. The operational months presented in the tables may vary depending on the start dates of each air monitoring site. The monthly and program maximum and average hourly concentrations are shown in **Table 2-3** through **Table 2-5**. The maximum and average concentrations included in these tables are not applicable for comparison to the UES AAQS and cannot be used to evaluate compliance/non-compliance with the UES AAQS.

The measurement period, data capture percentage and number of valid sampling days for each station and parameter are summarized in **Table 2-6** through **Table 2-8**.

Table 2-3: Kwajalein Data Summary

	Hourly SO_2 Concentrations (ppb)		Hourly NO_2 Concentrations (ppb)		Hourly $PM_{2.5}$ Concentrations (µg/m^3)		24-Hour $PM_{2.5}$ Concentrations (µg/m^3)	
	Maximum	**Average**	**Maximum**	**Average**	**Maximum**	**Average**	**Maximum**	**Average**
August	6	3	1	0	1	0	0	0
September	4	1	35	2	10	0	2	0
October	3	1	95	1	18	0	5	0
November	3	2	62	4	25	1	16	1
December	3	1	35	11	15	3	6	3
Program Summary	6	1	95	3	25	0	16	0

Definitions:
NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
ppb – parts per billion
SO_2 – sulfur dioxide (measured in parts per billion)
µg/m^3 – micrograms per cubic meter

Table 2-4: Meck Data Summary

	Hourly SO_2 Concentrations (ppb)		Hourly NO_2 Concentrations (ppb)		Hourly $PM_{2.5}$ Concentrations (µg/m^3)		24-Hour $PM_{2.5}$ Concentrations (µg/m^3)	
	Maximum	**Average**	**Maximum**	**Average**	**Maximum**	**Average**	**Maximum**	**Average**
September	7	0	57	3	16	1	5	1
October	4	1	74	9	12	0	5	0
November	5	1	124	20	85	1	11	1
December	3	2	129	42	12	3	4	2
Program Summary	7	1	129	17	85	1	11	1

Definitions:
NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
ppb – parts per billion
SO_2 – sulfur dioxide (measured in parts per billion)
µg/m^3 – micrograms per cubic meter

Table 2-5: Roi-Namur Data Summary

	Hourly SO_2 Concentrations (ppb)		Hourly NO_2 Concentrations (ppb)		Hourly $PM_{2.5}$ Concentrations (µg/m^3)		24-Hour $PM_{2.5}$ Concentrations (µg/m^3)	
	Maximum	**Average**	**Maximum**	**Average**	**Maximum**	**Average**	**Maximum**	**Average**
September	0	0	13	0	42	2	7	2
October	0	0	4	0	46	2	6	1
November	0	0	5	0	47	1	7	1
December	0	0	23	3	91	5	10	4
Program Summary	0	0	23	0	91	2	10	1

Definitions:
NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
ppb – parts per billion
SO_2 – sulfur dioxide (measured in parts per billion)
µg/m^3 – micrograms per cubic meter

Table 2-6: Kwajalein Data Capture (%) Summary

	SO_2	NO_2	$PM_{2.5}$
Monitoring Period	8/30/17 13:00 – 12/13/17 8:00	8/30/17 13:00 – 12/13/17 7:00	8/30/17 22:00 – 12/8/17 10:00
Hourly Data Capture %	99.4%	86.0%	99.8%
Number of Valid Sampling Days	104	88	99

Definitions:
NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
SO_2 – sulfur dioxide (measured in parts per billion)

Table 2-7: Meck Data Capture (%) Summary

	SO_2	NO_2	$PM_{2.5}$
Monitoring Period	9/2/17 14:00 – 12/14/17 8:00	9/2/17 15:00 – 12/14/17 8:00	9/2/17 9:00 – 12/9/17 7:00
Hourly Data Capture %	96.6%	82.0%	99.0%
Number of Valid Sampling Days	97	82	97

Definitions:
NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
SO_2 – sulfur dioxide (measured in parts per billion)

Table 2-8: Roi-Namur Data Capture (%) Summary

	SO_2	NO_2	$PM_{2.5}$
Monitoring Period	9/12/17 16:00 – 12/15/17 9:00	9/12/17 16:00 – 12/15/17 9:00	9/12/17 16:00 – 12/12/17 11:00
Hourly Data Capture %	99.6%	71.4%	99.5%
Number of Valid Sampling Days	93	65	90
Definitions: NO_2 – nitrogen dioxide (measured in parts per billion) $PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter) SO_2 – sulfur dioxide (measured in parts per billion)			

2.2.2 Meteorological Summary

Kwajalein airport meteorological data was obtained from the National Climatic Data Center (ftp://ftp.ncdc.noaa.gov/pub/data/noaa/). Monthly and program wind roses were generated and included in **Appendix B**. During the measurement period, the predominant wind direction was from the east-northeast to easterly direction between 3 and 9 meters per second. The monthly wind roses show a higher frequency in east-northeast and easterly winds in November and December than in September and October. Additionally, there was a general increase in wind speeds during the project, with lower winds speeds in September and higher wind speeds in November and December. These general trends are consistent with our expectations for the meteorological conditions during this time of year as compared to climatological normal conditions.

The meteorological conditions verify that the locations of the air monitoring stations were placed in the primary downwind direction from the major contributing source at each of the islands.

2.2.3 Data Analysis

The AAQS exceedance summaries for SO_2, NO_2, and $PM_{2.5}$ are presented in the tables below. The AAQS are set to 80% of the USEPA's NAAQS per the Environmental Standards and Procedures for USAKA Activities in the Republic of the Marshall Islands (September 2016). The AAQS standards are listed by parameter in **Table 4-1** in **Section 4**.

A summary of the UES AAQS standards and the number of daily maximum concentrations greater than the UES AAQS is provided in **Table 2-9**. Additionally, plots of the daily maximum SO_2 and NO_2 concentrations compared to the UES AAQS are included in **Figure 2-1** and **Figure 2-2**, respectively. Likewise, a plot of the daily average $PM_{2.5}$ concentrations compared to the UES AAQS is included in **Figure 2-3**. These plots show that the measured daily maximum SO_2 and 24-hour average $PM_{2.5}$ concentrations were less than the UES AAQS throughout the duration of the air monitoring project. There were, however, daily maximum NO_2 concentrations measured greater than UES AAQS at the Kwajalein and Meck air monitoring stations, though there was no exceedence of the NAAQS at Kwajalein. A detailed list of the daily maximum NO_2 concentrations greater than the UES AAQS are provided in **Table 2-10**. In accordance with the UES AAQS, if the measured 99th percentile concentration (2nd highest high concentration for measurements spanning between 51 and 100 days) exceeded the standard, then the UES AAQS was exceeded. For Kwajalein, there was only one measured day with maximum concentration above the UES AAQS so the 2nd highest concentration is below the standard. For Meck, there were several days with maximum concentrations above the UES AAQS so the 2nd highest concentration is above the standard. However, due to the short period of monitoring, this does not indicate a violation of the standard. This is because measured violation of the SO_2, NO_2, and $PM_{2.5}$ standards requires three consecutive calendar years of monitoring. For NO_2, the 98th percentile daily 1-hour maximum concentration from each year is averaged for comparison to the standard. For shorter periods, the measurements provide an indication of the likely outcome of a full three-year monitoring period, but the shorter periods cannot be used to certify a violation of the ambient standard.

Pollution roses for each parameter and island are included with the monitor locations in **Appendix C**. The pollution roses show that the largest concentrations are from the predominant wind directions. Further evaluation of the wind conditions and hourly concentrations is included in **Appendix D,** which includes a listing of hourly NO_2 concentrations greater than the UES AAQS

Table 2-9: UES AAQS Evaluation and Exceedance Summary

UES AAQS Standard		**Number of Daily Concentrations Greater than UES AAQS**		
		Kwajalein	**Meck**	**Roi-Namur**
SO_2	The 1-hour standard is met when the three-year average of the annual (99th percentile) of the daily maximum 1-hour average concentrations is less than or equal to 60 ppb, as determined in accordance with 40 CFR 50 Appendix T.	0	0	0
	US NAAQS – The 1-hour standard is met when the three-year average of the annual (99th percentile) of the daily maximum 1-hour average concentrations is less than or equal to 75 ppb, as determined in accordance with 40 CFR 50 Appendix T.	0	0	0
NO_2	The 1-hour primary standard is met when the three-year average of the annual (99th percentile) of the daily maximum 1-hour concentrations is less than or equal to 80 ppb, as determined in accordance with 40 CFR 50 Appendix S.	1	14	0
	US NAAQS – The 1-hour primary standard is met when the three-year average of the annual (99th percentile) of the daily maximum 1-hour concentrations is less than or equal to 100 ppb, as determined in accordance with 40 CFR 50 Appendix S.	0	5	0
$PM_{2.5}$	The 24-hour primary standard is met when the 24-hour $PM_{2.5}$ NAAQS design value (DV) is less than or equal to 28 µg/m^3 as determined in accordance with 40 CFR 50 Appendix N. Three years of valid annual $PM_{2.5}$ 98th percentile mass concentrations are required to produce a valid 24-hour $PM_{2.5}$ NAAQS DV.	0	0	0
	US NAAQS – The 24-hour primary standard is met when the 24-hour $PM_{2.5}$ NAAQS design value (DV) is less than or equal to 35 µg/m^3 as determined in accordance with 40 CFR 50 Appendix N. Three years of valid annual $PM_{2.5}$ 98th percentile mass concentrations are required to produce a valid 24-hour $PM_{2.5}$ NAAQS DV.	0	0	0

Definitions:
AAQS – Ambient Air Quality Standard
NO_2 – nitrogen dioxide
$PM_{2.5}$ – particulate matter ≤2.5 microns
ppb – parts per billion
SO_2 – sulfur dioxide
µg/m^3 – micrograms per cubic meter

Notes:
- The UES AAQS are set to 80% of the US NAAQS.

Figure 2-1: **Daily Maximum Hourly SO_2 Concentrations compared to the UES AAQS and US NAAQS**

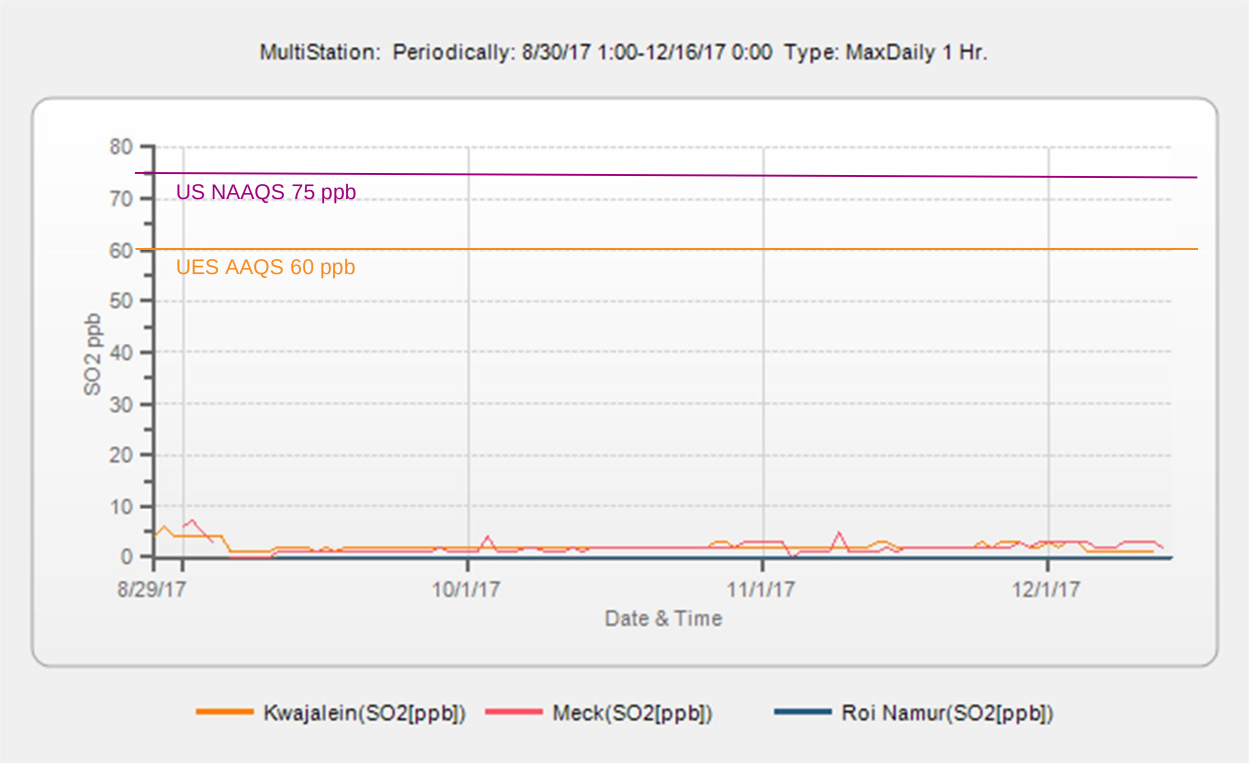


Figure 2-2: Daily Maximum Hourly NO_2 Concentrations compared to the UES AAQS and US NAAQS

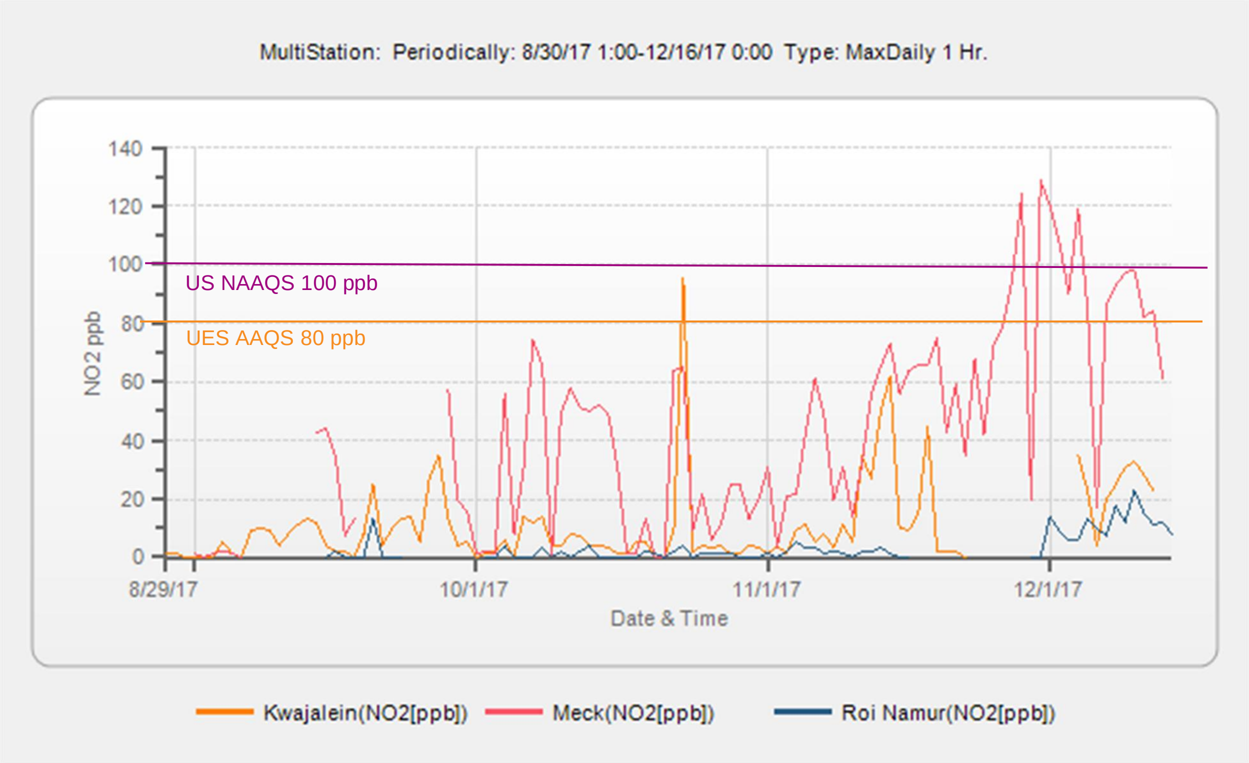


Figure 2-3: Daily Average $PM_{2.5}$ Concentrations compared to the UES AAQS and US NAAQS

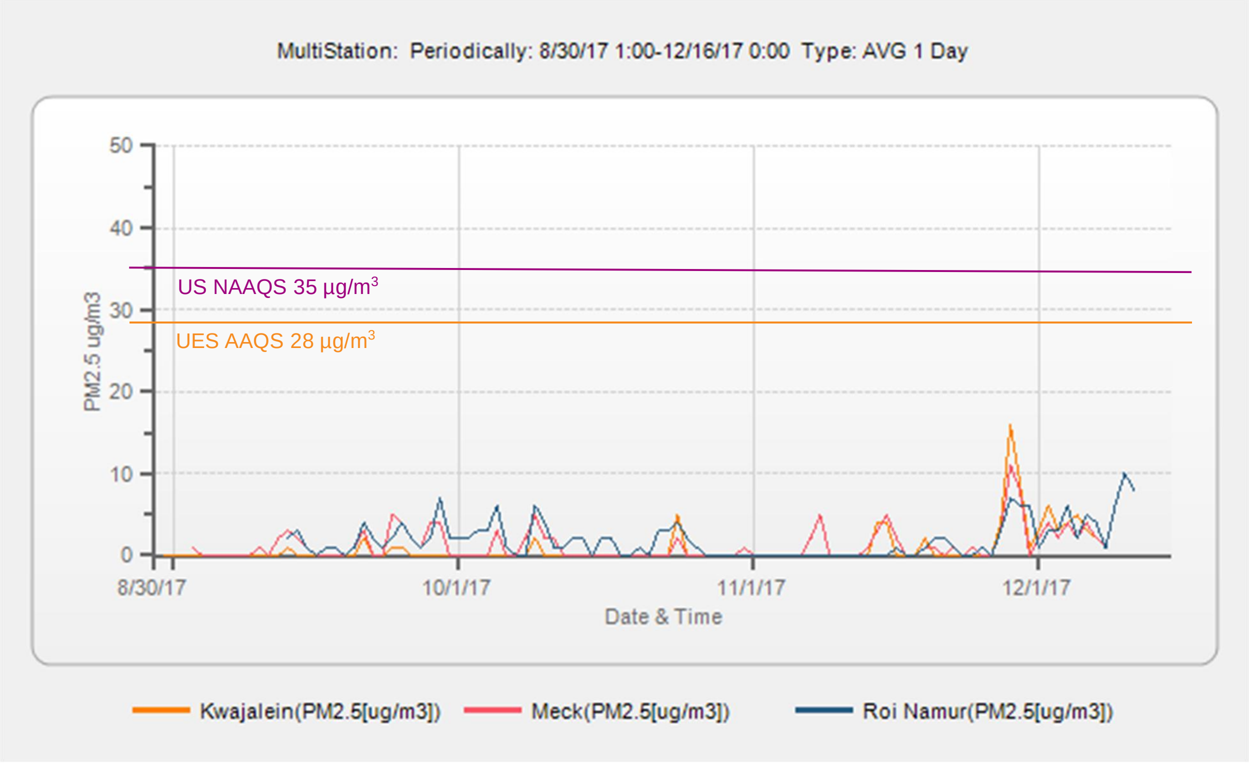


Table 2-10: Daily Maximum NO_2 Concentrations Greater than UES AAQS

Kwajalein		Meck		Roi-Namur	
Date with Daily Maximum Concentration > UES AAQS	Daily Maximum Concentration (ppb)	Date with Daily Maximum Concentration > UES AAQS	Daily Maximum Concentration (ppb)	Date with Daily Maximum Concentration > UES AAQS	Daily Maximum Concentration (ppb)
10/24/2017	95	12/1/2017	129	NA	NA
		11/29/2017	124*		
		12/2/2017	120		
		12/5/2017	119		
		12/3/2017	108		
		12/11/2017	98		
		12/10/2017	97		
		11/28/2017	95		
		12/9/2017	93		
		12/4/2017	90		
		12/8/2017	86		
		12/6/2017	85		
		12/13/2017	84		
		12/12/2017	82		

Definitions:
AAQS – Ambient Air Quality Standard
NO_2 – nitrogen dioxide
ppb – parts per billion
NA – not applicable
UES -

Notes:
*Represent the 99th percentile for concentrations measured during the 3 month period. This concentration is compared to the UES AAQS for compliance determination.
-Highlighted concentrations represent values greater than the US NAAQS.

2.3 Quality Assurance Quality Control (QA/QC)

Routine QA/QC checks were conducted and documented to verify that the data collected meets the criteria specified in the AAMP. An itemized list of the QA/QC checks performed and results are included in **Appendix E.**

Validation of the air monitoring data was performed routinely throughout the project. For data to be considered valid, they should: 1) be accurate and precise within prescribed limits; 2) represent factual conditions; 3) be obtained from a calibrated, well-functioning instrument; 4) be from air sampled without interference or obstruction; and 5) be thoroughly documented as to traceability to recognized primary standards.

Periods of significant data loss are presented in **Table 2-11**, **Table 2-12**, and **Table 2-13** for each of the Islands.

Table 2-11: Kwajalein Significant Data Loss Summary

Parameter	Date	Data Capture (%)	Period(s) of Missing Data	Cause/Comments
SO_2	NA	NA	NA	No significant data loss.
NO_2	9/12/17	41.6	10:00AM – 11:00PM	Analyzer malfunction (intermittent). Instrument was replaced with spare on 9/14/17.
	9/13/17	70.8	12:00AM 6:00PM – 11:00PM	
	9/14/17	12.5	12:00AM – 3:00PM	
	11/23/17	16.6	4:00AM – 11:00PM	Analyzer pump failed and was replaced on 12/5/17. A multi-point verification was performed following the pump replacement.
	11/24/17	0.0	12:00AM – 11:00PM	
	11/25/17	0.0	12:00AM – 11:00PM	
	11/26/17	0.0	12:00AM – 11:00PM	
	11/27/17	0.0	12:00AM – 11:00PM	
	11/28/17	0.0	12:00AM – 11:00PM	
	11/29/17	0.0	12:00AM – 11:00PM	
	11/30/17	0.0	12:00AM – 11:00PM	
	12/1/17	0.0	12:00AM – 11:00PM	
	12/2/17	0.0	12:00AM – 11:00PM	
	12/3/17	0.0	12:00AM – 11:00PM	
	12/4/17	0.0	12:00AM – 11:00PM	
	12/5/17	50.0	12:00AM – 10:00AM	
$PM_{2.5}$	NA	NA	NA	No significant data loss.

Definitions:
NA – not applicable
NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
SO_2 – sulfur dioxide (measured in parts per billion)

Notes:
-A monitoring day must have at least 75 percent of hourly concentration values to be considered valid.
-Data loss does not include periods of missing data due to mobilization and instrument startup/shut down activities.

Table 2-12: Meck Significant Data Loss Summary

Parameter	Date(s)	Data Capture (%)	Period(s) of Missing Data	Cause/Comments
SO_2	9/5/17	66.6	4:00PM – 11:00PM	Moisture in sample line leading to analyzer. Sample lines were dried and insulated on 9/7/17 and air conditioner temperature was increased to 76°F.
	9/6/17	0.0	12:00AM – 11:00PM	
	9/7/17	37.5	12:00AM – 2:00PM	
	10/10/17	20.8	5:00AM – 11:00PM	Analyzer pump failed and was replaced on 10/11/17. A Precision/Level 1 verification was performed following the pump replacement.
	10/11/17	58.3	12:00AM – 9:00AM	
NO_2	9/7/17	29.1	7:00AM – 11:00PM	Moisture in sample line leading to analyzer. Sample lines were dried and insulated on 9/7/17 and air conditioner temperature was increased to 76°F. Analyzer malfunction (ozonator failed). Instrument was replaced with spare on 9/15/17.
	9/8/17	0.0	12:00AM – 11:00PM	
	9/9/17	0.0	12:00AM – 11:00PM	
	9/10/17	0.0	12:00AM – 11:00PM	
	9/11/17	0.0	12:00AM – 11:00PM	
	9/12/17	0.0	12:00AM – 11:00PM	
	9/13/17	0.0	12:00AM – 11:00PM	
	9/14/17	0.0	12:00AM – 11:00PM	
	9/15/17	54.1	12:00AM – 10:00AM	
	9/19/17	45.8	11:00AM – 11:00PM	Data were deemed invalid based on daily spans and multi-point verification. Adjustment was made to analyzer during multi-point on 9/29/17.
	9/20/17	0.0	12:00AM – 11:00PM	
	9/21/17	0.0	12:00AM – 11:00PM	
	9/22/17	0.0	12:00AM – 11:00PM	
	9/23/17	0.0	12:00AM – 11:00PM	
	9/24/17	0.0	12:00AM – 11:00PM	
	9/25/17	0.0	12:00AM – 11:00PM	
	9/26/17	0.0	12:00AM – 11:00PM	
	9/27/17	0.0	12:00AM – 11:00PM	
	9/28/17	0.0	12:00AM – 11:00PM	
	9/29/17	45.8	12:00AM – 12:00PM	
$PM_{2.5}$	NA	NA	NA	No significant data loss.

Definitions:
NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
SO_2 – sulfur dioxide (measured in parts per billion)

Notes:
-A monitoring day must have at least 75 percent of hourly concentration values to be considered valid.
-Data loss does not include periods of missing data due to mobilization and instrument startup/shut down activities.

Table 2-13: Roi Namur Significant Data Loss Summary

Parameter	Date(s)	Data Capture (%)	Period(s) of Missing Data	Cause/Comments
SO_2	NA	NA	NA	No significant data loss.
NO_2	9/12/17	0.0	12:00AM – 11:00PM	Analyzer drift. Multi-point calibration performed on 9/16/17.
	9/13/17	0.0	12:00AM – 11:00PM	
	9/14/17	0.0	12:00AM – 11:00PM	
	9/15/17	0.0	12:00AM – 11:00PM	
	9/16/17	45.8	12:00AM – 12:00PM	
	9/24/17	16.6	4:00AM – 11:00PM	Analyzer drift from calibration on 9/21/17 until instrument pump failure. Data acceptable up to last good daily span on 9/24/17. Instrument pump was replaced and multi-point calibration performed on 10/3/17.
	9/25/17	0.0	12:00AM – 11:00PM	
	9/26/17	0.0	12:00AM – 11:00PM	
	9/27/17	0.0	12:00AM – 11:00PM	
	9/28/17	0.0	12:00AM – 11:00PM	
	9/29/17	0.0	12:00AM – 11:00PM	
	9/30/17	0.0	12:00AM – 11:00PM	
	10/1/17	0.0	12:00AM – 11:00PM	
	10/2/17	0.0	12:00AM – 11:00PM	
	10/3/17	50.0	12:00AM – 11:00AM	
	11/17/17	33.3	8:00AM – 11:00PM	Analyzer pump failed and the pump diaphragm was replaced on 11/30/17. A Multi-point verification was performed following the diaphragm replacement.
	11/18/17	0.0	12:00AM – 11:00PM	
	11/19/17	0.0	12:00AM – 11:00PM	
	11/20/17	0.0	12:00AM – 11:00PM	
	11/21/17	0.0	12:00AM – 11:00PM	
	11/22/17	0.0	12:00AM – 11:00PM	
	11/23/17	0.0	12:00AM – 11:00PM	
	11/24/17	0.0	12:00AM – 11:00PM	
	11/25/17	0.0	12:00AM – 11:00PM	
	11/26/17	0.0	12:00AM – 11:00PM	
	11/27/17	0.0	12:00AM – 11:00PM	
	11/28/17	0.0	12:00AM – 11:00PM	
	11/29/17	0.0	12:00AM – 11:00PM	
	11/30/17	50.0	12:00AM – 11:00AM	
$PM_{2.5}$	NA	NA	NA	No significant data loss.

Definitions:
NA – not applicable
NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
SO_2 – sulfur dioxide (measured in parts per billion)

Notes:
-A monitoring day must have at least 75 percent of hourly concentration values to be considered valid.
-Data loss does not include periods of missing data due to mobilization and instrument startup/shut down activities.

3. Ambient Air Quality Modeling

3.1 Model Selection and Application

The suitability of an air quality dispersion model for a particular application is dependent upon several factors. The following selection criteria were evaluated for this application:

- stack height relative to nearby structures;
- dispersion environment;
- local terrain; and
- representative meteorological data.

The USEPA Guidelines prescribe a set of approved models for regulatory applications for a wide range of source types and dispersion environments. Based on a review of the factors discussed below, the modeling was conducted with the latest version of USEPA's AERMOD dispersion model (Version 16121r).

3.2 Good Engineering Practice Stack Height

Good engineering practice (GEP) stack height is defined as the stack height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutant as a result of atmospheric downwash, wakes, or eddy effects created by the source, nearby structures, or terrain features.

A GEP stack height analysis was performed for the Kwajalein, Roi-Namur and Meck Power Plant engine stacks in accordance with USEPA's guidelines[4]. Per the guidelines, the physical GEP height, (H_{GEP}), is determined from the dimensions of all buildings which are within the region of influence using Equation 2.

$H_{GEP} = H + 1.5L$ (**Equation 2**)

where:

H = height of the structure within 5L of the stack which maximizes H_{GEP}, and
L = lesser dimension (height or projected width) of the structure.

For a squat structure, i.e., height less than projected width, the formula reduces to Equation 3.

$H_{GEP} = 2.5H$ (**Equation 3**)

In the absence of influencing structures, a "default" GEP stack height is credited up to 65 meters (213 feet).

A GEP analysis was conducted for the power plant stacks and buildings on each island respectively. The analysis was conducted with USEPA's Building Profile Input Program (BPIP). **Figures 3-1** (Kwajalein), **3-2** (Roi-Namur) and **3-3** (Meck) show the stack locations, buildings and elevation above grade for each power plant/island respectively. The wind direction-specific building dimensions generated with BPIP were input to AERMOD to account for building downwash in the dispersion modeling. In each case, the stack heights were shorter than GEP height (especially at Meck), which would result in aerodynamically-induced building downwash effects. The simulation of the downwash is a function of the position of the stacks relative to the building as well as influences of factors that may not be incorporated into AERMOD, such as the wind approach angle, the building length, etc. These effects are discussed later in this report.

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[4] US EPA 1985. Guideline for Determination of Good Engineering Practice Stack Height. EPA Document No. EPA-450/4-80-023R. Office of Air Quality Planning and Standards, Research Triangle Park, NC. June 1985.

Figure 3-1: Buildings and Stacks for GEP Analysis - Kwajalein

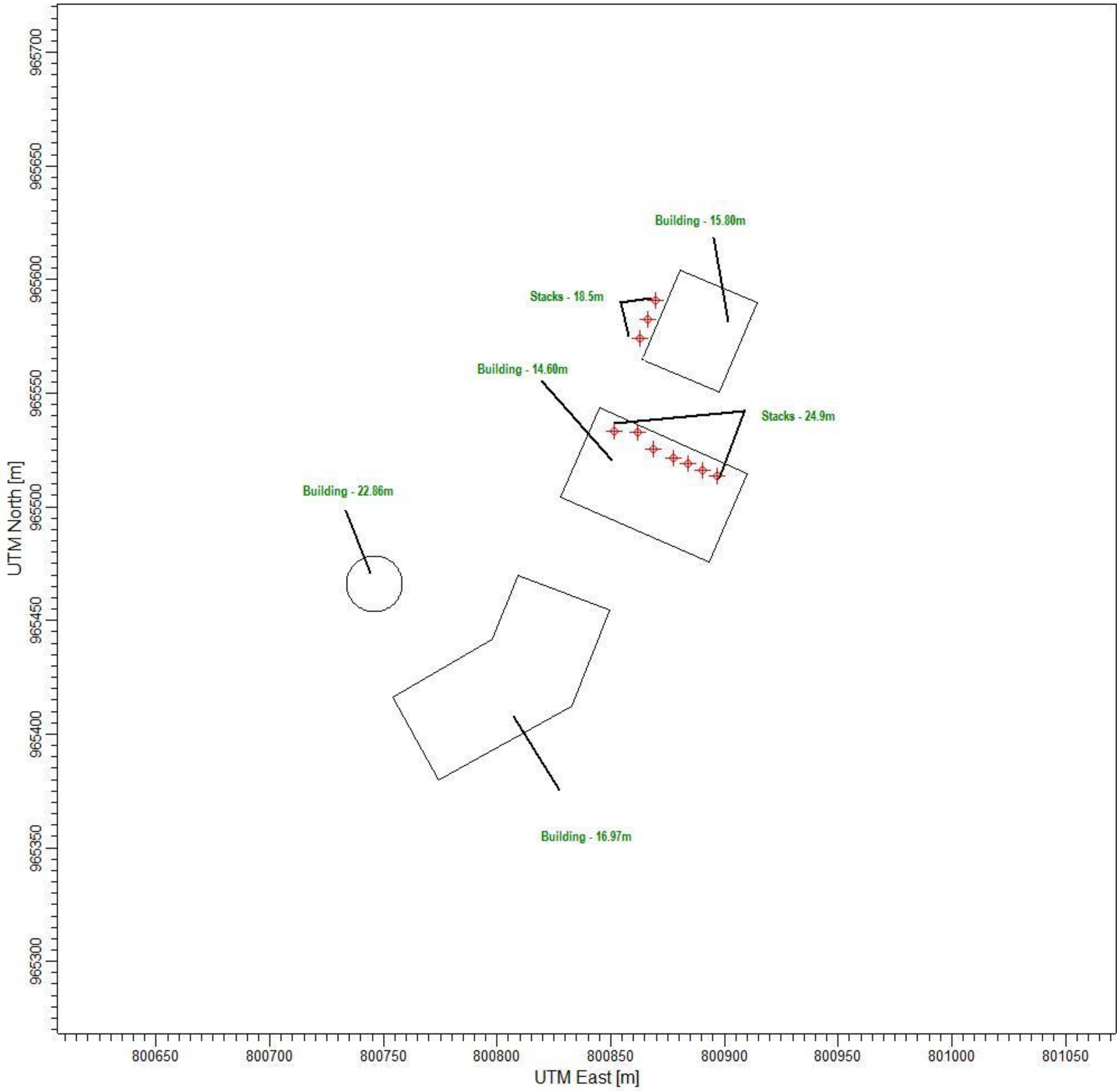


Figure 3-2: Buildings and Stacks for GEP Analysis - Roi-Namur

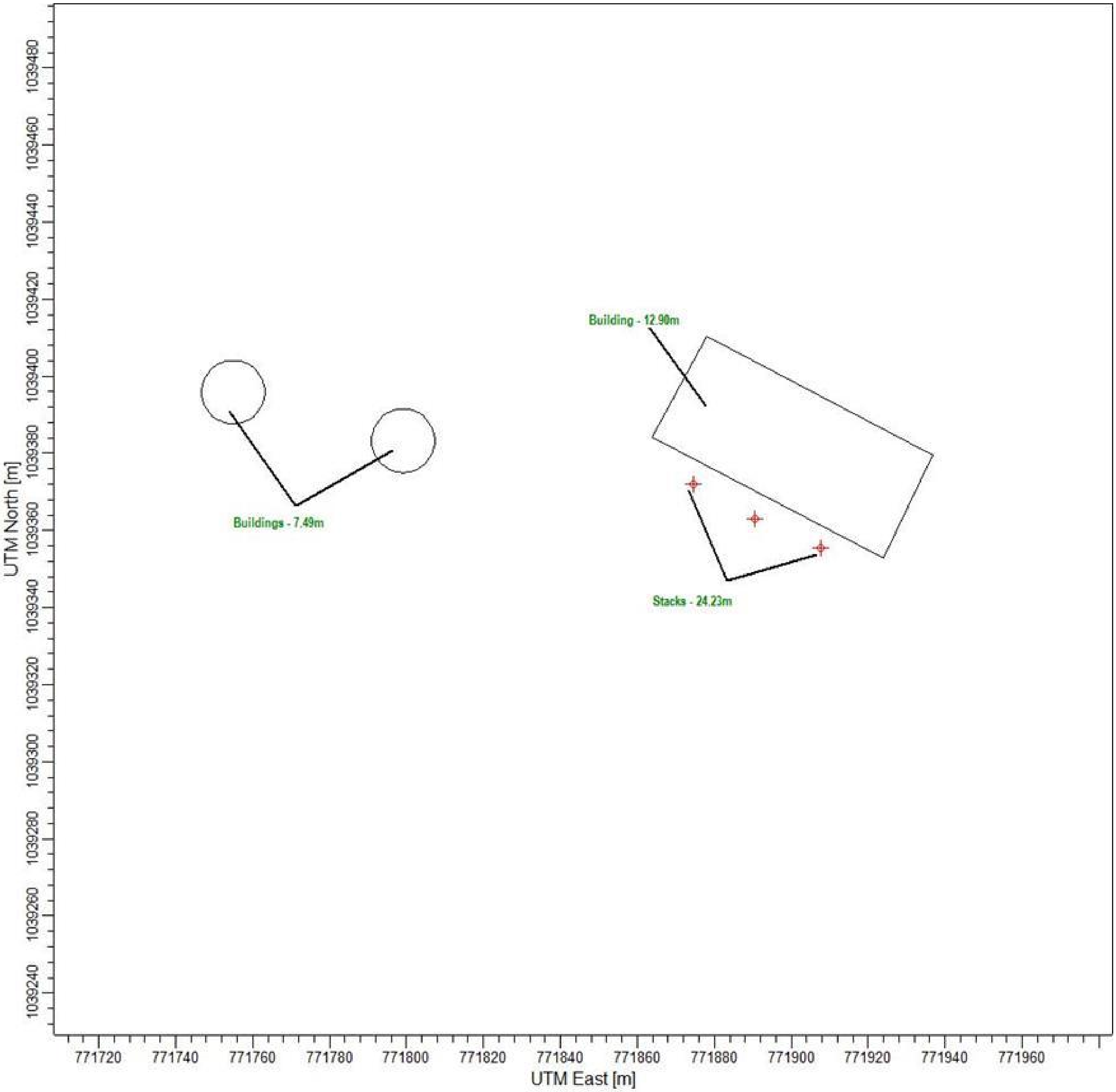


Figure 3-3: Buildings and Stacks for GEP Analysis - Meck

3.3 Dispersion Environment

According to USEPA modeling guidelines, if more than 50% of an area within a three-kilometer radius of the proposed facility is classified as rural, then rural dispersion coefficients are to be used in the dispersion modeling analysis. Conversely, if more than 50% of the area is urban, urban dispersion coefficients are used. Given the areas surrounding each power plant is predominantly rural, use of the urban option in AERMOD was not necessary.

3.4 Model Receptor Grids

A comprehensive Cartesian receptor grid was developed for each island to ensure resolution of the maximum modeled ground-level pollutant concentrations. All maximum concentrations modeled by AERMOD were located within the near-field portion of the grid where receptors were spaced at 10-meters.

The Cartesian receptor grid for Kwajalein, Meck and Roi-Namur consisted of the following receptor spacing, also shown in **Figures 3-4** through **3-9** which highlights near-field and far-field grid spacing:

- For Kwajalein:
  - 10 meter spacing out to 500 meters from approximately the center of island;
  - 50 meter spacing from 500 meters to 1000 meters; and
  - 100 meter spacing from 1000 meters to 2500 meters.
- For Meck:
  - 10 meter spacing out to 500 meters from approximately the center of island; and
  - 50 meter spacing from 500 meters to 800 meters.
- For Roi-Namur:
  - 10 meter spacing out to 500 meters from approximately the center of island; and
  - 50 meter spacing out from 500 meters to 1000 meters; and
  - 100 meter spacing out from 1000 meters to approximately 1500 meters.

While the islands are generally flat, terrain elevations from Shuttle Radar Topography Mission (SRTM3) Global Coverage Version 2 were processed with USEPA's receptor processor, AERMAP, to develop the receptor terrain elevations required by AERMOD. The data was obtained from WebGIS at http://www.webgis.com/terraindata.html.

Figure 3-4: **Kwajalein Model Receptor Grid – Near-field**

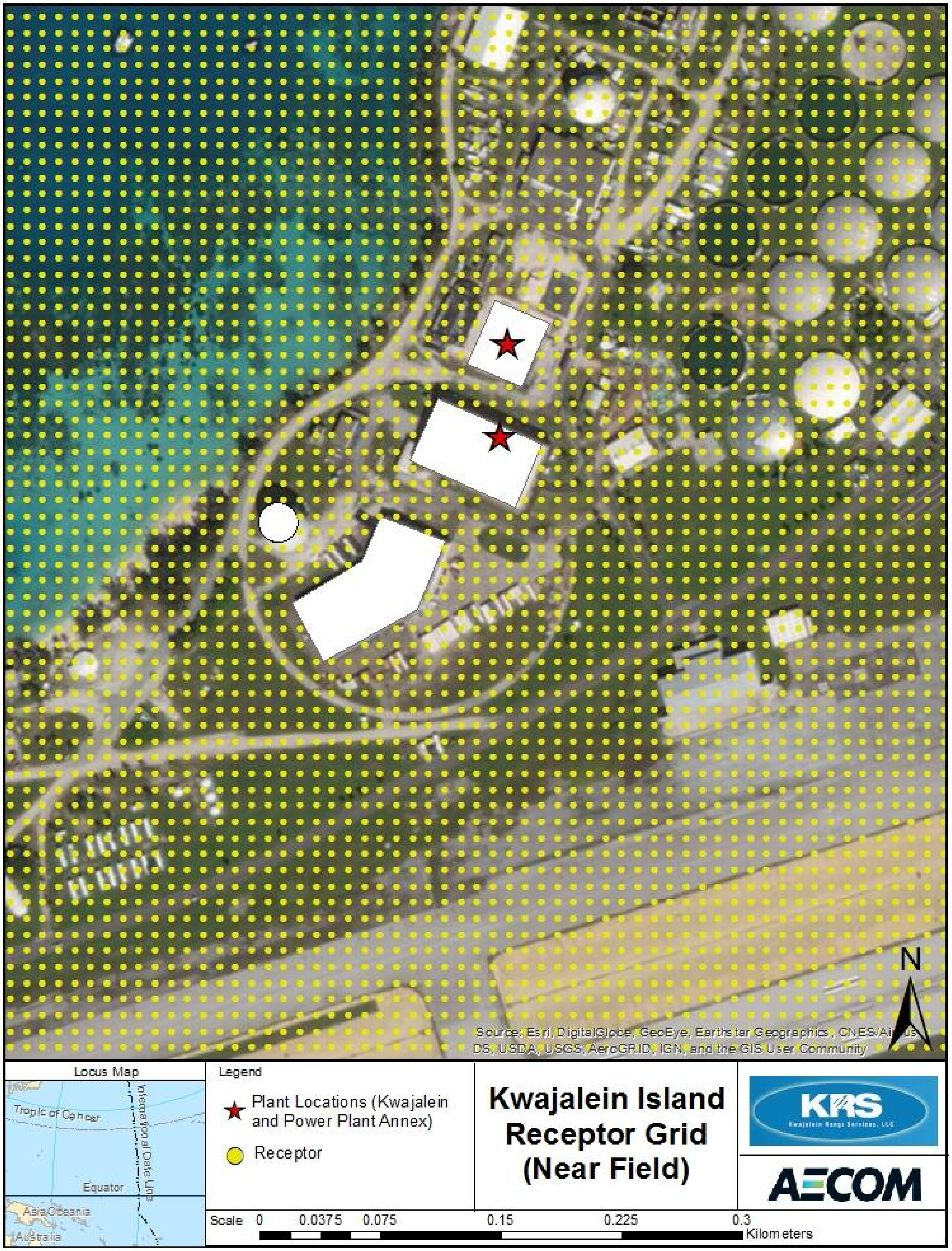
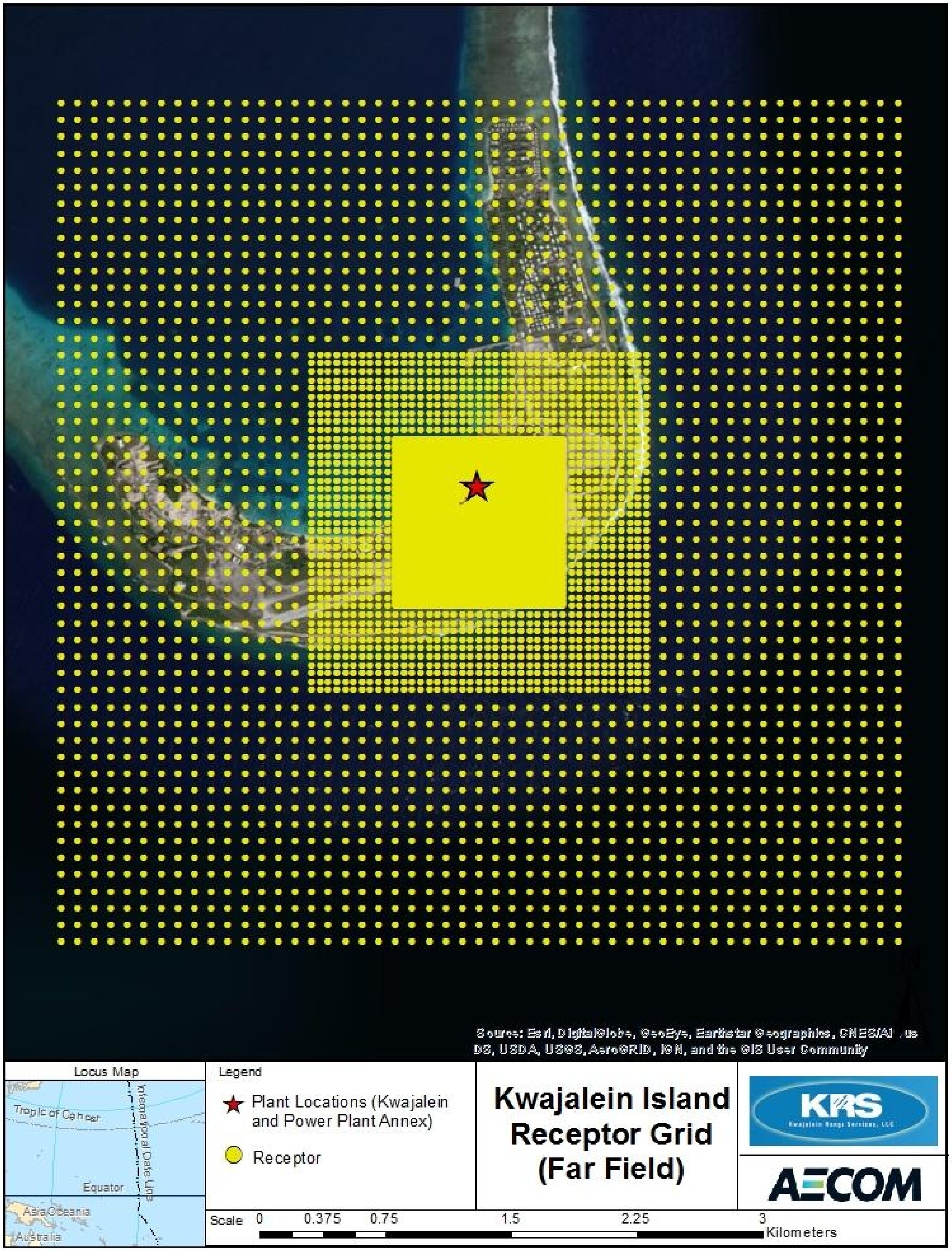


Figure 3-5: **Kwajalein Model Receptor Grid – Far-Field**



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3-6: Roi-Namur Model Receptor Grid – Near-field

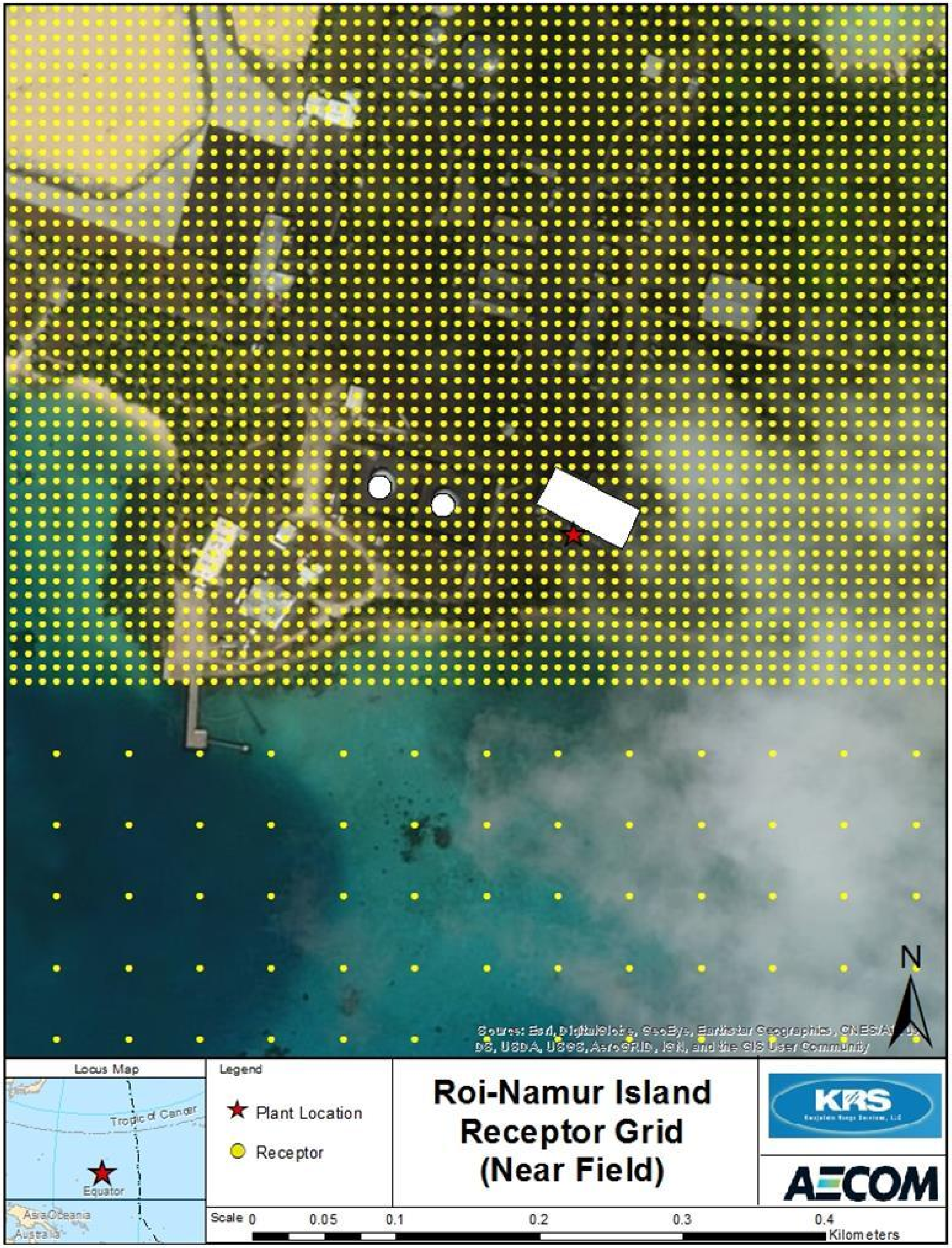
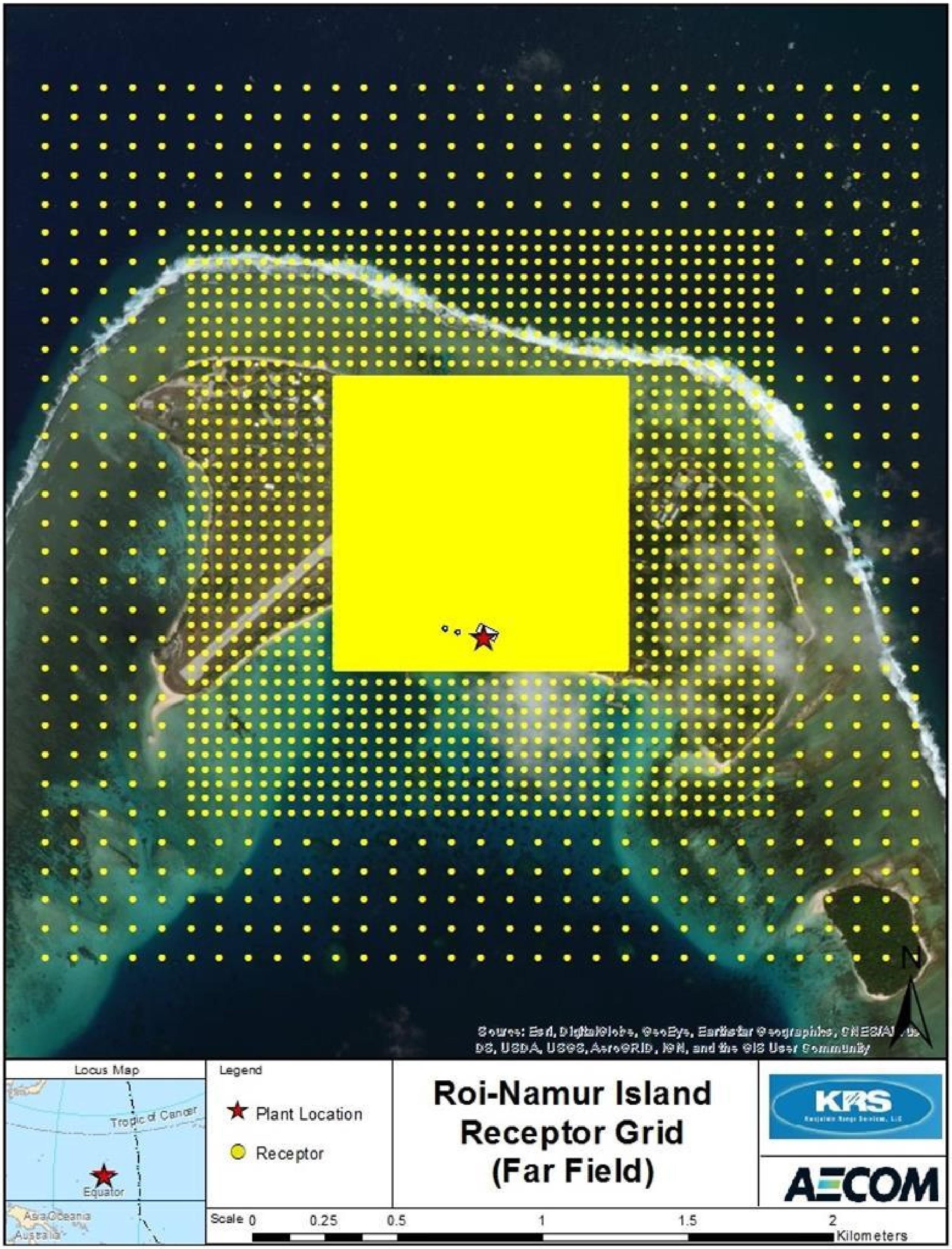


Figure 3-7: Roi-Namur Model Receptor Grid – Far-field



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Ai us DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3-8: Meck Model Receptor Grid – Near-field

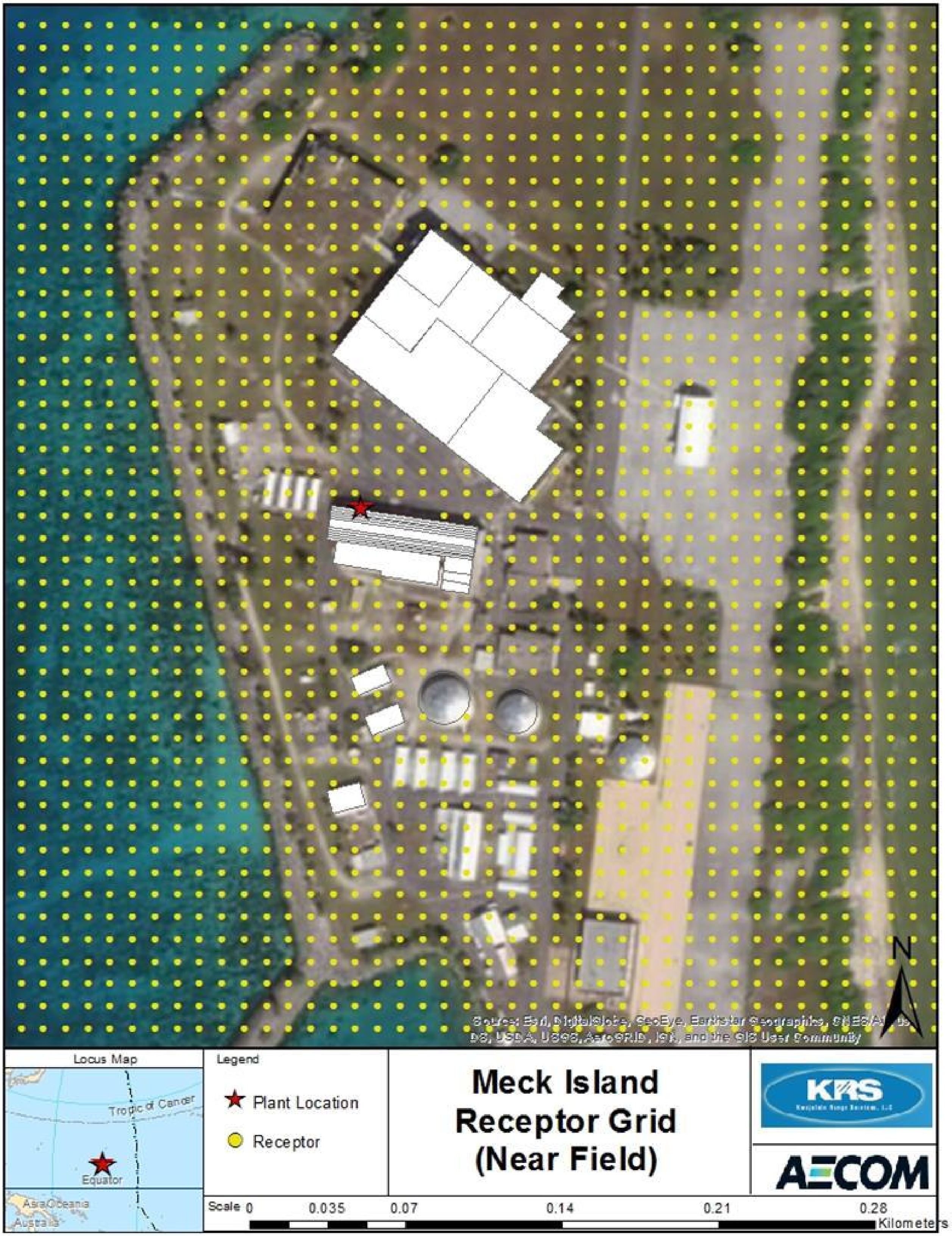


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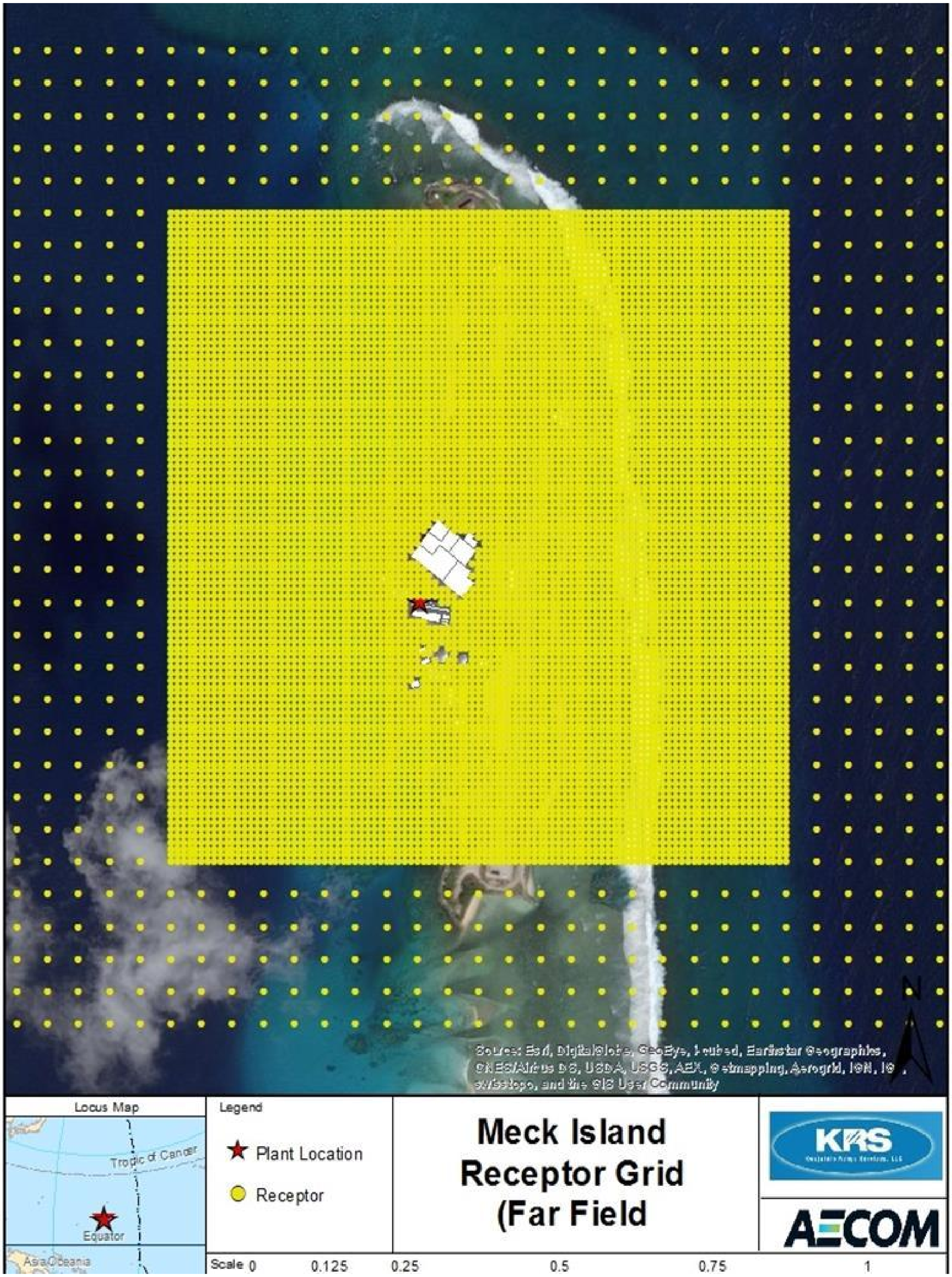
Figure 3-9: Meck Model Receptor Grid – Far-field



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IG , swisstopo, and the GIS User Community

3.5 Representative Meteorological Data

The modeling for each island was conducted with five years, 2012-2016, of hourly meteorological data from the Kwajalein Airport (see **Figure 3-10**). The data capture for this 5-year period was very good, ranging from 97-98% per year.

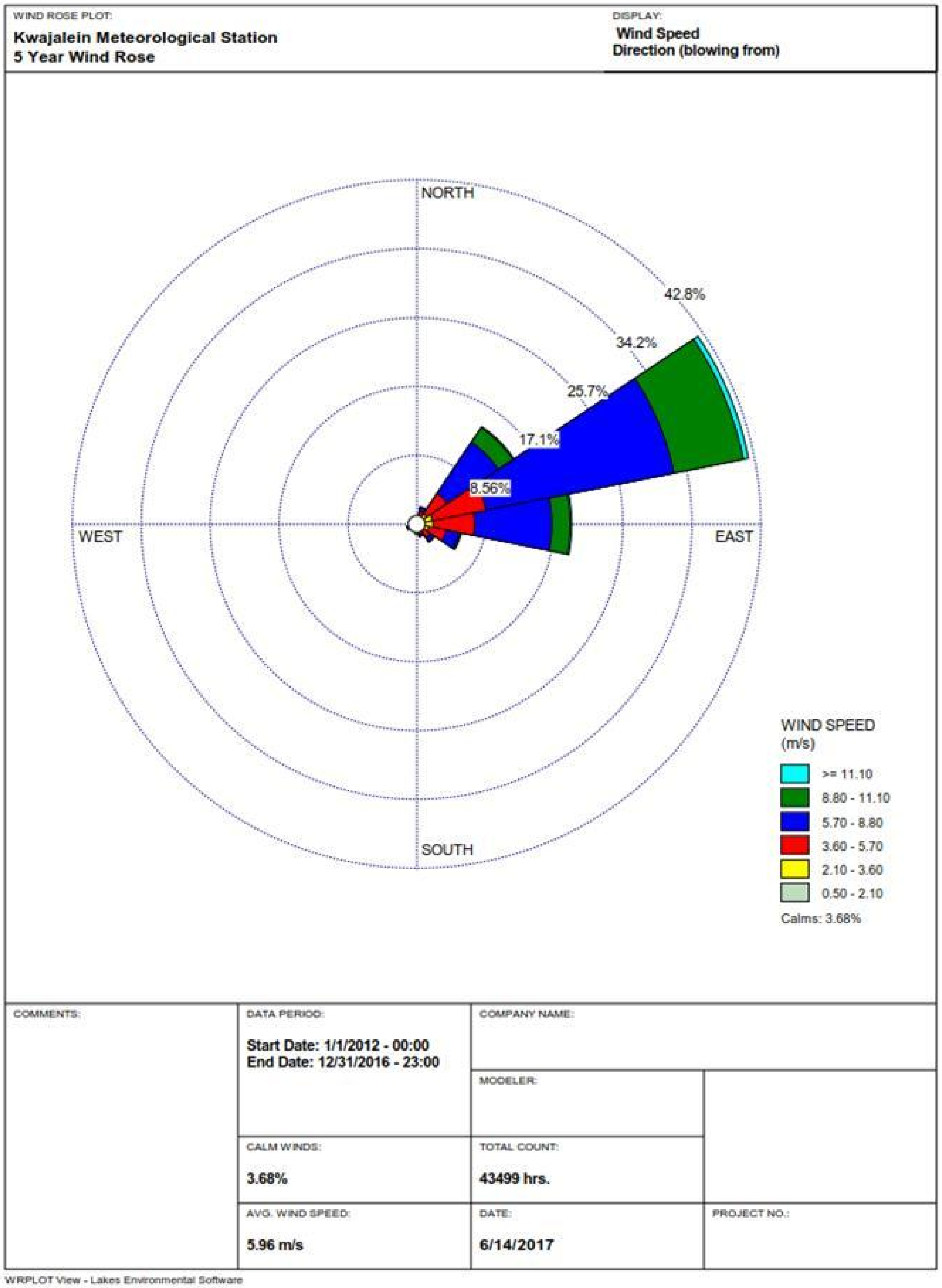
Figure 3-10: Location of the Kwajalein Airport

The wind rose illustrating the wind patterns and magnitude of wind speeds (**Figure 3-11**), indicates winds are predominantly from the east and east-northeast.

The meteorological data were processed with USEPA's AERMET (Version 16216) meteorological processor for input to AERMOD. AERMET was applied with the recently incorporated adjusted u-star option ("ADJ_U*"). This adjustment potentially refines model predictions during low-wind conditions.

AERMET and the application of AERMOD also require twice daily upper air soundings. While upper air soundings are taken at the Kwajalein Airport, the data capture is very poor and not suitable for the modeling. Therefore, concurrent upper air data from Majuro, Marshall Islands (located approximately 270 miles to the southeast of the Kwajalein Atoll) was used in the analysis as this was the closest representative upper air station with good data capture. Given the expected uniformity of mixing heights due to ocean influence, the data from a different Marshall Island atoll should be reasonably representative.

Figure 3-11: Kwajalein Airport Wind Rose (2012-2016)



WIND ROSE PLOT:

Kwajalein Meteorological Station
5 Year Wind Rose

DISPLAY:

Wind Speed
Direction (blowing from)

COMMENTS:

DATA PERIOD:

Start Date: 1/1/2012 - 00:00
End Date: 12/31/2016 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:

3.68%

TOTAL COUNT:

43499 hrs.

AVG. WIND SPEED:

5.96 m/s

DATE:

6/14/2017

PROJECT NO.:

WRPLOT View - Lakes Environmental Software

3.6 NO_x to NO_2 Conversion

USEPA provides a tiered approach for modeling NO_2 from NO_x emissions that provide for increased levels of refinement:

- Tier 1: Full conversion;
- Tier 2: Ambient Ratio Method 2 (ARM2); and
- Tier 3: Ozone Limiting Method (OLM) or Plume Volume Molar Ratio Method (PVMRM). PVMRM and OLM options in AERMOD account for ambient conversion of NO_x to NO_2 in the presence of ozone based on the same basic chemical mechanism of ozone titration, the interaction of NO_x with ambient ozone (O_3) to form NO_2 and O_2. Two key model inputs for PVMRM and OLM are hourly ambient background ozone concentrations concurrent with the meteorological data and source-specific in-stack ratios of NO_2/NO_x emissions.

In the GAQM, USEPA states that PVMRM works best for relatively isolated and elevated point sources modeling, while OLM works best for large groups of sources, area sources, and near-surface releases, including roadway sources. For this reason, OLM was applied in the analysis given the groups of relatively short power plant stacks subject to building downwash. Application of OLM is also consistent with the 2012 analysis to estimate refined NO_2 concentrations from the power plant NO_x emissions.

Two key model inputs for OLM are the source-specific in-stack ratios of NO_2/NO_x emissions and ambient background ozone concentration. Initially, OLM takes into account that some NO_2 is formed during the combustion process and emitted directly to the atmosphere. Therefore, to account for this initial component of NO_2, OLM as implemented in AERMOD uses a specified in-stack ratio (ISR) for each source in addition to the NO_x emission rate. The remaining fraction of NO_x emissions are assumed to be NO and available for conversion to NO_2 by oxidation in combination with atmospheric ozone. The amount of NO that can be converted to NO_2 is limited by the ambient ozone concentration, hence the name of the modeling approach: “ozone limiting method.” The OLM computations are performed on an hourly basis and therefore require a representative database of hourly ozone concentrations concurrent with the meteorological data input to AERMOD. If an hourly database is not available, a representative value can be used for all hourly calculations.

An in-stack NO_2/NO_x ratio of 0.1 was used in the analysis for all power plant engines consistent with the 2012 AQIR. USEPA provides a reference database, NO2_ISR_database.XLS on the Support Center for Regulatory Models (SCRAM) website[5]. This database contains ISR’s for a number of Caterpillar diesel-fired engines ranging from 0.022 to 0.096 with an average of 0.066. Therefore, the conservative use of 0.1 for the in-stack ratios for all power plant stacks (all Caterpillar diesel fired engines) is supported by the USEPA database.

As noted, OLM also requires specification of ozone data. If available, representative hourly ozone data that is concurrent with the meteorological data is most desirable for the application of OLM. Ambient ozone data are not available for the Marshall Islands. Consistent with the 2012 AQIR modeling analysis, the most representative ozone data available, albeit expected to be very conservative given the isolated location of the Marshall Islands, is from Honolulu, Hawaii. Hourly data were obtained from USEPA’s AirData web site (https://aqs.epa.gov/api).

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[5] https://www3.epa.gov/scram001/no2_isr_database.htm

4. Ambient Air Impact Criteria

The USEPA has promulgated NAAQS to protect human health and welfare. The NAAQS include primary standards, which are designed to protect human health, including the health of sensitive subpopulations such as children, elderly and those with chronic respiratory problems. The NAAQS also include secondary standards designed to protect public welfare, including economic interests, visibility, vegetation, animal species, and other concerns not related to human health.

Each NAAQS are expressed in terms of an air concentration level and an associated averaging period. As previously noted, the UES AAQS are set to eighty-percent of the USEPA NAAQS standards.

The criteria pollutants and averaging periods that were the focus of this study included:

- NO_2, 1-hour average
- SO_2, 1-hour average
- $PM_{2.5}$, 24-hour and annual
- CO, 1-hour and 8-hour.

As noted in **Section 1.1**, the NAAQS and AAQS for these criteria pollutants and averaging periods are summarized in **Table 4-1**. Footnotes to **Table 4-1** explain how compliance with each NAAQS is assessed.

Table 4-1: Ambient Air Quality Standards

Pollutant	NAAQS Primary Standards		NAAQS Secondary Standards	UES AAQS – [80% NAAQS] ($\mu g/m^3$)		Averaging Times
	($\mu g/m^3$)	(ppb)	($\mu g/m^3$)	($\mu g/m^3$)	(ppb)	
Carbon Monoxide	40,000	35,000	---	32,000	28,000	1-Hour[1]
	10,000	9,000	---	8,000	7,200	8-Hour[1]
Nitrogen Dioxide	188	100	--	150.4	80	1-hour[3]
Particulate Matter ($PM_{2.5}$)	35	---	35	28	---	24-Hour[5]
	12	---	15	9.6	---	Annual[4]
Sulfur Oxides	196	75	--	156.8	60	1-Hour[2]

Source: http://www.epa.gov/air/criteria.html.

1 Not to be exceeded more than once per year.

2 Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 parts per billion (“ppb”).

3 To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).

4 To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 12.0 micrograms per cubic meter (“$\mu g/m^3$”).

5 To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 $\mu g/m^3$ (effective December 17, 2006).

5. Source Data

5.1 Kwajalein Power Plants

The modeling analysis assessed the air quality impacts associated with the Kwajalein main power plant as well as the new Power Plant Annex. The main power plant consists of five (5) Caterpillar C280-16 diesel engines, one (1) Caterpillar C280-6 engine, and one Caterpillar 3616 engine currently out of service that will be rebuilt/converted to a C280-16 engine. The new Power Plant Annex consists of three (3) Caterpillar C280-16 diesel engines and each engine exhausts to its own, dedicated stack. Note that subsequent to the modeling analysis, it was determined that the Power Plant Annex engines are actually Caterpillar C280-12 units. However, the modeling conducted with the C280-16's should be conservative as impacts are expected to be lower with the C280-12 engines. This is primarily because, as a smaller engine, the emissions for the C280-12's are lower than for the C280-16 engines. In addition, a shorter stack height was modeled for the C280-16's (18.5 meters vs actual stack height of 25 meters). Further, the modeling results documented in **Section 5** show that the main power plant emissions dominate the highest modeled concentrations. A comparison of the source parameters for both units is provided in **Appendix F**.

Three plant operational load cases were evaluated in the analysis:

- Representative Maximum Load – five (5) Caterpillar C280-16 engines from the main power plant and the three Power Plant Annex Caterpillar C280-16 engines (equipped with Selective Catalytic Reduction [SCR] to control NO_x emissions).
- Normal Load - two (2) Caterpillar C280-16 diesel engines plus one (1) Caterpillar C280-6 engine from the main power plant and two Power Plant Annex Caterpillar C280-16 engines.
- Reduced Load – one (1) Caterpillar C280-16 diesel engine from the main power plant and one (1) Power Plant Annex Caterpillar C280-16 engine. Note for this case, a reduced sulfur fuel (15 ppm) was assumed.

The maximum load represents the maximum expected load that the plant will operate. The normal operational load is based on current normal operations. The reduced load represents a future reduced emissions scenario to simulate air quality benefits of energy savings measures.

The source parameters for the main power plant engines are summarized in **Table 5-1** and the source parameters for the Power Plant Annex engines are summarized in **Table 5-2**.

Table 5-1: Source Parameters – Main Power Plant

Parameter	**Caterpillar Diesel Engine**	
	C280-16	**C280-6**
Stack Height, meters	24.9	24.9
Stack exit diameter, meters	0.79	0.79
Stack gas temperature, Kelvin	722	656.05
Stack gas exit velocity, m/sec	31.13	13.46
Fuel use, gal/hr(1)	162.6	121.5
Heat input, MMBtu/hr	22.28	16.65
$PM_{2.5}$ emissions, lb/hr(2)	1.24	0.93
NO_x emissions, lb/hr(2)	71.28	53.27
SO_2 emissions, lb/hr(2)(3)	1.80 (0.03 for reduced S case)	1.34 (0.03 for reduced S case)
CO emissions, lb/hr(2)	18.93	14.15
Acrolein emissions, lb/hr(2)	1.76E-04	1.31E-04
Formaldehyde emissions, lb/hr(2)	1.76E-03	1.31E-03

1) Based on 12-month fuel use (June 2016 through May 2017).
2) Emissions are for one engine and based on use of USEPA AP42 factors (October 1996).
3) SO_2 emission rate based on 800 parts per million (ppm) sulfur (S) for maximum and normal operational cases, 15 ppm for the reduced scenario.

Table 5-2: Source Parameters – Power Plant Annex

Parameter	Caterpillar Diesel Engine
	C280-16(4)
Stack Height, meters	18.5
Stack exit diameter, meters	0.61
Stack gas temperature, Kelvin	657
Stack gas exit velocity, m/sec	44.54
Fuel use, gal/hr(1)	162.6
Heat input, MMBtu/hr	22.28
$PM_{2.5}$ emissions, lb/hr(2)	1.24
NO_x emissions, lb/hr(2)	7.06
SO_2 emissions, lb/hr(2)(3)	1.80 (0.03 for reduced S case)
CO emissions, lb/hr(2)	18.93
Acrolein emissions, lb/hr(2)	1.76E-04
Formaldehyde emissions, lb/hr(2)	1.76E-03

1) Based on 12-month fuel use of C280-16 engines (June 2016 through May 2017).
2) Emissions are for one engine and based on use of USEPA AP42 factors (October 1996), with NO_x adjusted to account for 90% SCR removal efficiency.
3) SO_2 emission rate based on 800 ppm S for maximum and normal operational cases, 15 ppm for the reduced scenario.
4) As discussed in the text, the Power Plant Annex engines are actually Caterpillar C280-12 units. However, the modeling conducted with the C280-16's should be conservative as impacts are expected to be lower with the C280-12 engines.

5.2 Roi-Namur Power Plant

The Roi-Namur power plant consists of nine (9) Caterpillar C3606 diesel engines.

Three plant operational load cases were evaluated in the analysis:

- Representative Maximum Load – six (6) Caterpillar C3606 engines.
- Normal Load - four (4) Caterpillar C3606 engines.
- Reduced Load – one (1) Caterpillar C3606 engine. Note for this case, a reduced sulfur fuel (15 ppm) is assumed.

The maximum load represents the maximum expected load that the plant will operate. The normal operational load is based on current normal operations. The reduced load represents a future reduced emissions scenario to simulate air quality benefits of energy savings measures.

Note that there are three stacks that service the power plant and the exhaust from three engines are ducted to each stack. The plant tries to evenly distribute which engines operate. For the maximum load case, three stacks were modeled and it was assumed that two engines vented to each stack. For the normal load case, three stacks were modeled and it was assumed that two engines vented to one stack and the other two stacks each had one engine venting to it. For the reduced load case, a single stack was modeled with one engine vented it.

The source parameters for the main power plant engines are summarized in **Table 5-3** for the three stack cases reflecting the variability in exhaust flow rate and emissions depending on the number of engines vented.

Table 5-3: Source Parameters – Roi-Namur Power Plant

	Caterpillar C3606 Diesel Engine	
	# Engines per Stack (1)	
Parameter (per stack)	**2**	**1**
Stack Height, meters	24.2	24.2
Stack exit diameter, meters	0.51	0.51
Stack gas temperature, Kelvin	709	709
Stack gas exit velocity, m/sec	58.64	29.32
Fuel use, gal/hr (per engine)(2)	62.3	62.3
Heat input, MMBtu/hr (per engine)	8.54	8.54
$PM_{2.5}$ emissions, lb/hr(3)	0.95	0.47
NO_x emissions, lb/hr(3)	54.62	27.31
SO_2 emissions, lb/hr(3)(4)	1.38 (0.03 for reduced S case)	0.69 (0.01 for reduced S case)
CO emissions, lb/hr(3)	14.51	7.25
Acrolein emissions, lb/hr(3)	1.35E-04	6.73E-05
Formaldehyde emissions, lb/hr(3)	1.35E-03	6.73E-04

1) The number of engines vented to each stack varies depending on load as described in the text.
2) Based on 12-month fuel use (June 2016 through May 2017).
3) Emissions are based on use of USEPA AP42 factors (October 1996).
4) SO_2 emission rate based on 800 ppm S for maximum and normal operational cases, 15 ppm for the reduced scenario.

5.3 Meck Power Plant

The Meck power plant consists of five (5) Caterpillar C3508 diesel engines each serviced by a dedicated stack.

Three plant operational load cases were evaluated in the analysis:

- Representative Maximum Load – four (4) Caterpillar C3508 engines.
- Normal Load - three (3) Caterpillar C3508 engines.
- Reduced Load – one (1) Caterpillar C3508 engine. Note for this case, a reduced sulfur fuel (15 ppm) is assumed.

The maximum load represents the maximum expected load that the plant will operate. The normal operational load is based on current normal operations. The reduced load represents a future reduced emissions scenario to simulate air quality benefits of energy savings measures.

The source parameters for the main power plant engines are summarized in **Table 5-3**.

Table 5-4: Source Parameters – Meck Power Plant

Parameter	Caterpillar Diesel Engine
	C3508
Stack Height, meters	13.7
Stack exit diameter, meters	0.2
Stack gas temperature, Kelvin	815
Stack gas exit velocity, m/sec	76.6
Fuel use, gal/hr(1)	16.7
Heat input, MMBtu/hr	2.29
$PM_{2.5}$ emissions, lb/hr(2)	0.13
NO_x emissions, lb/hr(2)	7.32
SO_2 emissions, lb/hr(2)(3)	0.18 (0.003 in reduced S case)
CO emissions, lb/hr(2)	1.94
Acrolein emissions, lb/hr(2)	1.80E-05
Formaldehyde emissions, lb/hr(2)	1.81E-04

1) Based on 12-month fuel use (June 2016 through May 2017).
2) Emissions are for one engine based on use of USEPA AP42 factors (October 1996).
3) SO_2 emission rate based on 800 ppm S for maximum and normal operational cases, 15 ppm for the reduced scenario.

6. Modeling Results - AAQS and Health Risk Analyses

AERMOD was applied with the 5-years of Kwajalein meteorological data to determine the maximum ground-level concentrations of the criteria pollutants SO_2, NO_2, CO and $PM_{2.5}$ for each island and the power plant operating scenarios described in **Section 5.1**. The modeling results for the criteria pollutants are evaluated relative to the AAQS discussed in **Section 4,** which are set at 80% of the USEPA NAAQS. In addition to evaluating the various air emission cases relative to the AAQS, the modeling results were also used to site the monitor locations on each island.

Dispersion modeling was also conducted for formaldehyde and acrolein air emissions from the power plants and the maximum modeled concentrations were evaluated relative to the RSLs to assess the potential for adverse health effects.

6.1 Kwajalein Power Plant

6.1.1 Criteria Pollutants

A summary of the modeled concentrations for the three Kwajalein operating load cases is provided in **Table 6-1**.

The following is a summary of the modeling results in **Table 6-1**:

- NO_2 (1-hour) - the highest modeled concentrations exceed the AAQS (150.4 mg/m^3) for all load scenarios. **Figures 6-1** through **6-3** illustrate the modeling results as isopleths (overlaid on a satellite image of the island) for the maximum, normal and reduced load cases, respectively. As indicated by the 150 mg/m^3 AAQS contour shown in the figures (AAQS and NAAQS contours are shaded in blue), the modeled concentrations above the AAQS are generally limited to the areas adjacent to the power plant; especially for the normal and reduced load cases where the exceedance area is limited to the immediate area adjacent to the power plant. Note that given the modeled NO_2 concentrations were determined using very conservative ozone data from Honolulu, HI, the conversion of NO_x to NO_2 was likely over-predicted by the model and results would be closer to the AAQS if site specific ozone data were available. This would be consistent with the monitored concentrations, which indicate actual measured concentrations are below the AAQS with the exception of one day with a measured daily maximum 1-hour NO_2 concentration above the AAQS.
- $PM_{2.5}$ (24-hour) - modeled concentrations exceed the AAQS (28 mg/m^3) for the maximum and normal load scenarios, but are below the AAQS for the reduced load scenario. The modeling results for the maximum and normal load cases are shown in **Figures 6-4** and **Figure 6-5**, respectively. As indicated by the 28 mg/m^3 AAQS contour shown in the figures, the modeled concentrations above the AAQS are limited to the immediate area adjacent to the power plant.
- $PM_{2.5}$ (annual) - modeled concentrations exceed the AAQS (9.6 mg/m^3) for the maximum and normal operating loads, but are below the AAQS for the reduced load scenario. The modeling results for the maximum and normal load cases are shown in **Figures 6-6** and **6-7**. As indicated by the 9.6 mg/m^3 AAQS contour, the modeled concentrations above the AAQS are limited to the immediate area adjacent to the power plant.
- SO_2 (1-hour) – modeled concentrations are below the AAQS (157 mg/m^3) for all operational load scenarios. **Figure 6-8** shows isopleths for the maximum load case.
- CO (1- and 8-hour) – modeled concentrations are below the AAQS (32,000 mg/m^3 and 8,000 mg/m^3, respectively) for all operational load scenarios.
- The highest modeled concentrations are primarily due to the emissions from the main power plant engines. The contribution of the Power Plant Annex engines to the total modeled concentrations is shown in parentheses in Table 6-1. The results indicate, that with the exception of the CO concentrations which are all well below the AAQS, the maximum modeled concentrations are dominated by the main power plant engine emissions.

The modeling results were also used to site the location of the monitoring station. As indicated on the isopleth figures, the Kwajalein monitoring station was located in the area of maximum modeled concentrations adjacent to the power plant to the southwest.

Table 6-1: Criteria Pollutant Modeling Results – Kwajalein Power Plants

Pollutant	**Averaging Period**	**Operating Load Scenario**	**Total Modeled Conc.(2) (mg/m^3)**	**AAQS (mg/m^3) (1)**	**% of AAQS**
NO_2	1-hour	Maximum	413.13 (0.01)	150.4	275
		Normal	279.05	150.4	186
		Reduced	162.97	150.4	108
$PM_{2.5}$	24-hour	Maximum	50.38 (0.32)	28.0	180
		Normal	29.86	28.0	107
		Reduced	11.85	28.0	42
	Annual	Maximum	32.91 (0.73)	9.6	343
		Normal	19.73	9.6	206
		Reduced	7.45	9.6	78
SO_2	1-hour	Maximum	86.25 (10.23)	156.8	55
		Normal	54.79	156.8	35
		Reduced	0.38	156.8	0.2
CO	1-hour	Maximum	1,037.77 (367.19)	32,000	3
		Normal	661.37	32,000	2
		Reduced	272.89	32,000	1
	8-hour	Maximum	855.74 (18.95)	8,000	11
		Normal	559.42	8,000	7
		Reduced	214.05	8,000	3

1) AAQS are set to 80% of the USEPA NAAQS.
2) Total modeled concentrations from the main power plant and Power Plant Annex engines. Contribution of the Power Plant Annex engines for the maximum operating scenario are shown in parentheses.

Figure 6-1: Kwajalein – Modeled NO_2 1-Hour Isopleth – Maximum Operating Scenario

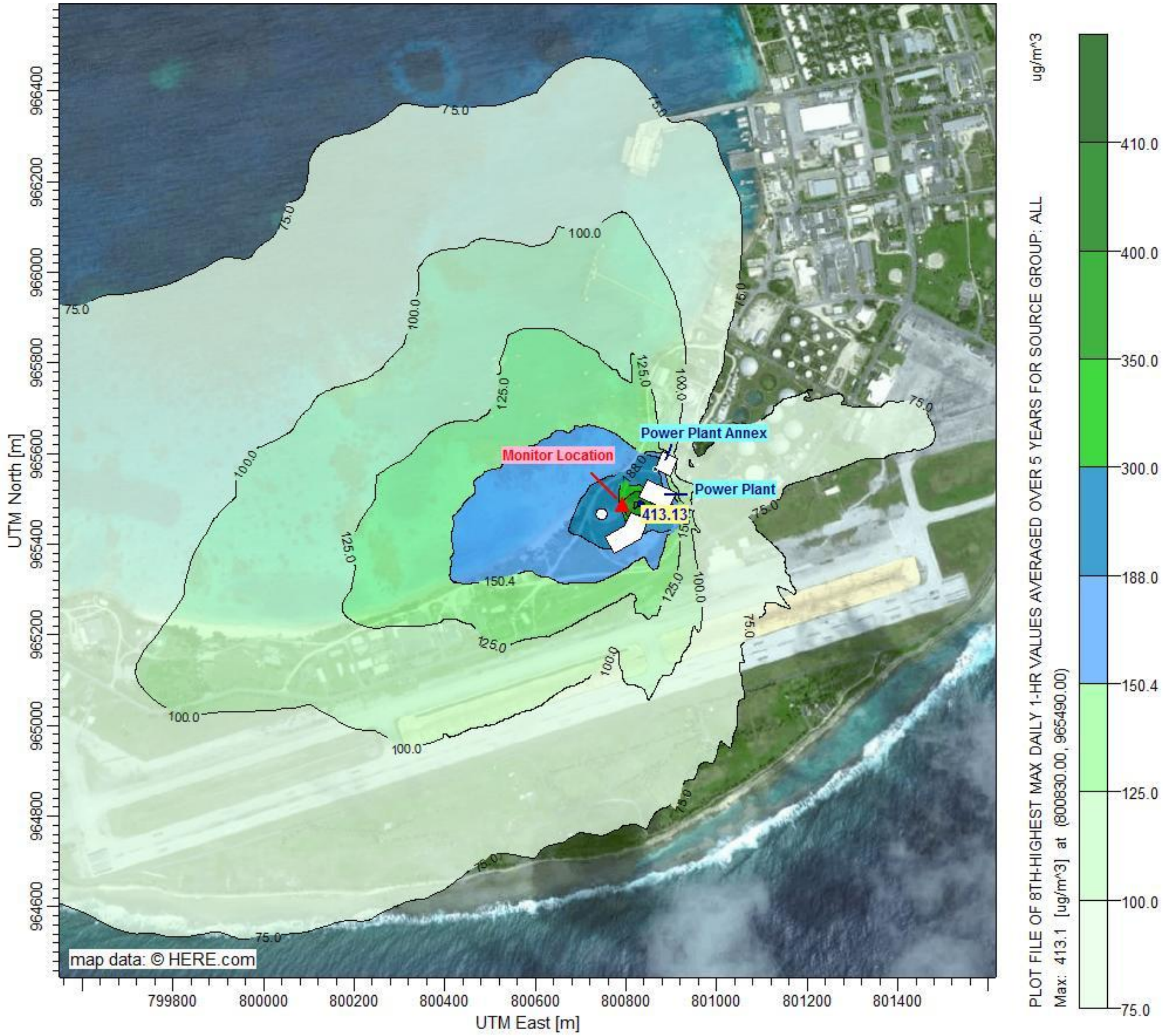


Figure 6-2: Kwajalein – Modeled NO_2 1-Hour Isopleth – Normal Operating Scenario

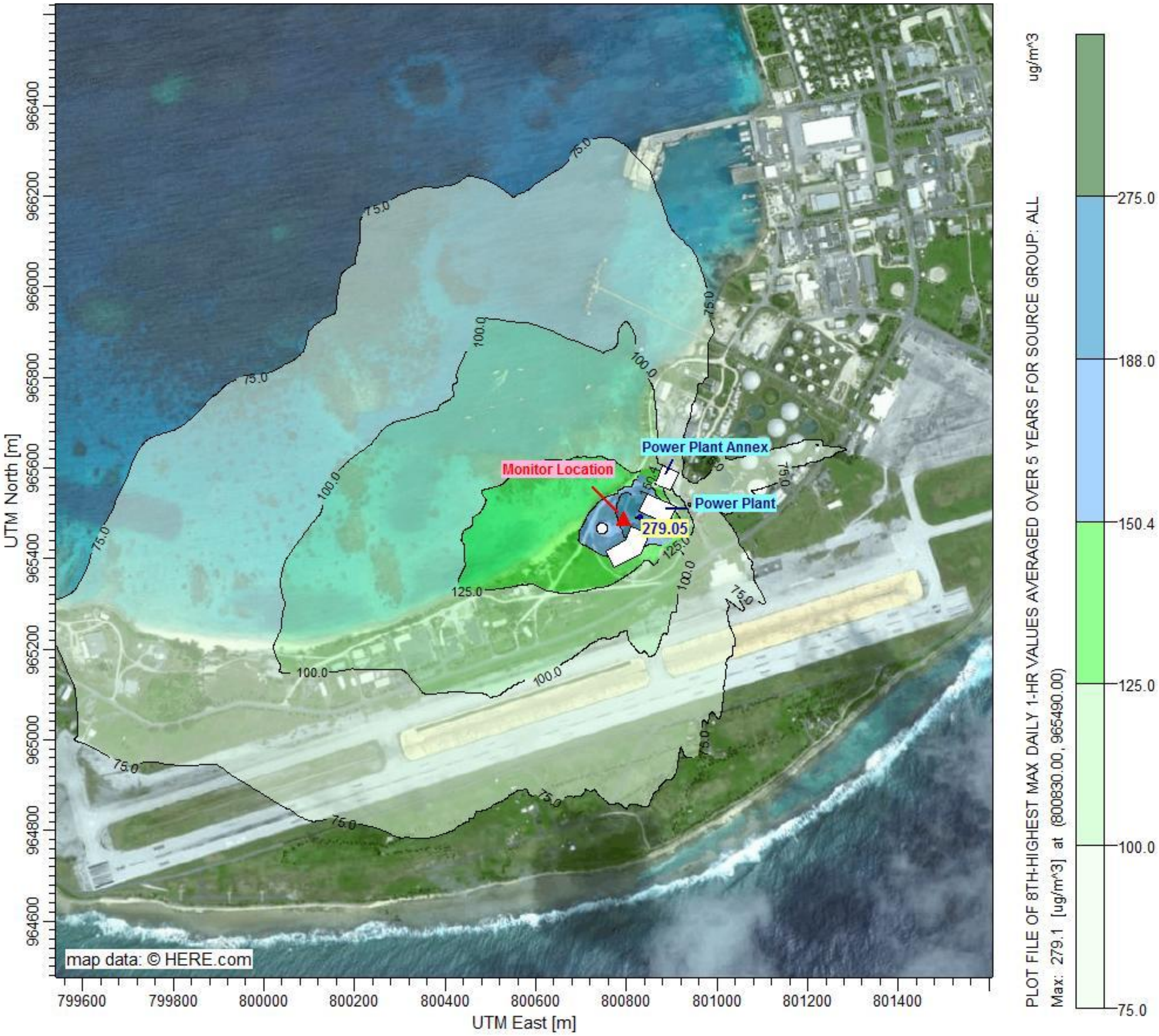


Figure 6-3: Kwajalein – Modeled NO_2 1-Hour Isopleth – Reduced Operating Scenario

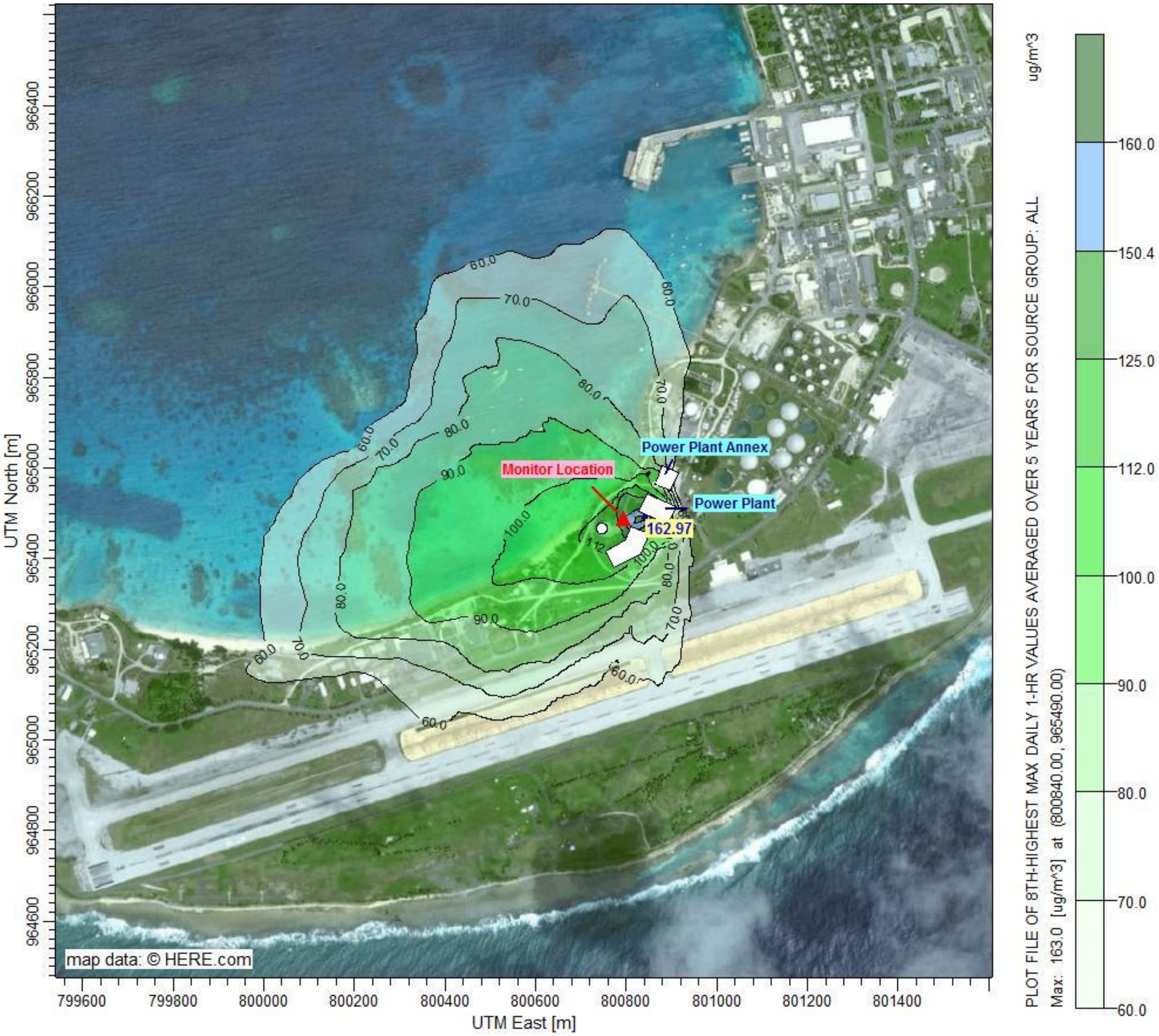


Figure 6-4: Kwajalein – Modeled $PM_{2.5}$ 24-Hour Isopleth – Maximum Operating Scenario

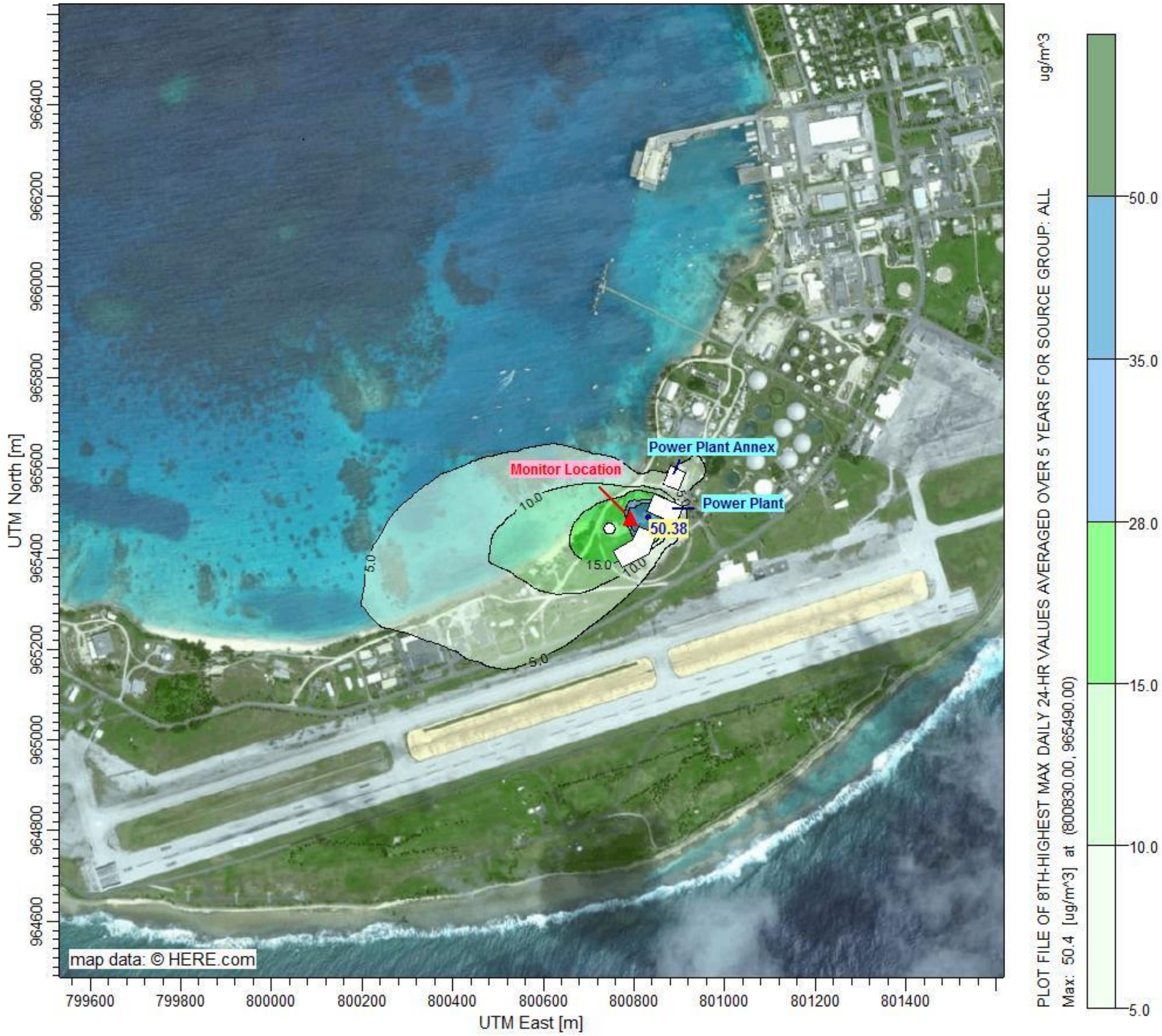


Figure 6-5: Kwajalein – Modeled $PM_{2.5}$ 24-Hour Isopleth – Normal Operating Scenario

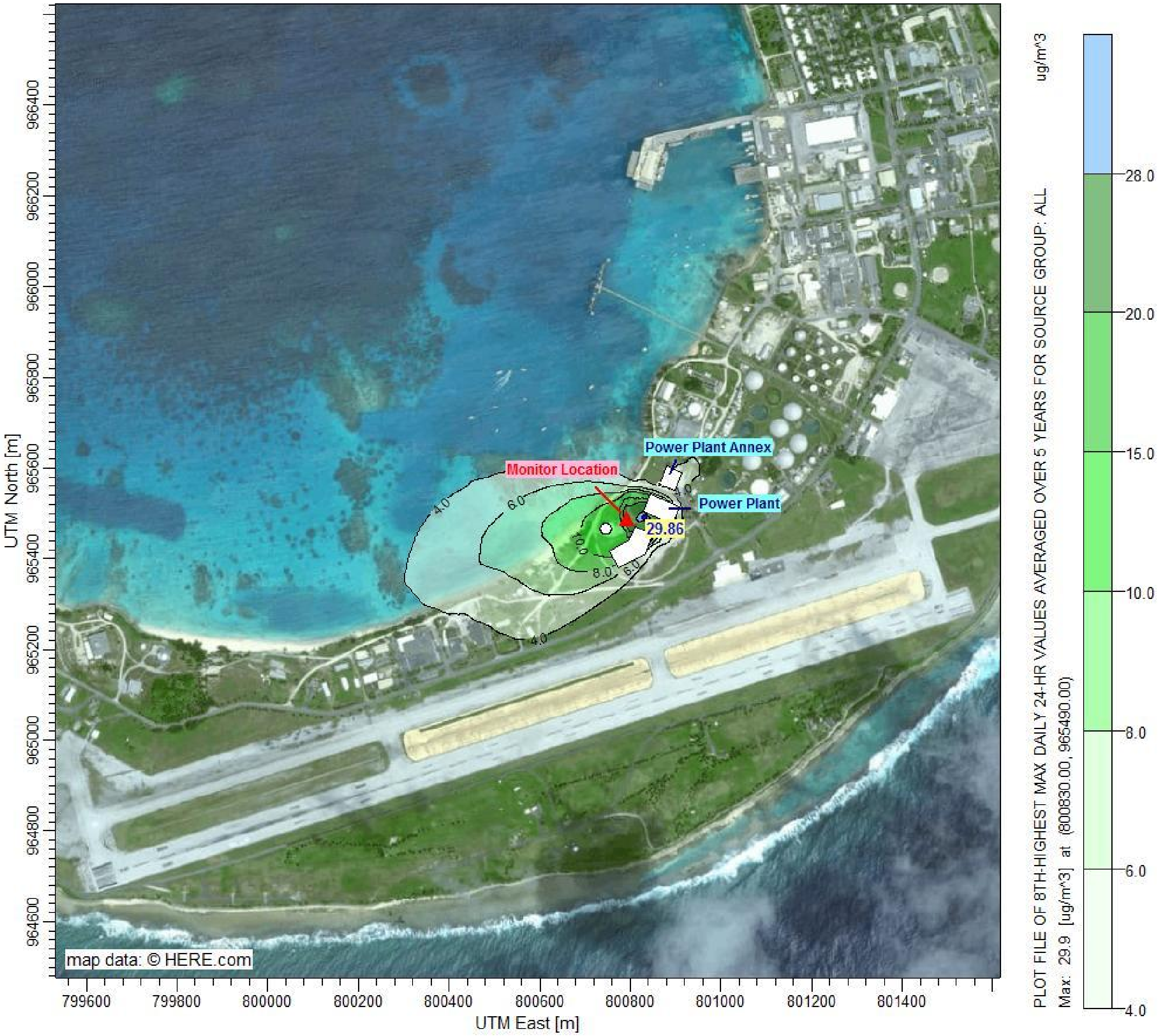


Figure 6-6: **Kwajalein – Modeled $PM_{2.5}$ Annual Isopleth – Maximum Operating Scenario**

Figure 6-7: Kwajalein – Modeled $PM_{2.5}$ Annual Isopleth – Normal Operating Scenario

Figure 6-8: Kwajalein – Modeled SO_2 1-Hour Isopleth – Maximum Operating Scenario

6.1.2 Health Risk Analysis – Formaldehyde and Acrolein

A summary of the RSL analysis for Kwajalein is provided in **Table 6-2**. As shown in the table, the maximum modeled concentrations are well below the RSLs for both formaldehyde and acrolein for the maximum operating load scenario. Given that the maximum load case showed impacts well below the RSLs, modeling for the normal and reduced loads was not necessary.

Table 6-2: RSL Analysis – Kwajalein Power Plants

Pollutant	Averaging Period	Operating Load Scenario	Modeled Conc. (mg/m^3)	Residential RSL (mg/m^3)	Industrial RSL (mg/m^3)	% of Residential RSL	% of Industrial RSL
Formaldehyde	Annual	Maximum	0.051	0.22	0.94	23	5
Acrolein	Annual	Maximum	0.0051	0.021	0.088	24	6

6.2 Roi-Namur Power Plant

6.2.1 Criteria Pollutants

A summary of the modeled concentrations for the three Roi-Namur operating load cases is provided in **Table 6-3**.

The following is a summary of the modeling results in **Table 6-3**:

- NO_2 (1-hour) - the highest modeled concentrations exceed the AAQS (150 mg/m^3) for the maximum and normal operating loads, but below the AAQS for the reduced load case. **Figures 6-9** and **6-10** illustrate the NO_2 modeling results as isopleths (overlaid on a satellite image of the island) for the maximum and normal load cases, respectively. As indicated by the 150.4 mg/m^3 AAQS contour shown in the figures (AAQS contour is in blue), the modeled concentrations above the AAQS are limited to the area adjacent to the power plant. Note that given the modeled concentrations are only 106% and 102% of the AAQS, respectively, for the maximum and normal operating cases, and given the modeled NO_2 concentrations were determined using very conservative ozone data from Honolulu, HI, the conversion of NO_x to NO_2 was likely over-predicted by the model and results would be below the AAQS if site specific ozone data were available. This would be consistent with the monitored concentrations which indicate actual measured concentrations are below the AAQS.
- $PM_{2.5}$ (24-hour) - modeled concentrations are below the AAQS (28 mg/m^3) for all operational load scenarios. **Figure 6-11** shows isopleths for the maximum load case.
- $PM_{2.5}$ (annual) - modeled concentrations are below the AAQS (9.6 mg/m^3) for all operating load scenarios. **Figure 6-12** shows isopleths for the maximum load case.
- SO_2 (1-hour) – modeled concentrations are below the AAQS (157 mg/m^3) for all operating load scenarios. **Figure 6-13** shows isopleths for the maximum load case.
- CO (1- and 8-hour) – modeled concentrations are below the AAQS (32,000 mg/m^3 and 8,000 mg/m^3, respectively) for all operating load scenarios.

The modeling results were also used to site the location of the monitoring station. The maximum concentrations for Roi-Namur were modeled to the northwest of the power plant, with an area of secondary maximum modeled to the southwest of the plant. However, the location of the overall maximum concentration was not consistent with the predominant northeasterly wind direction expected during the monitoring program, which would result in a higher frequency of monitored concentrations to the southwest of the power plant. Therefore, the monitoring station for Roi-Namur was located to the southwest of the power plant to maximize the exposure potential to the power plant stack emissions during the sampling program.

Table 6-3: Criteria Pollutant Modeling Results – Roi-Namur Power Plant

Pollutant	Averaging Period	Operating Load Scenario	Modeled Conc. (mg/m^3)	AAQS (mg/m^3)$^{(1)}$	% of AAQS
NO_2	1-hour	Maximum	159.79	150.4	106
		Normal	152.87	150.4	102
		Reduced	105.55	150.4	70
$PM_{2.5}$	24-hour	Maximum	7.34	28.0	26
		Normal	5.60	28.0	20
		Reduced	2.16	28.0	8
	Annual	Maximum	3.28	9.6	34
		Normal	2.73	9.6	28
		Reduced	1.03	9.6	11
SO_2	1-hour	Maximum	31.49	156.8	20
		Normal	26.58	156.8	17
		Reduced	0.21	156.8	0.1
CO	1-hour	Maximum	391.47	32,000	1
		Normal	314.33	32,000	1
		Reduced	126.47	32,000	0.4
	8-hour	Maximum	288.13	8,000	4
		Normal	220.57	8,000	3
		Reduced	99.68	8,000	1

(1) AAQS are set to 80% of the USEPA NAAQS.

Figure 6-9: Roi-Namur – Modeled NO_2 1-Hour Isopleth – Maximum Operating Scenario

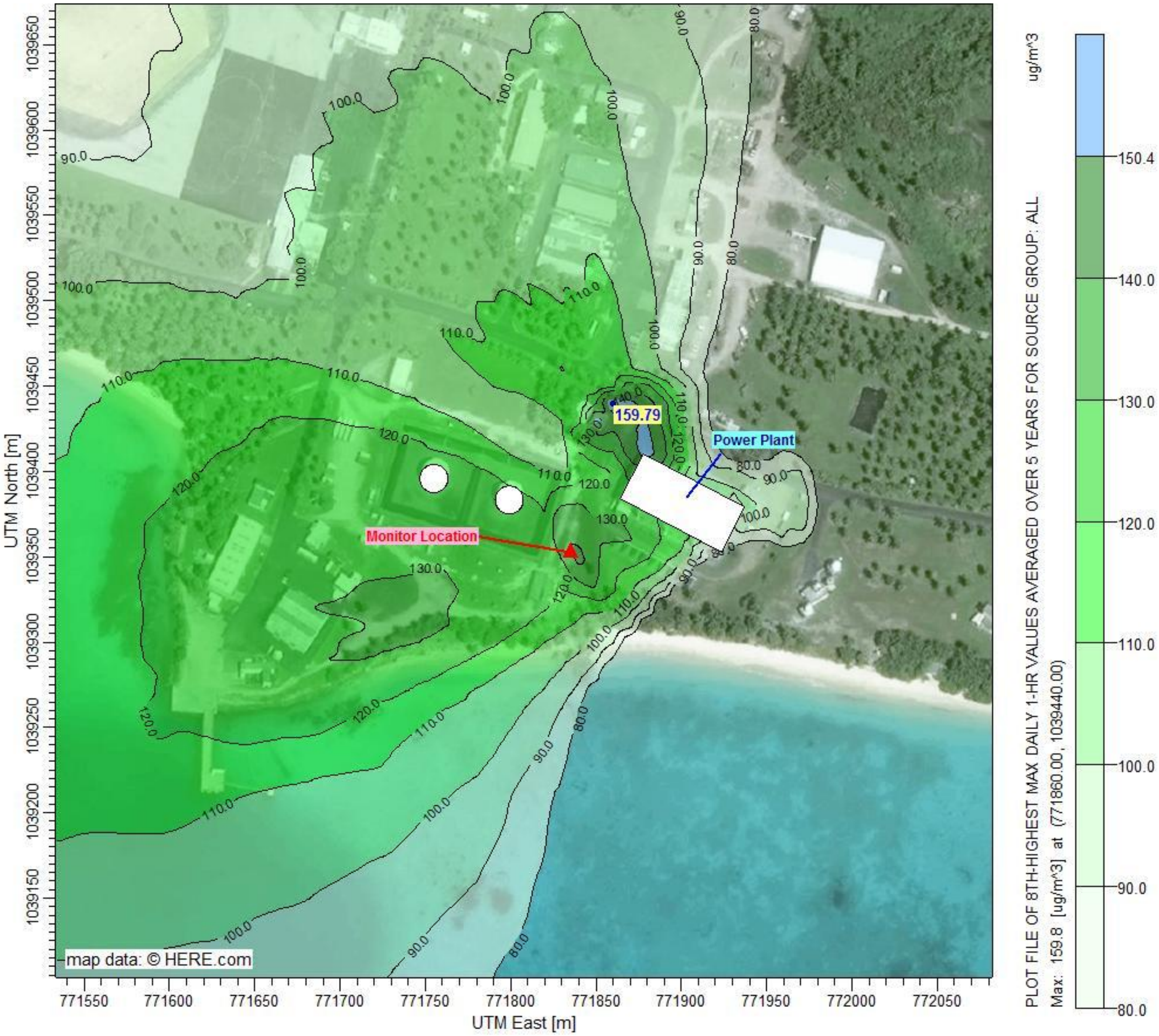


Figure 6-10: Roi-Namur – Modeled NO_2 1-Hour Isopleth – Normal Operating Scenario

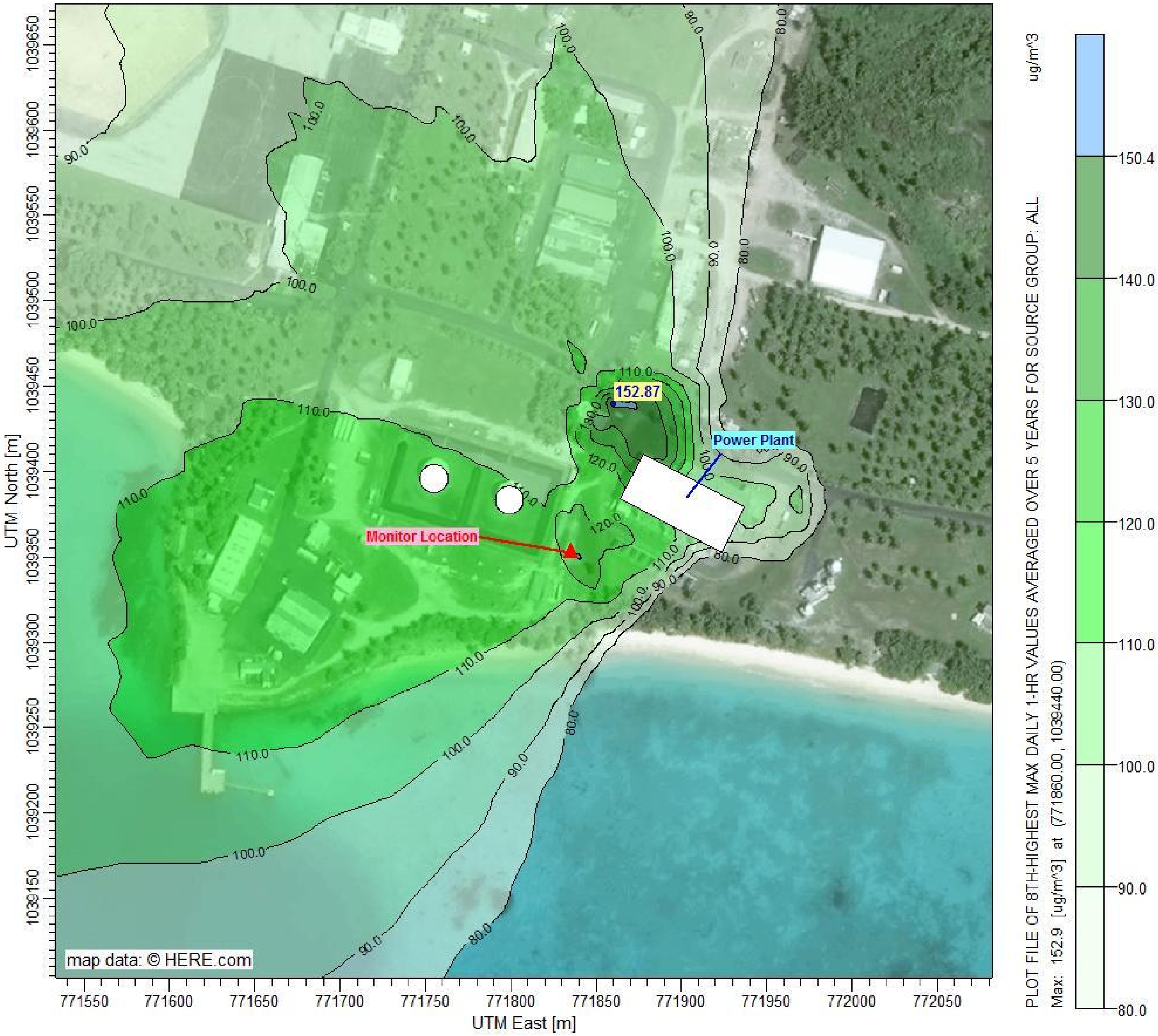


Figure 6-11: Roi-Namur – Modeled $PM_{2.5}$ 24-Hour Isopleth – Maximum Operating Scenario

Figure 6-12: **Roi-Namur – Modeled PM$_{2.5}$ Annual Isopleth – Maximum Operating Scenario**

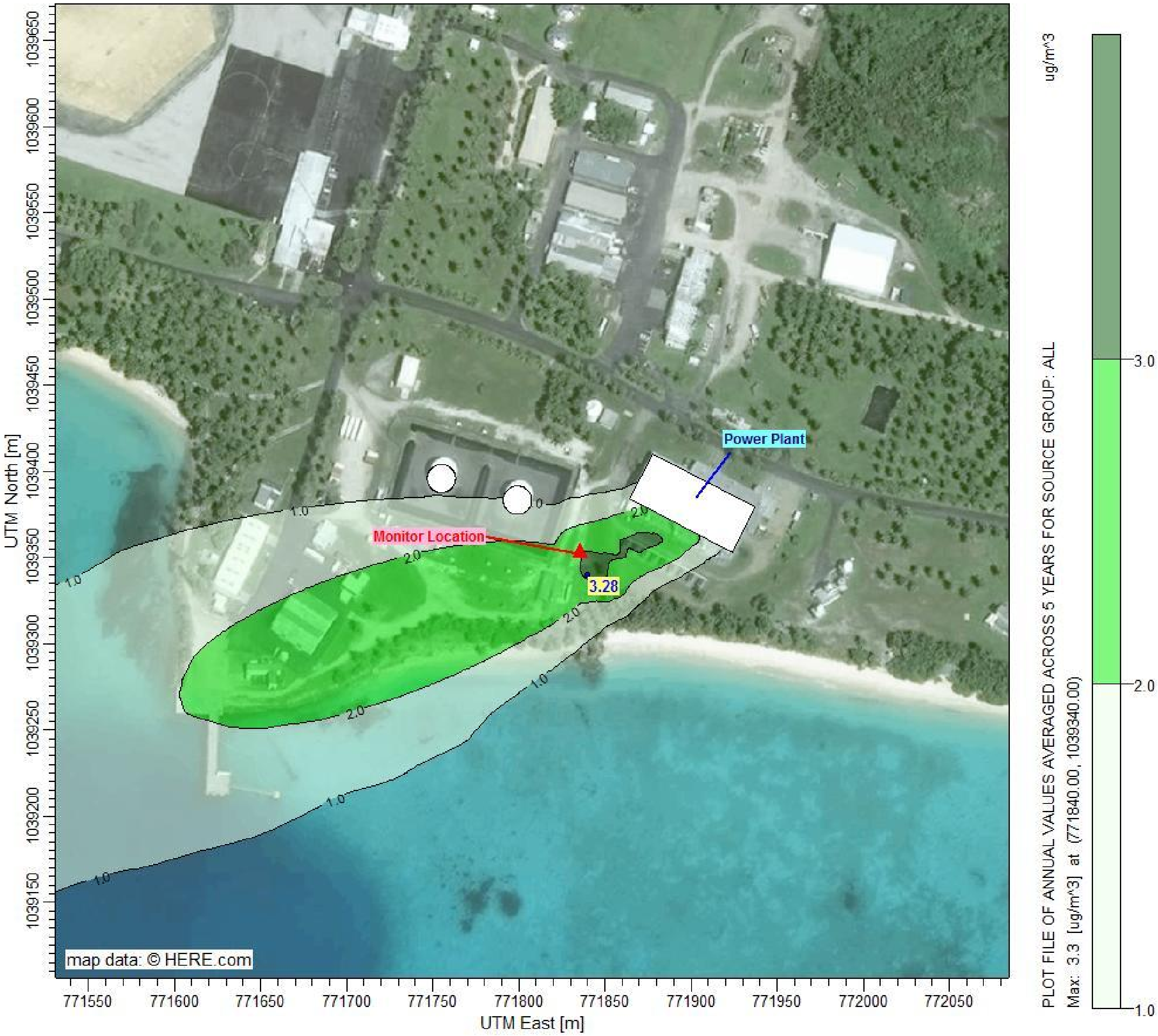


Figure 6-13: Roi-Namur – Modeled SO_2 1-Hour Isopleth – Maximum Operating Scenario

6.2.2 Health Risk Analysis – Formaldehyde and Acrolein

A summary of the RSL analysis for Roi-Namur is provided in **Table 6-4**. As shown in the table, the maximum modeled concentrations are well below the RSLs for both formaldehyde and acrolein for the maximum operating load scenario. Given that the maximum load case showed impacts well below the RSLs, modeling for the normal and reduced loads was not necessary.

Table 6-4: RSL Analysis – Roi-Namur Power Plant

Pollutant	Averaging Period	Operating Load Scenario	Modeled Conc. (mg/m^3)	Residential RSL (mg/m^3)	Industrial RSL (mg/m^3)	% of Residential RSL	% of Industrial RSL
Formaldehyde	Annual	Maximum	0.0056	0.22	0.94	3	1
Acrolein	Annual	Maximum	0.00056	0.021	0.088	3	1

6.3 Meck Power Plant

6.3.1 Criteria Pollutants

A summary of the modeled concentrations for the three Meck operating load cases is provided in **Table 6-5**.

The following is a summary of the modeling results in **Table 6-5**:

- NO_2 (1-hour) - the highest modeled concentrations are below the AAQS (150.4 mg/m^3) for all operating loads. **Figure 6-14** shows isopleths for the maximum load case.
- $PM_{2.5}$ (24-hour) - modeled concentrations are below the AAQS (28 mg/m^3) for all operational load scenarios. **Figure 6-15** shows isopleths for the maximum load case.
- $PM_{2.5}$ (annual) - modeled concentrations are below the AAQS (9.6 mg/m^3) for all operating load scenarios. **Figure 6-16** shows isopleths for the maximum load case.
- SO_2 (1-hour) – modeled concentrations are below the AAQS (157 mg/m^3) for all operating load scenarios. **Figure 6-17** shows isopleths for the maximum load case.
- CO (1- and 8-hour) – modeled concentrations are below the AAQS (32,000 mg/m^3 and 8,000 mg/m^3, respectively) for all operating load scenarios.

The modeling results were also used to site the location of the monitoring station. The maximum concentrations for Meck were modeled to the southeast of the power plant, with an area of secondary maximum modeled to the southwest of the plant. However, the location of the overall maximum concentration was not consistent with the predominant northeasterly wind direction expected during the monitoring program, which would result in a higher frequency of monitored concentrations to the southwest of the power plant. Therefore, the monitoring station for Meck was located to the southwest of the power plant to maximize the exposure potential to the power plant stack emissions during the sampling program.

Table 6-5: Criteria Pollutant Modeling Results – Meck Power Plant

Pollutant	Averaging Period	Operating Load Scenario	Modeled Conc. (mg/m^3)	AAQS (mg/m^3) (1)	% of AAQS
NO_2	1-hour	Maximum	128.83	150.4	86
		Normal	113.15	150.4	75
		Reduced	91.25	150.4	61
$PM_{2.5}$	24-hour	Maximum	5.70	28.0	20
		Normal	3.66	28.0	13
		Reduced	1.46	28.0	5
	Annual	Maximum	2.76	9.6	29
		Normal	1.71	9.6	18
		Reduced	0.63	9.6	7
SO_2	1-hour	Maximum	23.26	156.8	15
		Normal	16.93	156.8	11
		Reduced	0.10	156.8	0.1
CO	1-hour	Maximum	297.70	32,000	1
		Normal	222.18	32,000	1
		Reduced	77.44	32,000	0.2
	8-hour	Maximum	242.71	8,000	3
		Normal	182.87	8,000	2
		Reduced	62.19	8,000	1

(1)AAQS are set to 80% of the USEPA NAAQS.

Figure 6-14: Meck – Modeled NO_2 1-Hour Isopleth – Maximum Operating Scenario

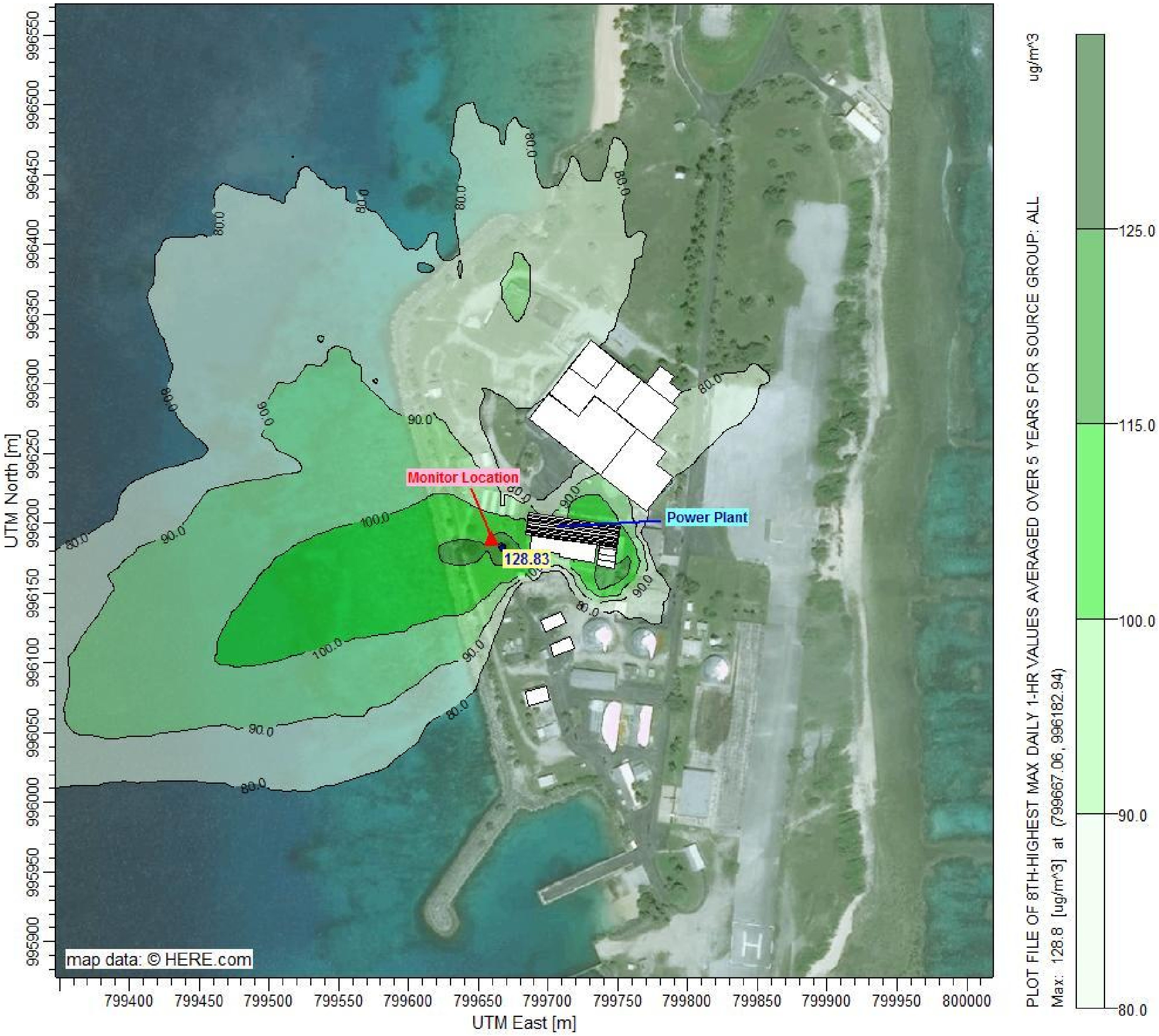


Figure 6-15: Meck – Modeled PM$_{2.5}$ 24-Hour Isopleth – Maximum Operating Scenario

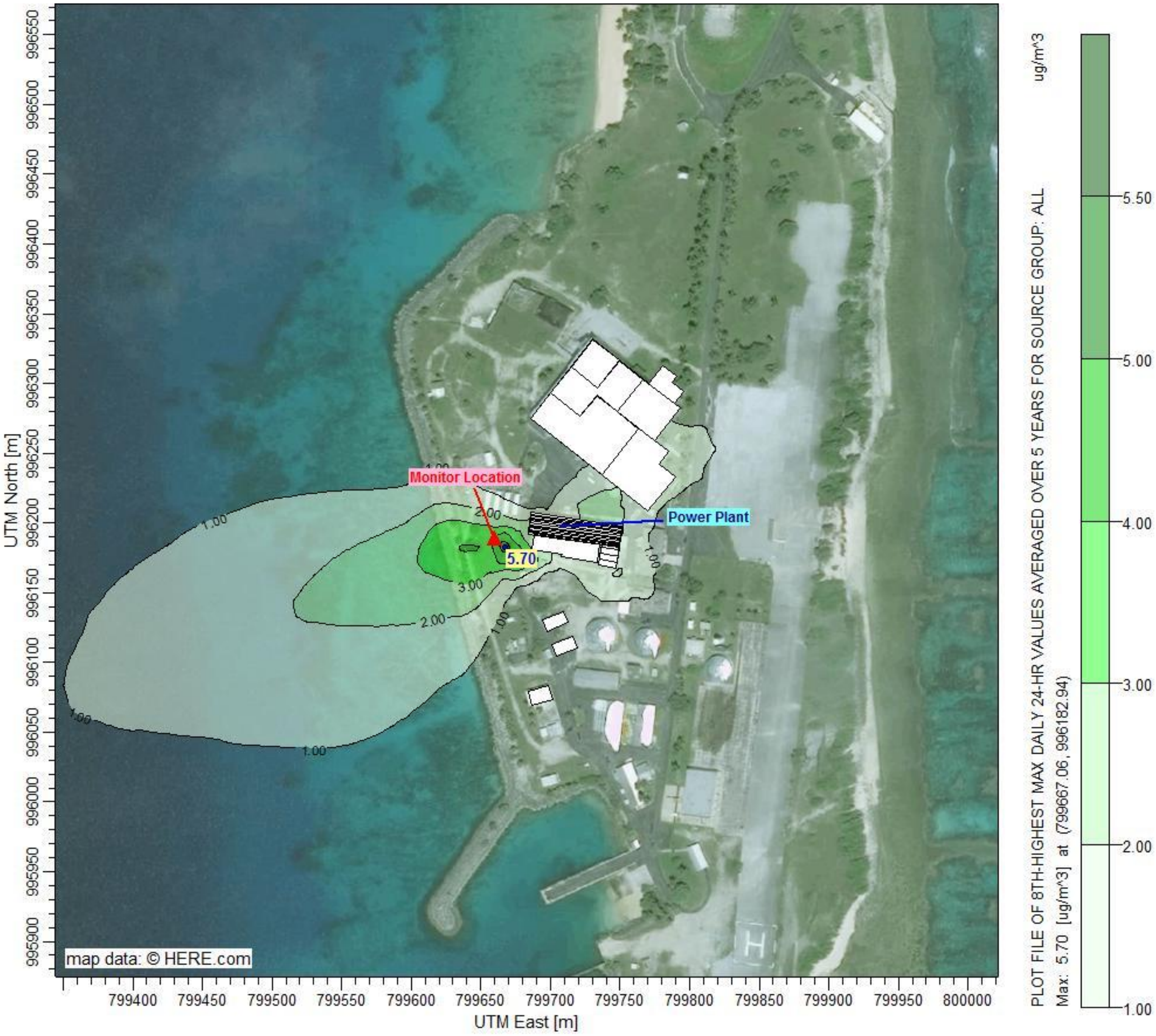


Figure 6-16: Meck – Modeled $PM_{2.5}$ Annual Isopleth – Maximum Operating Scenario

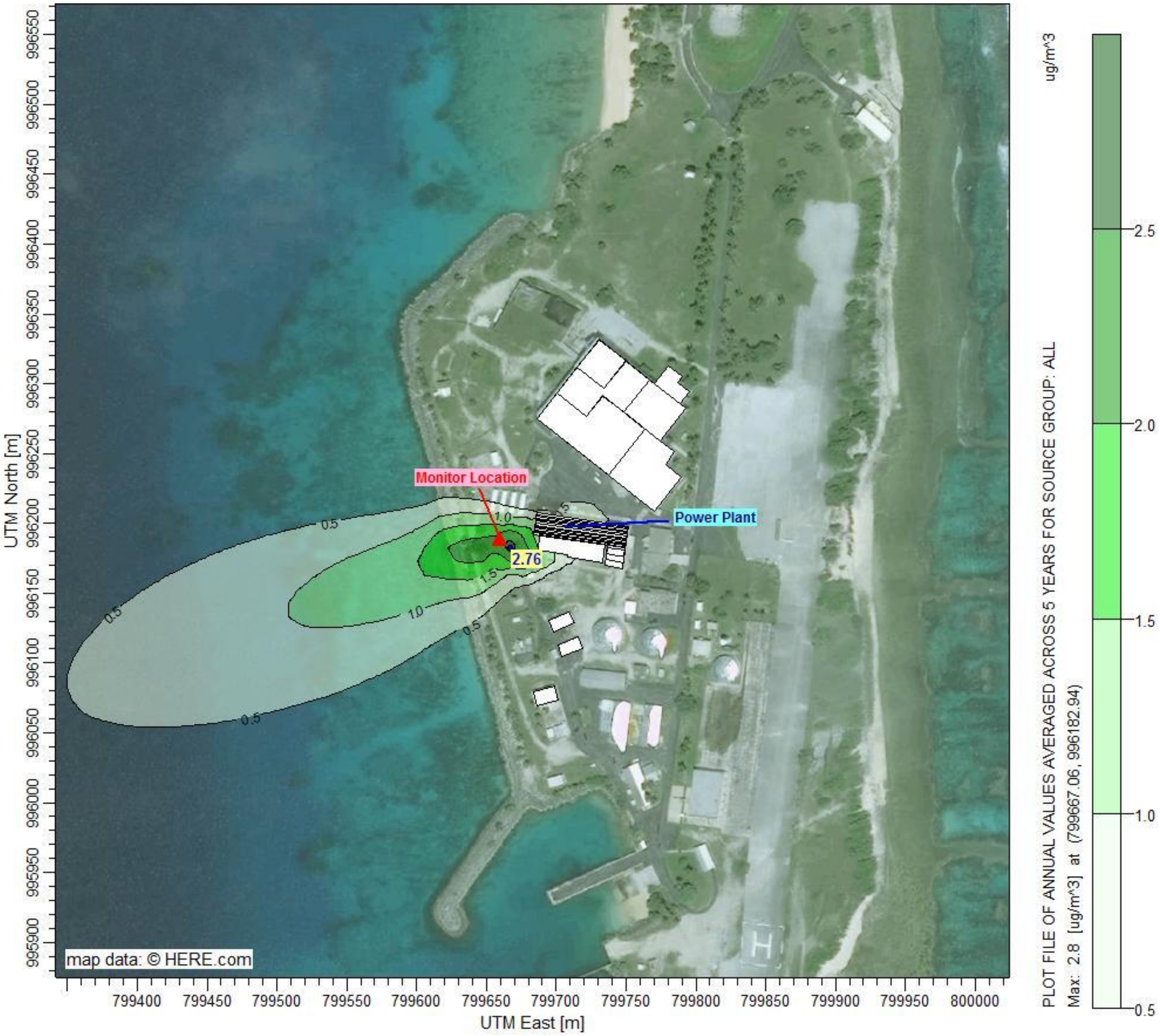
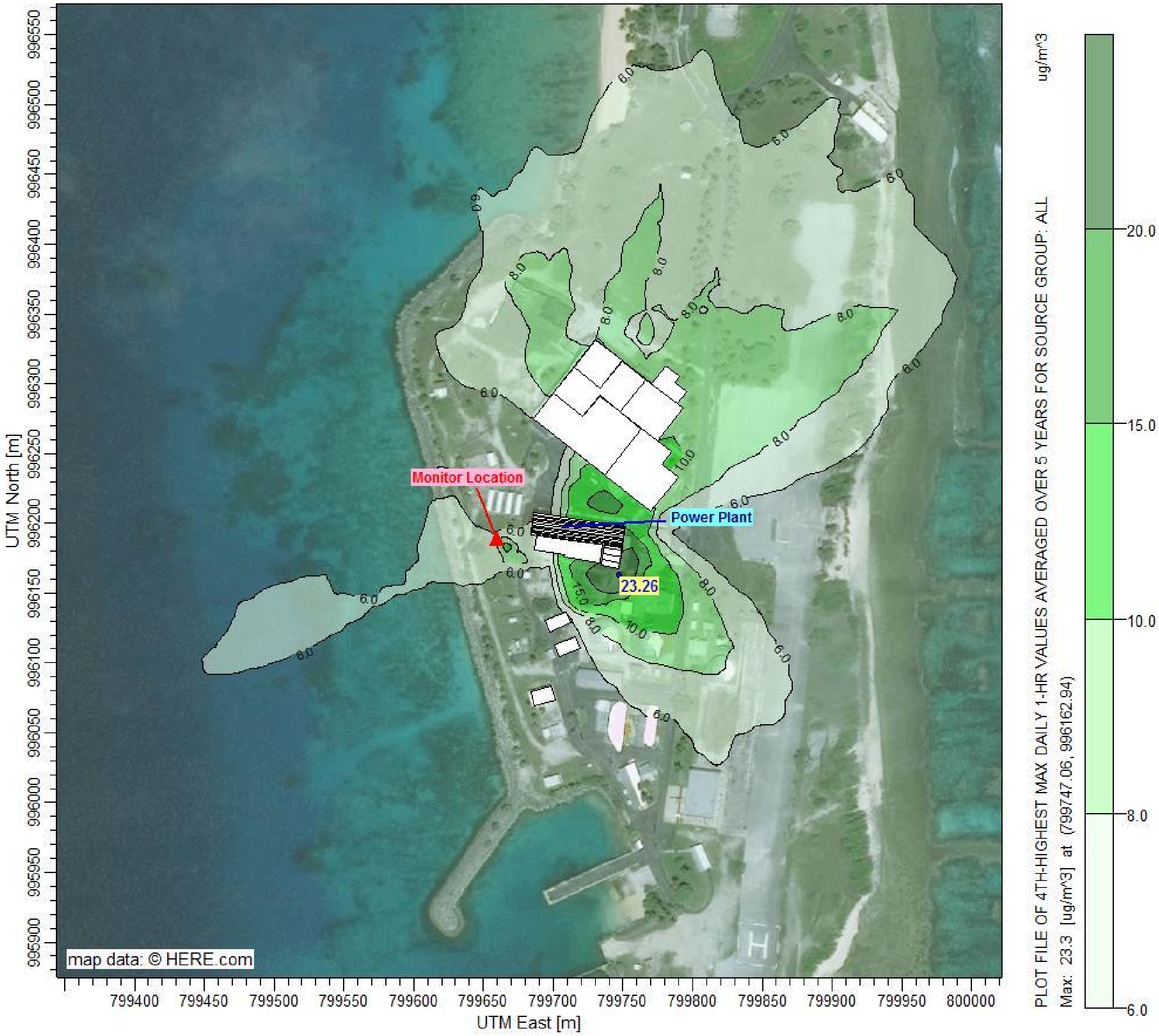


Figure 6-17: Meck – Modeled SO_2 1-Hour Isopleth – Maximum Operating Scenario



6.3.2 Health Risk Analysis – Formaldehyde and Acrolein

A summary of the RSL analysis for Meck is provided in **Table 6-6**. As shown in the table, the maximum modeled concentrations are well below the RSLs for both formaldehyde and acrolein for the maximum operating load scenario. Given that the maximum load case showed impacts well below the RSLs, modeling for the normal and reduced loads was not necessary.

Table 6-6: RSL Analysis – Meck Power Plant

Pollutant	Averaging Period	Operating Load Scenario	Modeled Conc. (mg/m^3)	Residential RSL (mg/m^3)	Industrial RSL (mg/m^3)	% of Residential RSL	% of Industrial RSL
Formaldehyde	Annual	Maximum	0.0046	0.22	0.94	2	0.5
Acrolein	Annual	Maximum	0.00046	0.021	0.088	2	1

7. Review of Monitoring and Modeling Results/Model Evaluation Analysis

This section provides a comparison of the ambient air quality data collected during the monitoring program at each island and the modeled concentrations (for receptors located at the monitor locations) using concurrent meteorological data from the Kwajalein Airport. The modeling conducted for the evaluation analysis utilized actual operating data provided by the power plants. Note that actual emissions data were not available, but were estimated from fuel use/engine load and published emission factors. The Kwajalein power plant provided hourly operational data including hourly load/hourly fuel use. Only daily load/fuel use was available for Roi-Namur and Meck. Note that the actual operating data were generally consistent with the normal operating parameters discussed in **Section 5**.

AERMOD was applied with meteorological data concurrent with the monitoring period for each island, and one receptor located at each monitoring station, to generate hourly (NO_2) and daily ($PM_{2.5}$) modeled concentrations for comparison to the monitored concentrations. Various plots/graphs of the modeling and monitoring results, including wind direction and speed, were prepared to facilitate the analyses.

Note that the analyses focuses on NO_2 and $PM_{2.5}$. The modeled/monitored SO_2 concentrations are very low and therefore provides less meaningful analysis compared to NO_2 and $PM_{2.5}$.

Figure 7-1 is a wind rose for the monitoring period. As shown in the figure, the winds were predominantly from the east-northeast, which maximized the exposure of the monitors relative to the power plant stacks on all three islands.

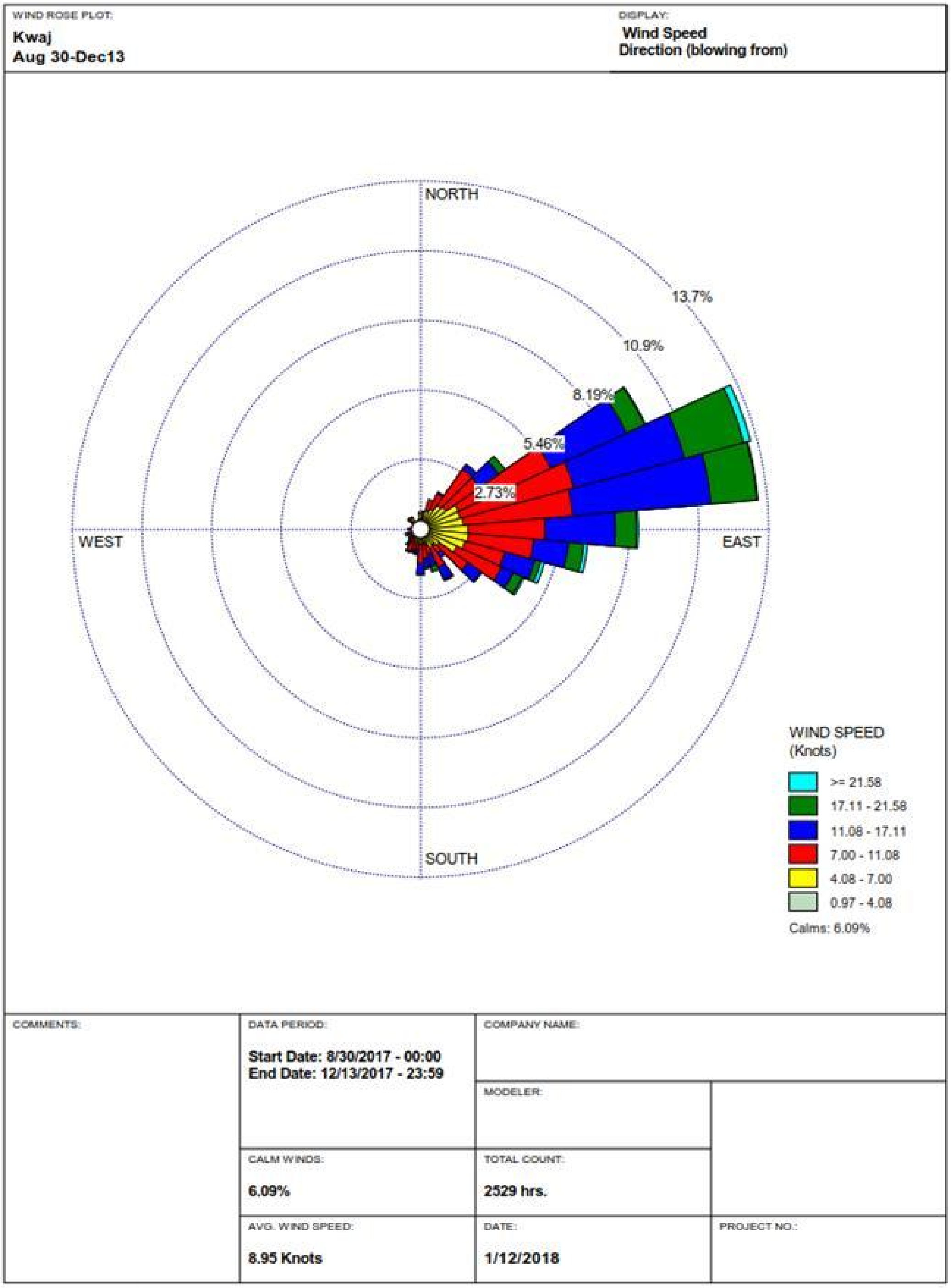
As noted, a number of graphs/plots were generated to facilitate the model/monitor evaluation for each island in the sub-sections below. They consist of time series plots, quantile-quantile plots, and plots of concentrations versus key model input parameters such as wind direction and wind speed. The time series plots provide useful information regarding the trend of concentrations during the field study as well as the magnitude and temporal distribution of the concentrations. The inclusion of wind speed on these plots introduces the dependence of the concentrations on a factor that is expected to influence the concentration levels.

A quantile-quantile (or “Q-Q”) plot is created by sorting by rank the predicted and the observed concentrations from a set of predictions initially paired in time and space. The sorted list of predicted daily concentrations is then plotted by rank against the observed concentrations, which is also sorted by rank. This type of plot is useful for answering the question, “Over a period of time at this location, does the distribution of the model predictions match those of observations?”.

The plots of concentration vs. wind direction determines that the airport meteorological data is representative of the monitoring sites by showing that the peak monitored concentrations occur for wind directions that would blow the emissions from the power plant sources to the monitor. Peak observed concentrations from other wind directions would indicate either other emission sources are influencing monitor concentrations or there are wind direction uncertainties, possibly during light wind conditions.

The plots of concentration versus wind speed provide insights into whether building downwash effects result in the highest observed (and predicted) ground-level concentrations. The effect of downwash results in an aerodynamic downdraft in high winds that brings the emissions to the ground faster than in lighter winds. Without that effect, the more effective dilution of the emissions by stronger winds would generally be expected to result in lower ground-level concentrations in high wind conditions.

Figure 7-1: Wind Rose – Monitoring Period



WIND ROSE PLOT:
Kwaj
Aug 30-Dec13

DISPLAY:
Wind Speed
Direction (blowing from)

COMMENTS:

DATA PERIOD:
Start Date: 8/30/2017 - 00:00
End Date: 12/13/2017 - 23:59

COMPANY NAME:

MODELER:

CALM WINDS:
6.09%

TOTAL COUNT:
2529 hrs.

AVG. WIND SPEED:
8.95 Knots

DATE:
1/12/2018

PROJECT NO.:

WRPLOT View - Lakes Environmental Software

7.1 Kwajalein

Figure 7-2 is a plot of the hourly monitored and modeled NO_2 concentrations versus wind direction. As expected, given the location of the monitor/model receptor, measured/modeled concentrations peak with east-northeast winds that align the power plant stacks with the monitor. The figure also shows that the model predicts higher concentrations than were monitored.

Figure 7-3 is a time series plot of the daily maximum 1-hour NO_2 monitored and modeled concentrations, as well as the daily average wind speed.

Figure 7-4 is a Q-Q plot of the top 50 modeled daily maximum 1-hour NO_2 concentrations (y-axis) versus the top 50 monitored concentrations (x-axis).

Figures 7-3 and **7-4** show that AERMOD consistently over-predicts compared to the monitored concentrations at the Kwajalein monitor. However, as indicated by **Figure 7-3**, while there are many days where the modeled predictions exceed the NO_2 AAQS (about 150 µg/m^3), there was only one day where the monitor recorded a concentration above the AAQS. Since over the monitoring period the second highest concentration[6] conforms to the 98th percentile value, the monitored concentration with the rank associated with the ambient standard shows a value below the AAQS.

Figure 7-3 also indicates that in general, the higher measured/modeled concentrations are associated with moderate to high wind speeds that were predominant during the last month of the field study (mid-November through mid-December). This is also illustrated in **Figure 7-5**, which is a plot of modeled and monitored concentrations versus wind speed. This is an indication that building downwash is an important factor in controlling the higher monitored concentrations. This was expected given the stacks at the power plant are below GEP height, and are subject to building downwash from the power plant building.

Figure 7-6 is a time series plot of the 24-hour $PM_{2.5}$ monitored and modeled concentrations over the monitoring period. **Figure 7-7** is a Q-Q plot of the top 25 modeled daily average concentrations (y-axis) versus the top 25 monitored concentrations (x-axis). **Figures 7-6** and **7-7** illustrate that the model is over-predicting $PM_{2.5}$ concentrations. However, as indicated by **Figure 7-3**, while there a number of days where the modeled predictions exceed the AAQS (28 µg/m^3), there are no days where the monitor recorded a concentration above the AAQS.

In addition, as indicated by **Figure 7-8** (which is a plot of daily-averaged monitored and modeled $PM_{2.5}$ concentrations versus daily-averaged wind speed, similar to the NO_2 analysis), there is some correlation of higher $PM_{2.5}$ concentrations with moderate to high wind speeds.

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[6] For a valid number of monitoring days between 51 and 100, the 98th percentile corresponds to the second highest peak daily 1-hour maximum concentration; see Table 1 at 75 FR 5434., February 9, 2010.

Figure 7-2: Kwajalein - Hourly Monitored and Modeled NO_2 vs Wind Direction

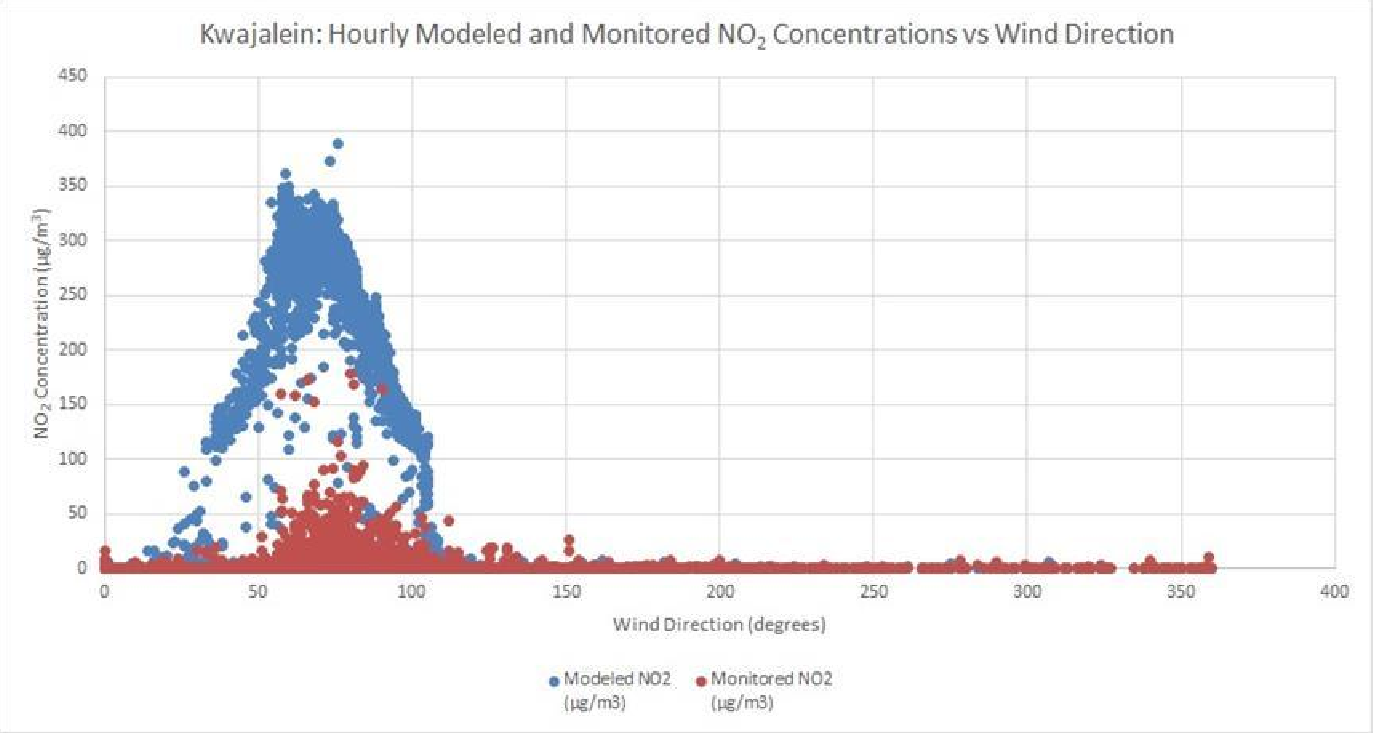


Figure 7-3: Kwajalein - Daily Maximum 1-Hour NO_2 Monitored and Modeled Concentrations

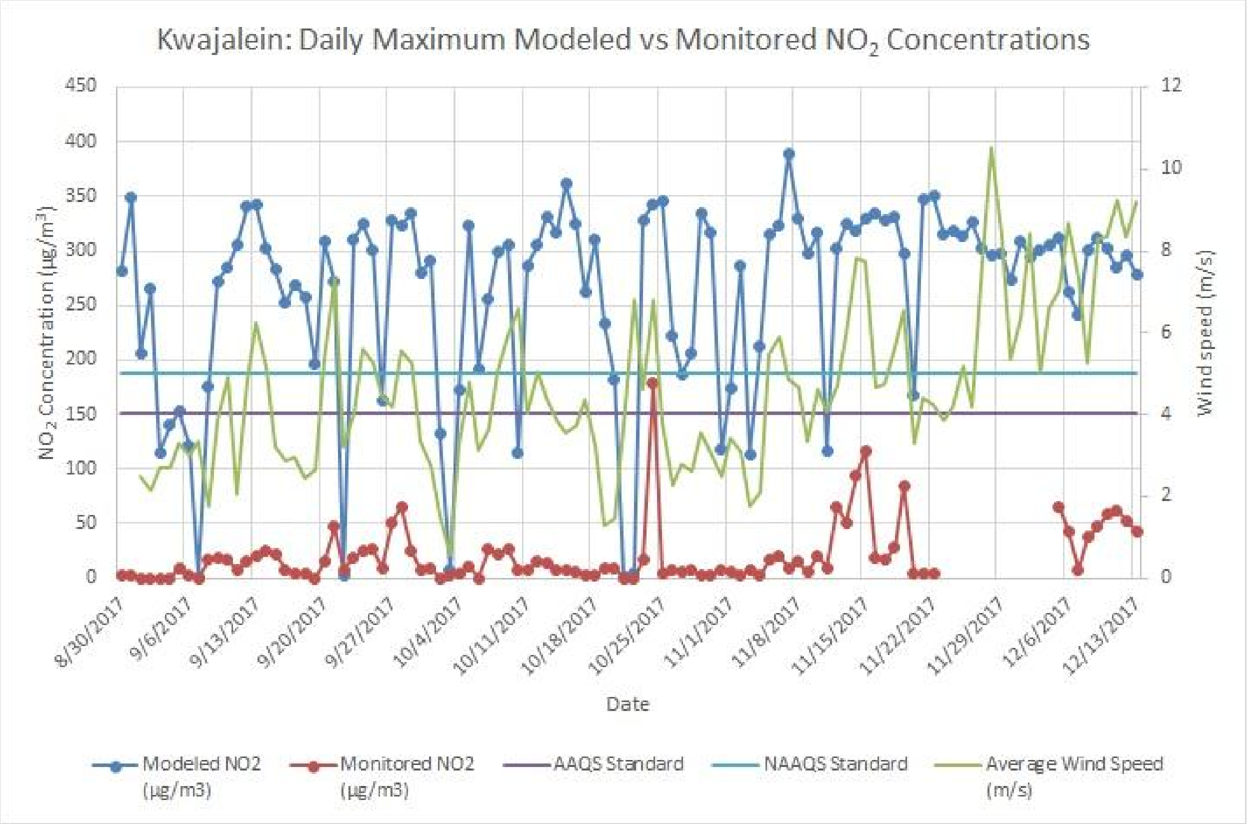


Figure 7-4: Kwajalein - Daily Maximum 1-Hour NO_2 Quantile-Quantile Plot

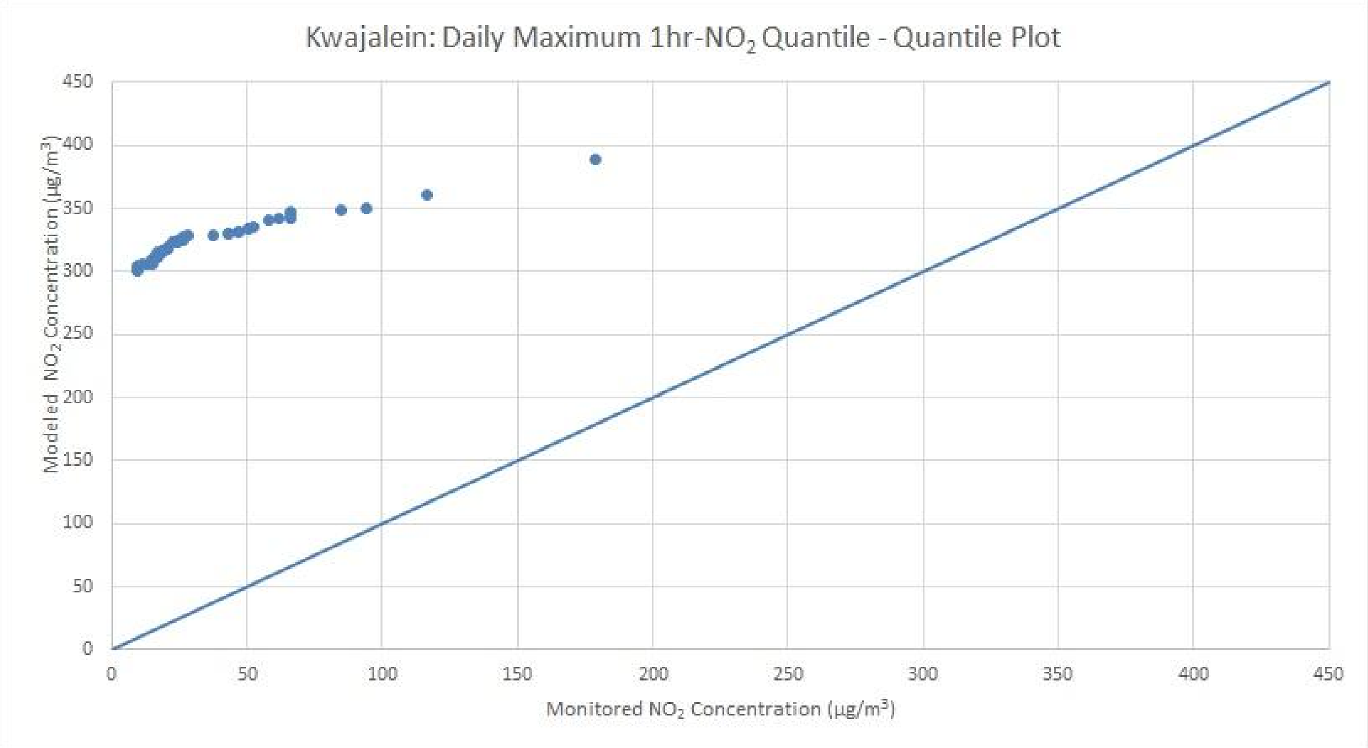


Figure 7-5: Kwajalein - Modeled and Monitored Daily Maximum 1-Hour NO_2 versus wind speed

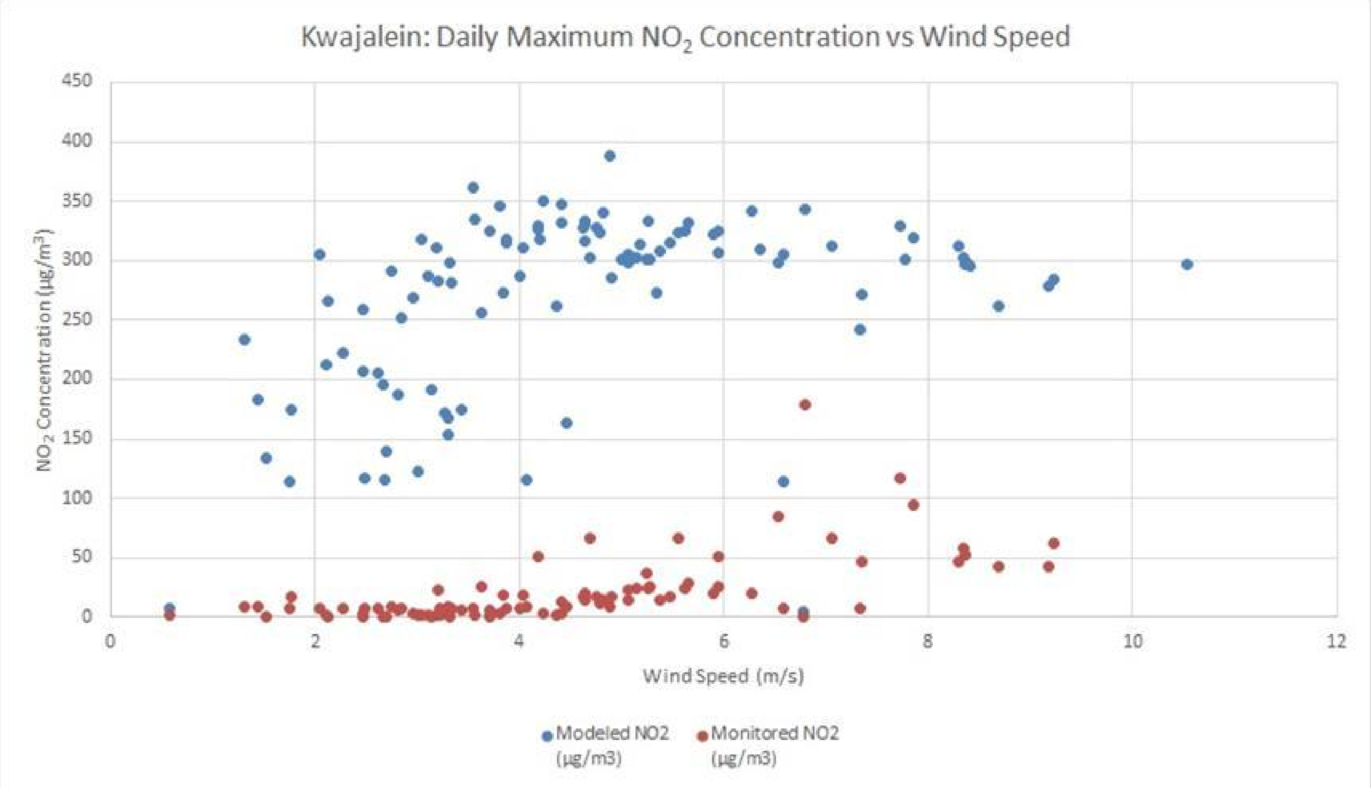


Figure 7-6: Kwajalein - Daily Average 24-Hour $PM_{2.5}$ Monitored and Modeled Concentrations

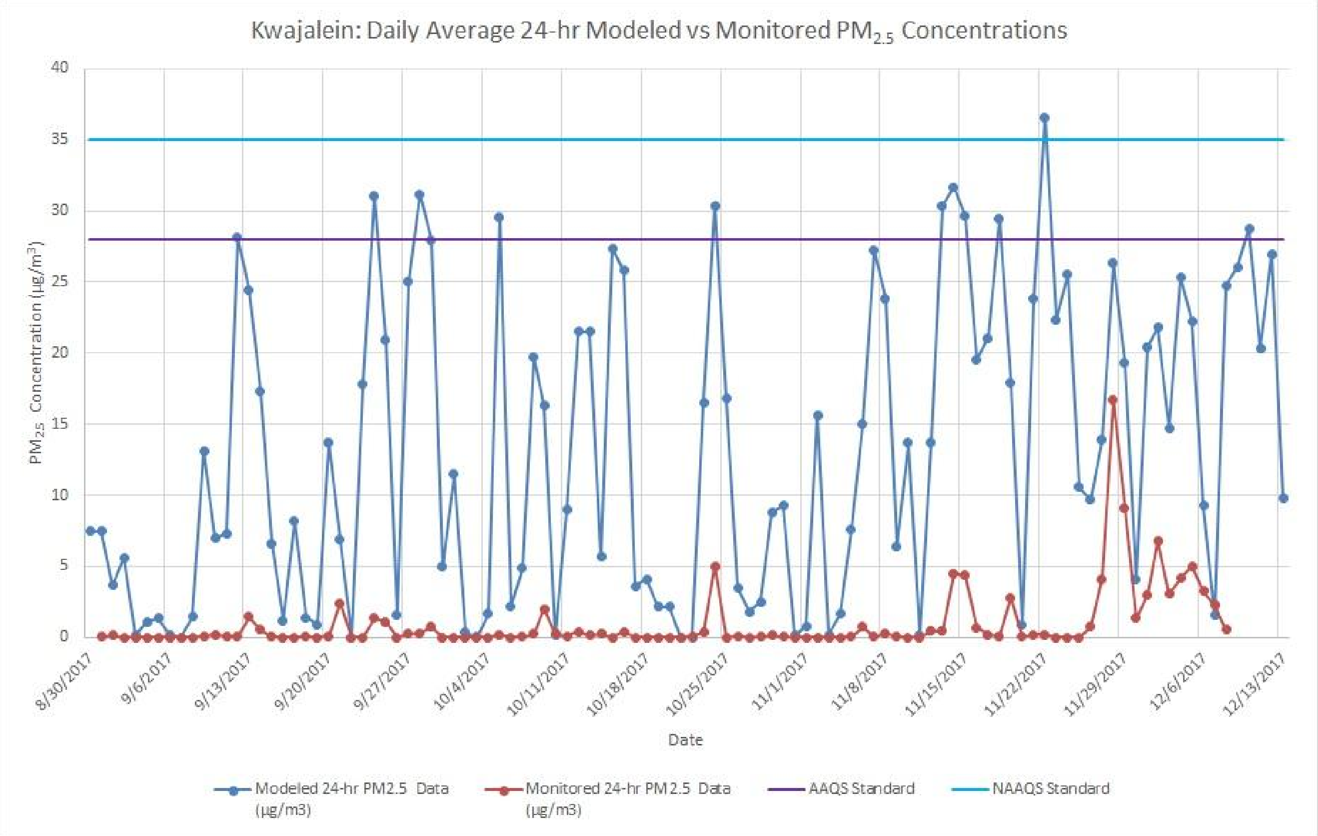


Figure 7-7: **Kwajalein - Daily Average 24-Hour $PM_{2.5}$ Quantile-Quantile Plot**

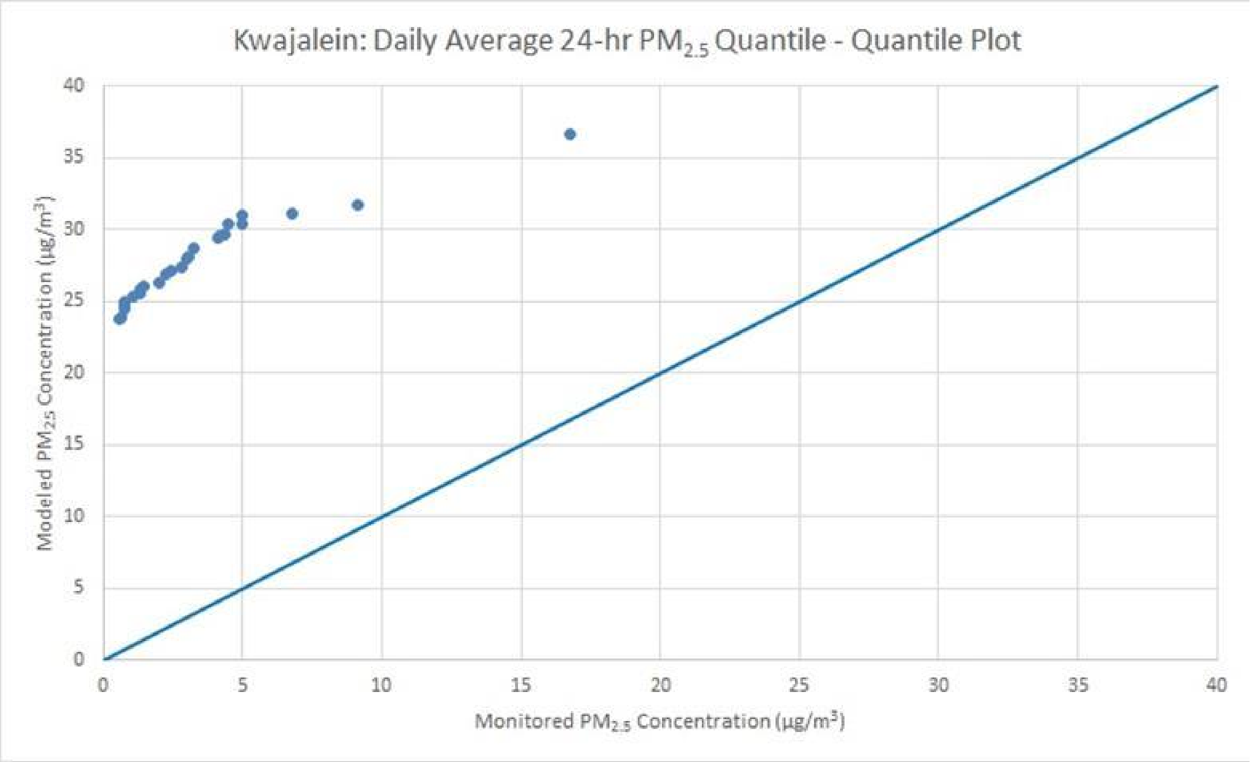
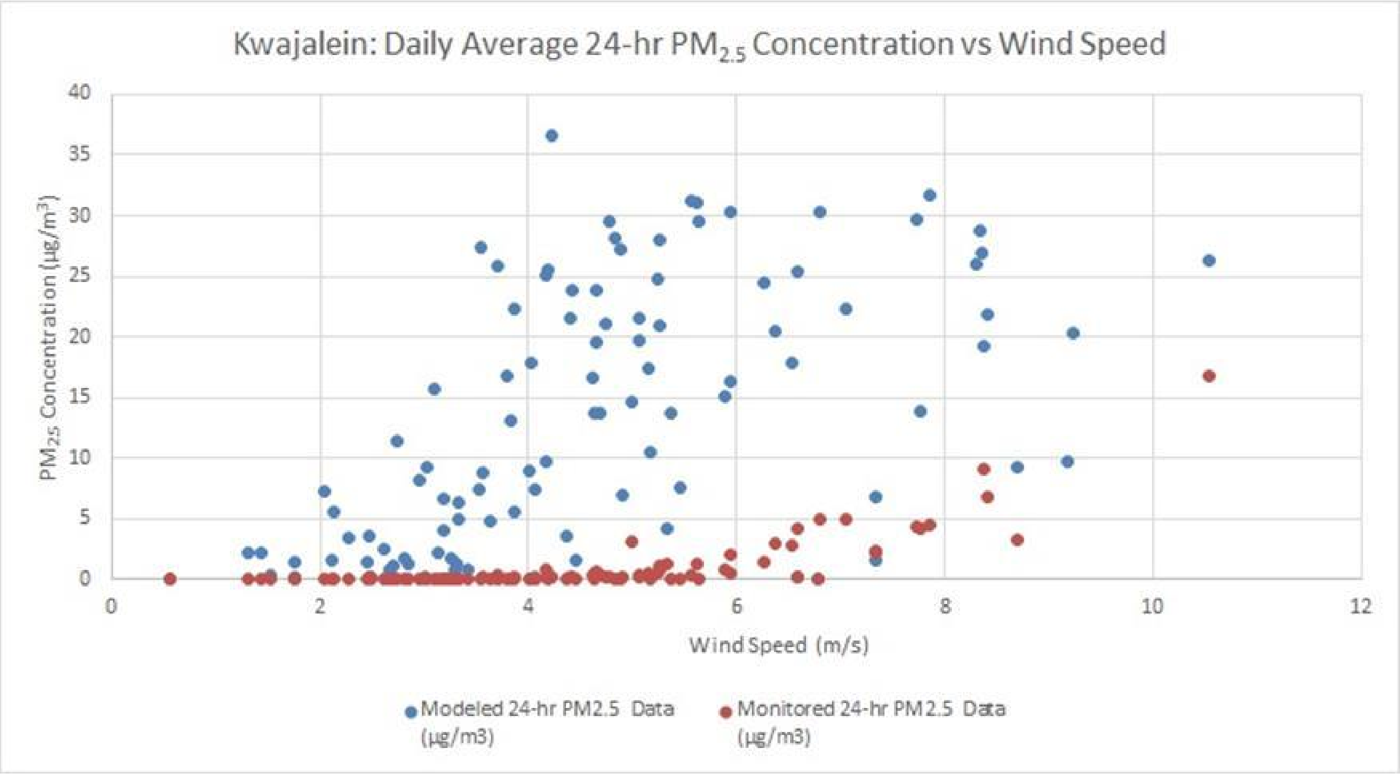


Figure 7-8: **Kwajalein - Modeled and Monitored Daily Average 24-Hour $PM_{2.5}$ versus wind speed**



7.2 Roi-Namur

Figure 7-9 is a plot of the hourly monitored and modeled NO_2 concentrations versus wind direction. As expected, given the location of the monitor/model receptor, measured/modeled concentrations peak with east-northeast winds that align the power plant stacks with the monitor. The figure also shows that the model predicts higher concentrations than were monitored.

Figure 7-10 is a time series plot of the daily maximum 1-hour NO_2 monitored and modeled concentrations, as well as the daily average wind speed. **Figure 7-11** is a Q-Q plot of the top 25 modeled peak daily1-hour maximum NO_2 concentrations (y-axis) versus the top 25 monitored concentrations (x-axis). **Figures 7-10** and **7-11** show that AERMOD consistently over-predicts compared to the monitored concentrations. **Figure 7-10** also indicates that in general, the higher measured/modeled concentrations are associated with moderate to high wind speeds. This is also illustrated in **Figure 7-12**, which is a plot of modeled and monitored concentrations versus wind speed. This is an indication that building downwash is an important factor in controlling the higher concentrations. This was expected given the stacks at the power plant are lower than GEP height and subject to building downwash from the power plant building. However, as indicated by **Figure 7-10**, while there are many days where the modeled predictions are just above the AAQS, there were no days where the monitor recorded a concentration even approaching the AAQS.

Figure 7-13 is a time series plot of the 24-hour $PM_{2.5}$ monitored and modeled concentrations over the monitoring period. **Figure 7-13** shows that both the modeled and measured concentrations are well below the AAQS and there is generally good agreement between the model and monitor for the general magnitude of the concentrations. This is also shown in **Figure 7-14**, which is a Q-Q plot of the modeled concentrations (y-axis) versus modeled concentrations (x-axis). **Figure 7-13** does indicate that the model under-predicts slightly when comparing the highest concentrations, but all concentrations are relatively low compared to the AAQS.

In addition, as indicated by **Figure 7-15**, which is a plot of monitored and modeled daily $PM_{2.5}$ concentrations versus daily-averaged wind speed, similar to the NO_2 analysis, there is some correlation of higher $PM_{2.5}$ concentrations with moderate to high wind speeds.

Figure 7-9: Roi-Namur - Hourly Monitored and Modeled NO_2 vs Wind Direction

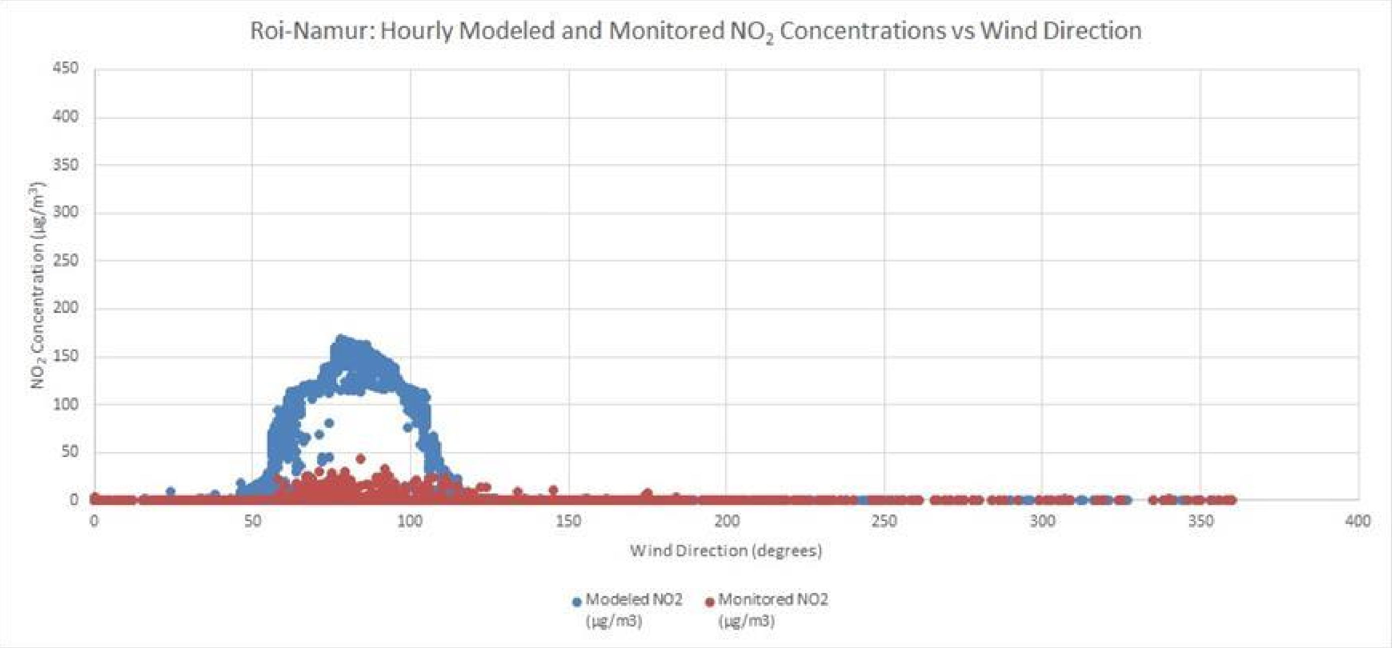


Figure 7-10: Roi-Namur- Daily Maximum 1-Hour NO_2 Monitored and Modeled Concentrations

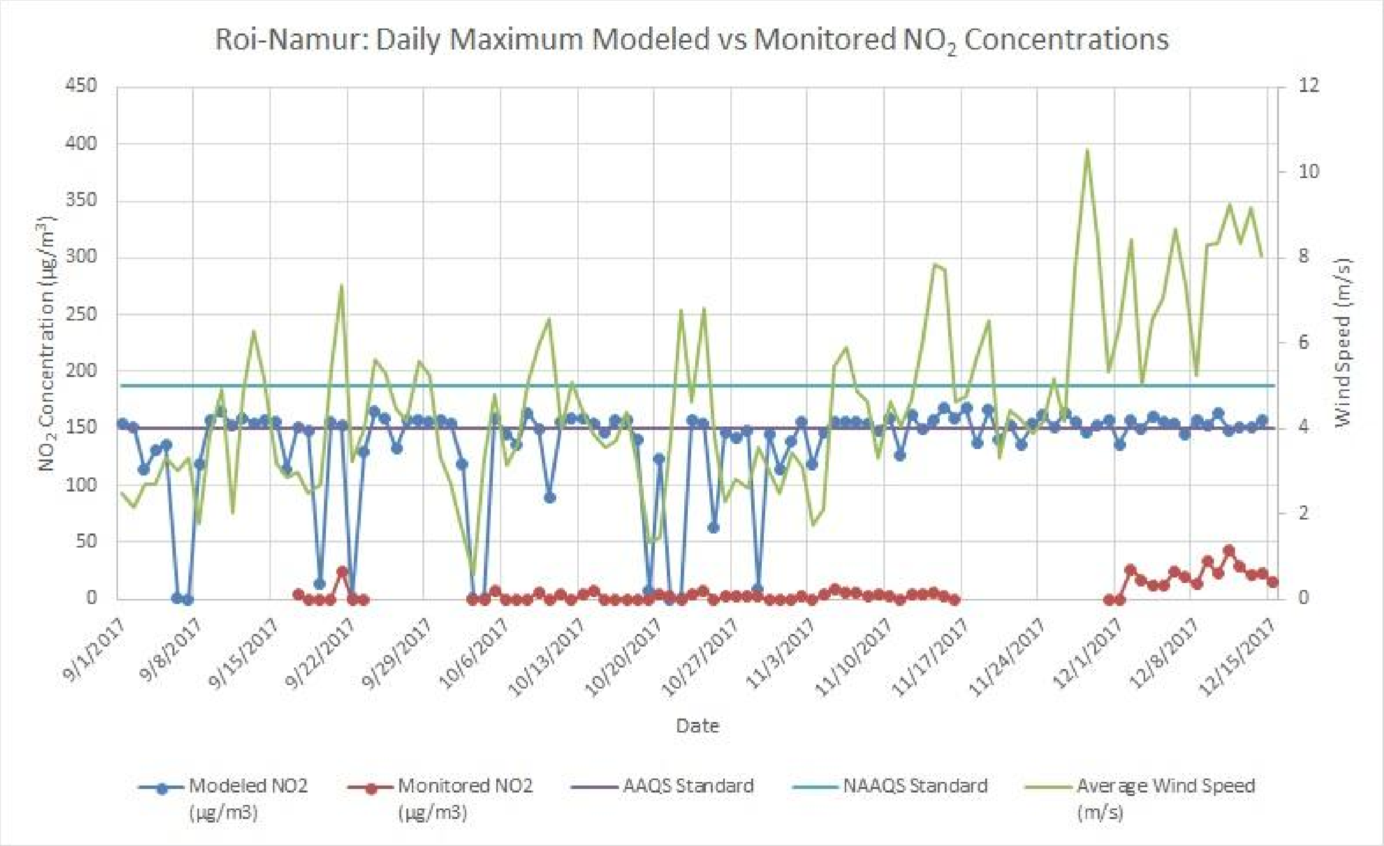


Figure 7-11: Roi-Namur - Daily Maximum 1-Hour NO_2 Quantile-Quantile Plot

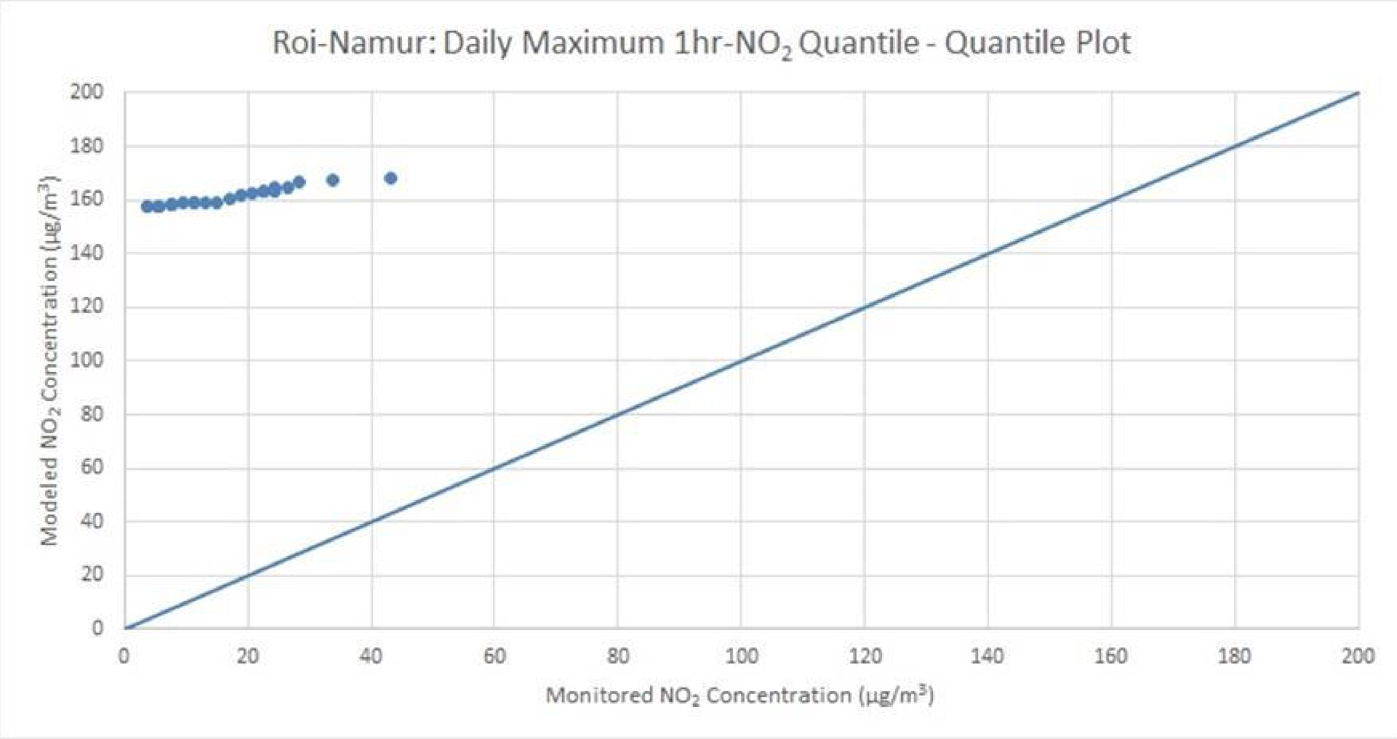


Figure 7-12: Roi-Namur - Modeled and Monitored Daily Maximum 1-Hour NO_2 versus wind speed

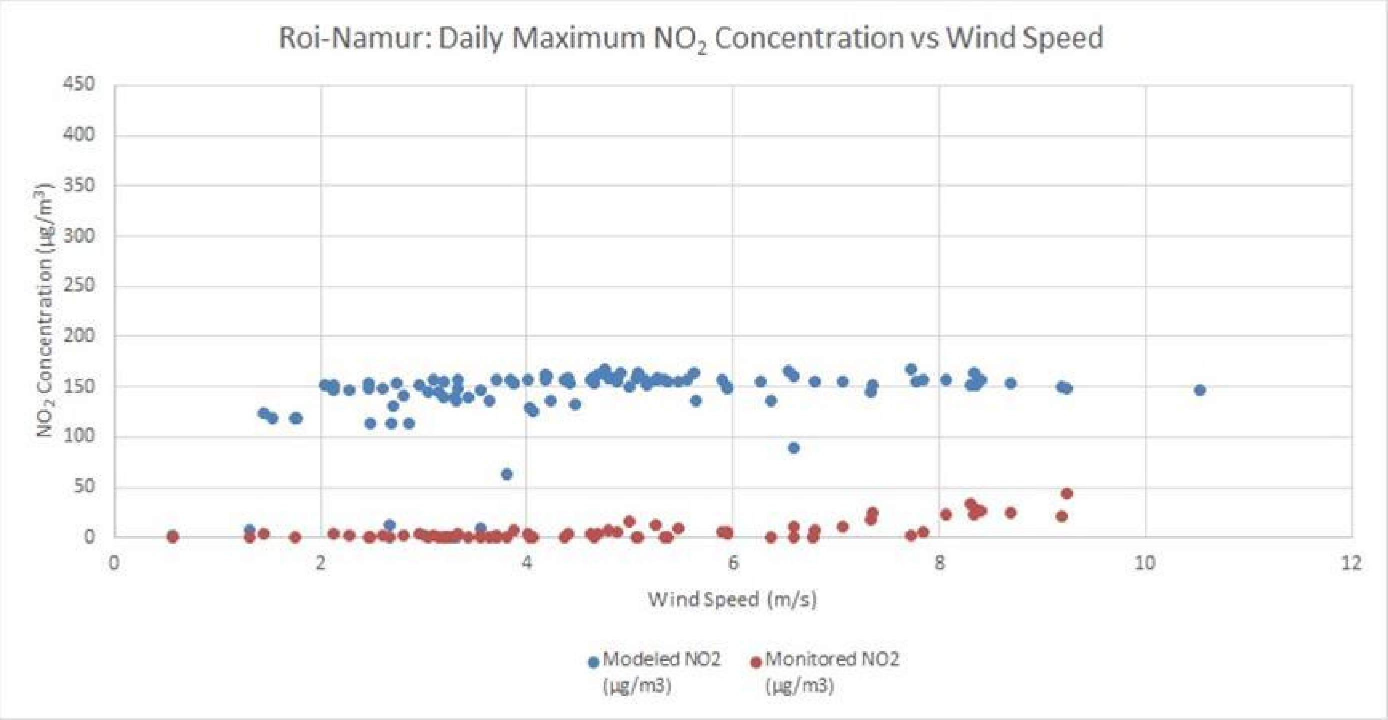


Figure 7-13: Roi-Namur - Daily Average 24-Hour $PM_{2.5}$ Monitored and Modeled Concentrations

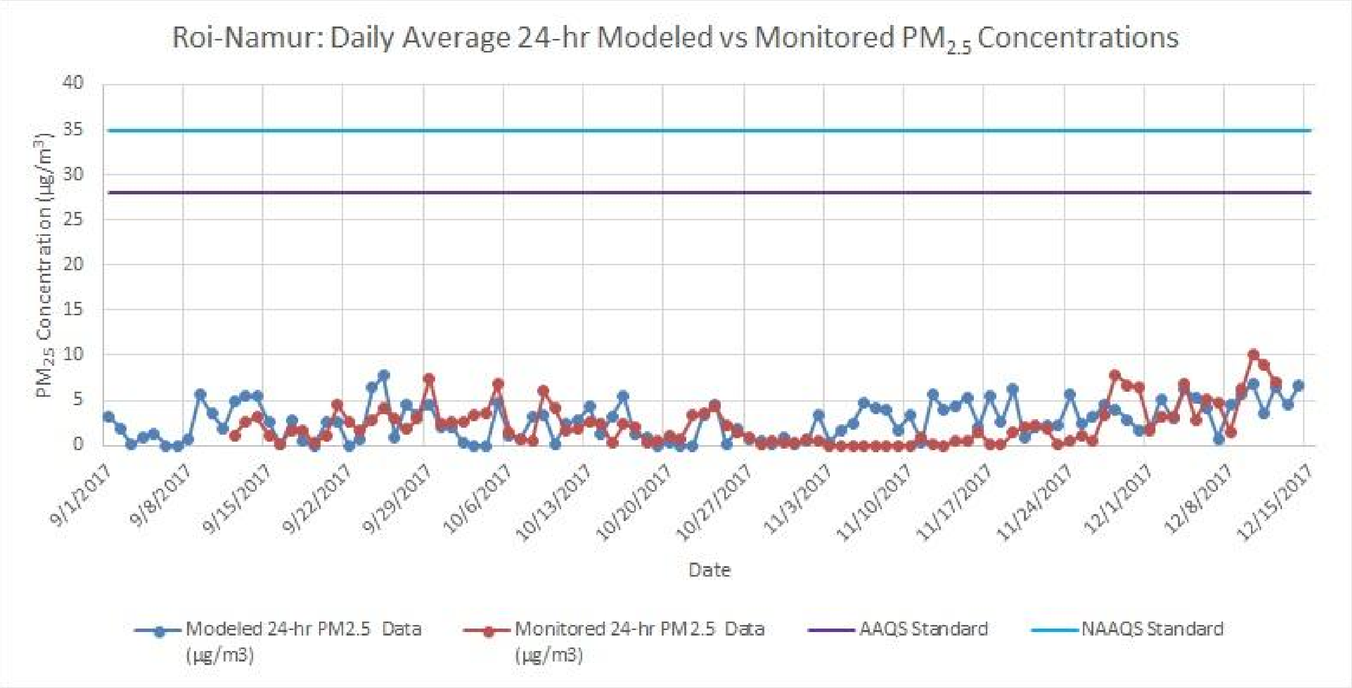


Figure 7-14: Roi-Namur - Daily Average 24-Hour $PM_{2.5}$ Quantile-Quantile Plot

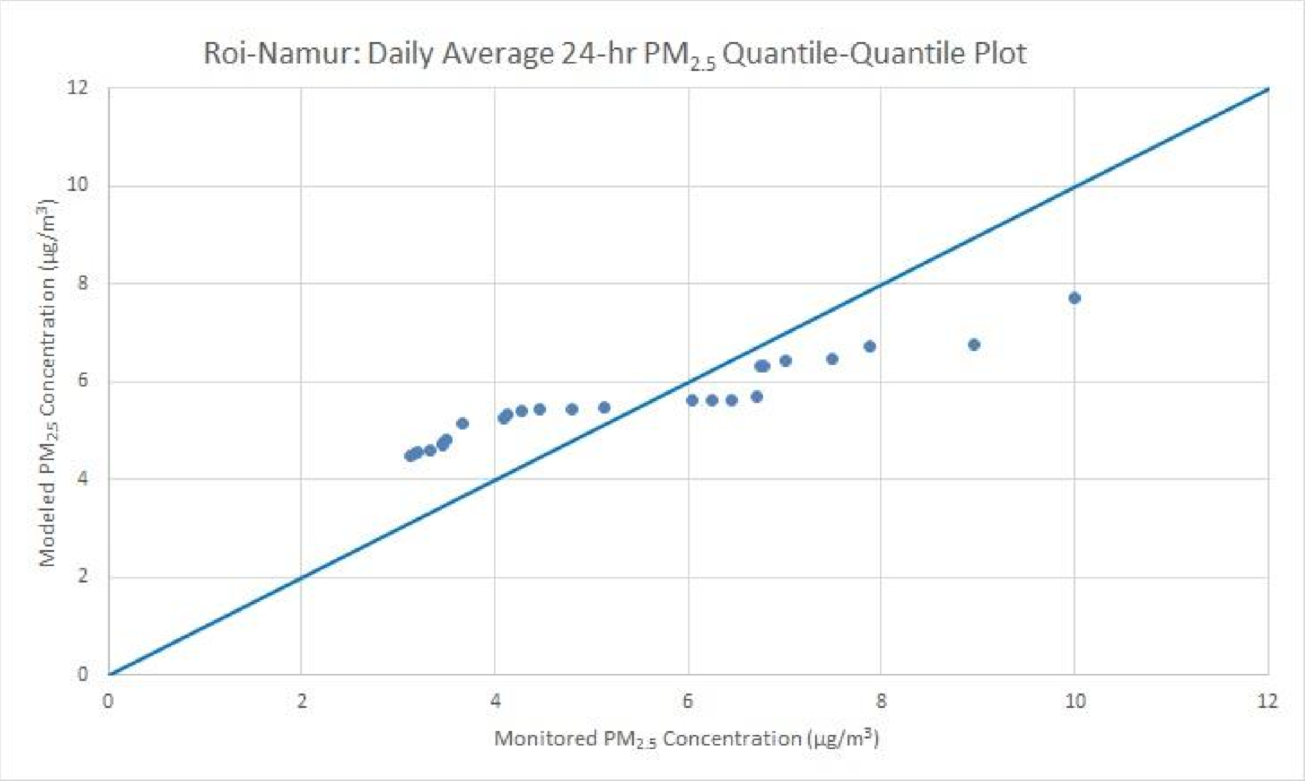
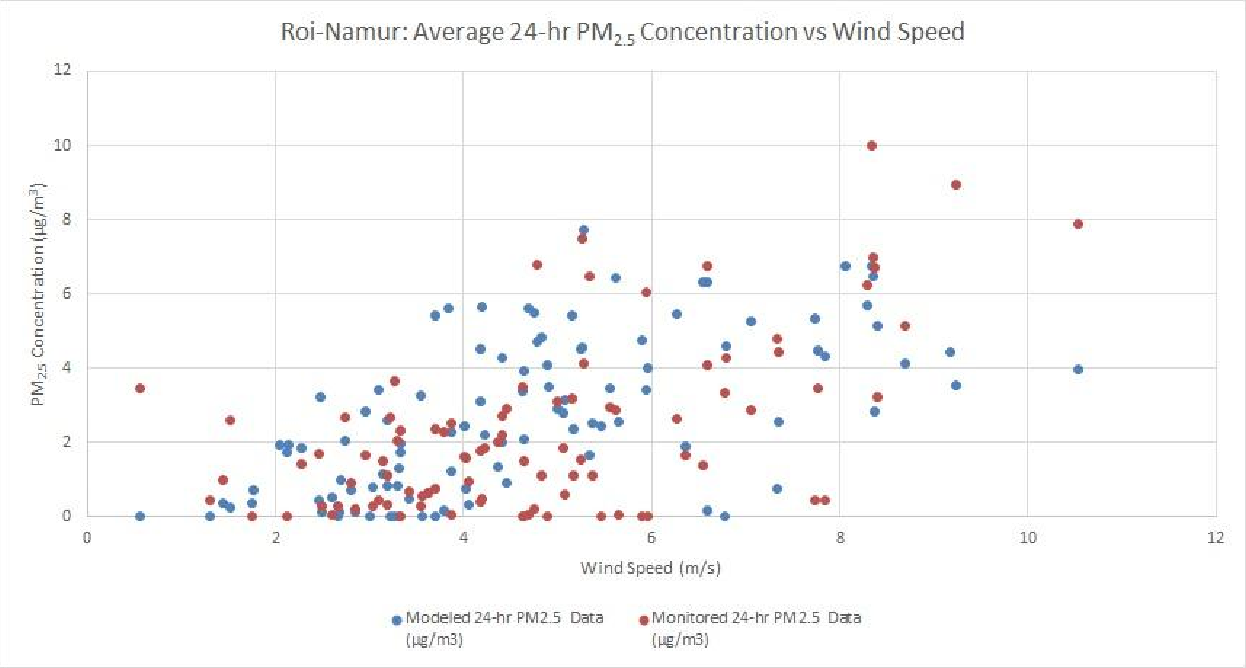


Figure 7-15: Roi-Namur - Modeled and Monitored Daily Average 24-Hour $PM_{2.5}$ versus wind speed



7.3 Meck

Figure 7-16 is a plot of the hourly monitored and modeled NO_2 concentrations versus wind direction. As expected, given the location of the monitor/model receptor, measured/modeled concentrations peak with east-northeast winds that align the power plant stacks with the monitor. **Figure 7-16** also shows that the model under-predicts the highest concentrations relative to the monitored values. In addition, **Figure 7-16** also indicates there were some moderate to high monitored concentrations associated with more southerly winds. This is likely due to the operation of the Meck incinerator which is located south of the monitoring station site. While the Meck monitor was influenced by the operation of the incinerator, note that in general, given the location of the incinerator south of the power plant, no overlap of the incinerator is expected with the maximum impacts from the power plant. This is also true for the incinerators on the Kwajalein and Roi-Namur islands, which are also located such that the plumes would not overlap with the maximum impacts from the power plants.

Figure 7-17 is a time series plot of the daily maximum 1-hour NO_2 monitored and modeled concentrations, as well as the daily average wind speed. **Figure 7-17** shows that there is reasonably good agreement between the model and monitor during September and October when winds were generally light to moderate and both the model and monitored concentrations are below the AAQS. However, AERMOD under-predicts relative to the highest monitored concentrations that are above the AAQS which occurred during higher wind conditions in late November and December. **Figure 7-18**, which is the plot of modeled and monitored concentrations versus wind speed, also shows the correlation between concentrations and wind speeds.

Similar to the other sites, the correlation between high concentrations and high winds is an indication that building downwash is an important factor, which is expected given the shorter stacks at Meck. However, as noted, AERMOD is not predicting high concentrations comparable to the measured concentrations during the higher wind conditions. This may be due to a known under-prediction tendency by AERMOD for low-level, down-washing stacks near an elongated building documented in "Characterization of pollutant dispersion near elongated buildings based on wind tunnel simulations" (Perry and Heist et al., Atmospheric Environment, July 2016)[7].

Figure 7-19 is the Q-Q plot of the modeled 1-hour NO_2 concentrations (y-axis) versus monitored concentrations (x-axis) which shows the under-prediction tendency of AERMOD for the higher monitored concentrations.

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[7] https://www.sciencedirect.com/science/article/pii/S1352231016305829.

Figure 7-20 is a time series plot of the 24-hour average $PM_{2.5}$ monitored and modeled concentrations over the monitoring period. As shown in **Figure 7-20**, both the modeled and monitored concentrations are low and well below the AAQS. For this reason, and given these are 24-hour averages as opposed to the NO_2 concentrations which are daily 1-hour maximum values, the difference in magnitude of the modeling and monitored concentrations is not as pronounced.

Figure 7-21 is a Q-Q plot of the modeled daily $PM_{2.5}$ concentrations (y-axis) versus modeled concentrations (x-axis), which shows the under-prediction tendency of AERMOD, especially for the higher monitored concentrations.

In **Figure 7-22**, which is a plot of monitored and modeled $PM_{2.5}$ daily concentrations versus the daily-averaged wind speed, similar to the NO_2 analysis, there is some correlation of higher $PM_{2.5}$ concentrations with moderate to high wind speeds.

Figure 7-16: Meck - Hourly Monitored and Modeled NO_2 vs Wind Direction

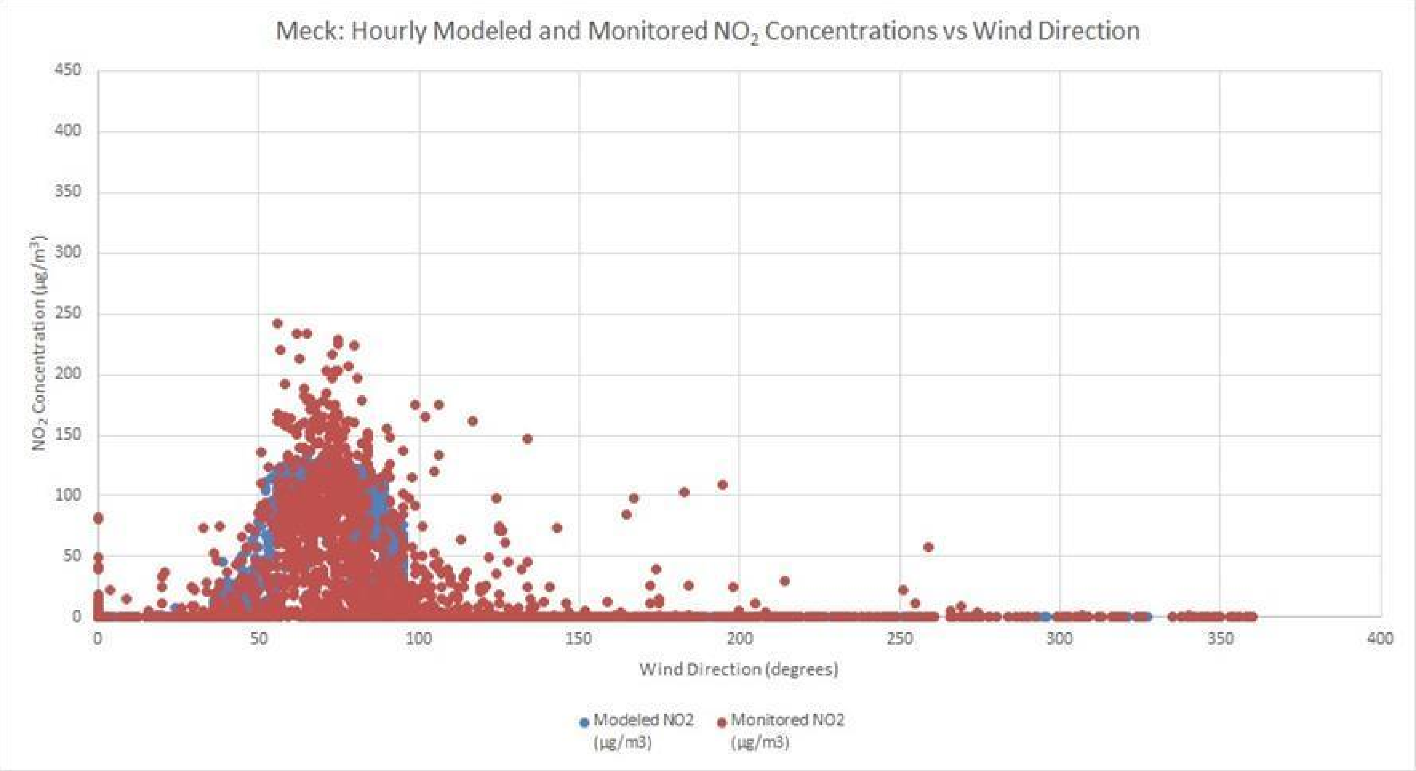


Figure 7-17: **Meck - Daily Maximum 1-Hour NO_2 Monitored and Modeled Concentrations**

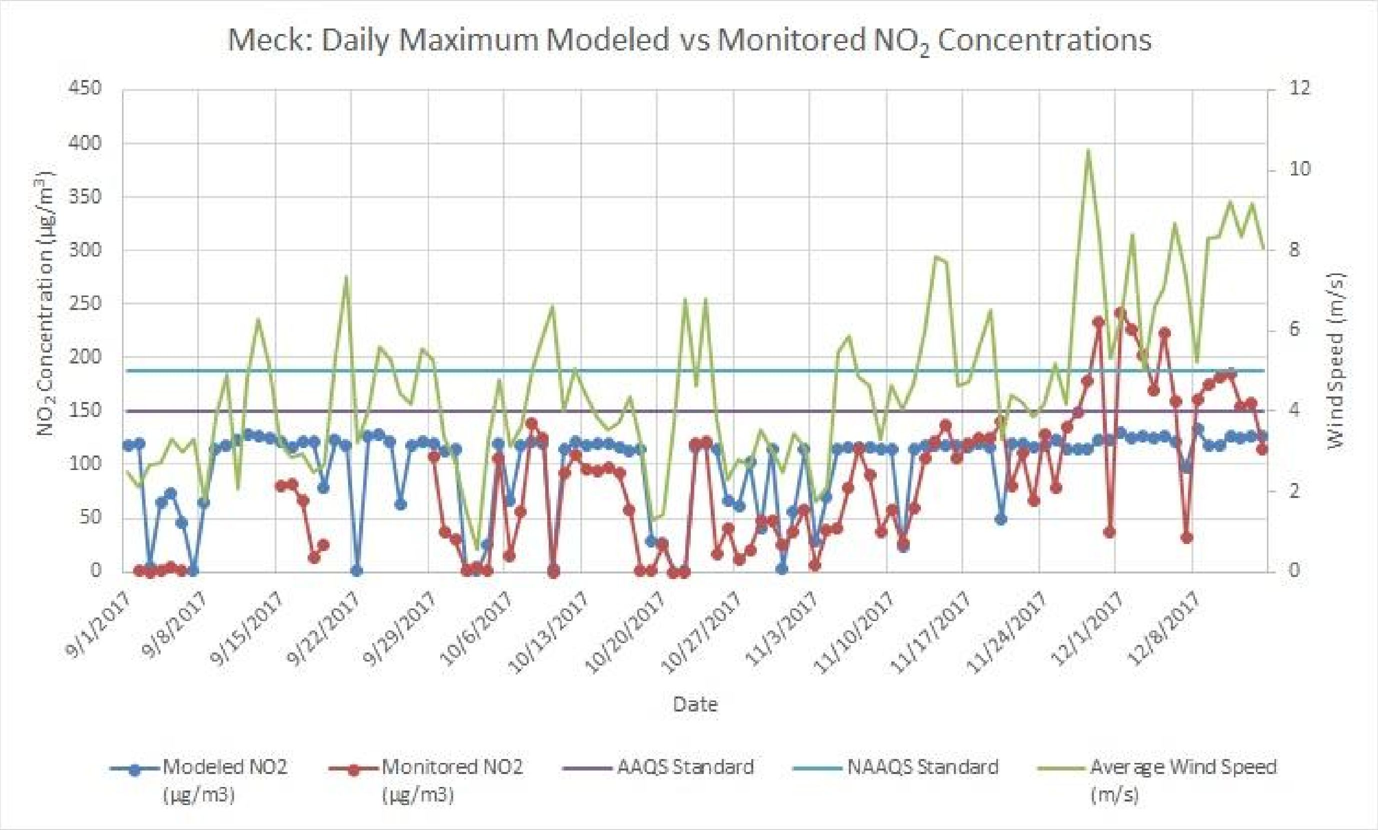


Figure 7-18: **Meck - Modeled and Monitored Daily Maximum 1-Hour NO_2 versus wind speed**

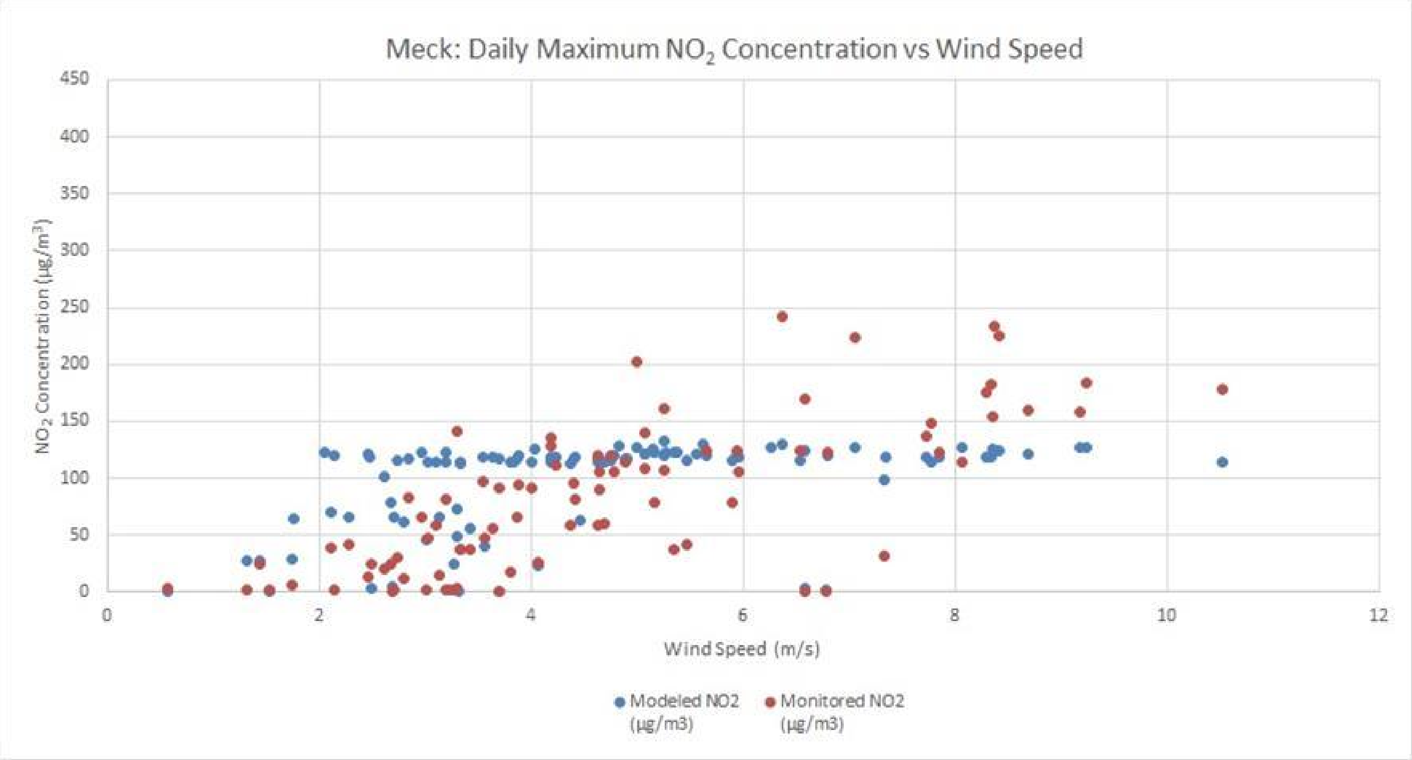


Figure 7-19: Meck - Daily Maximum 1-Hour NO_2 Quantile-Quantile Plot

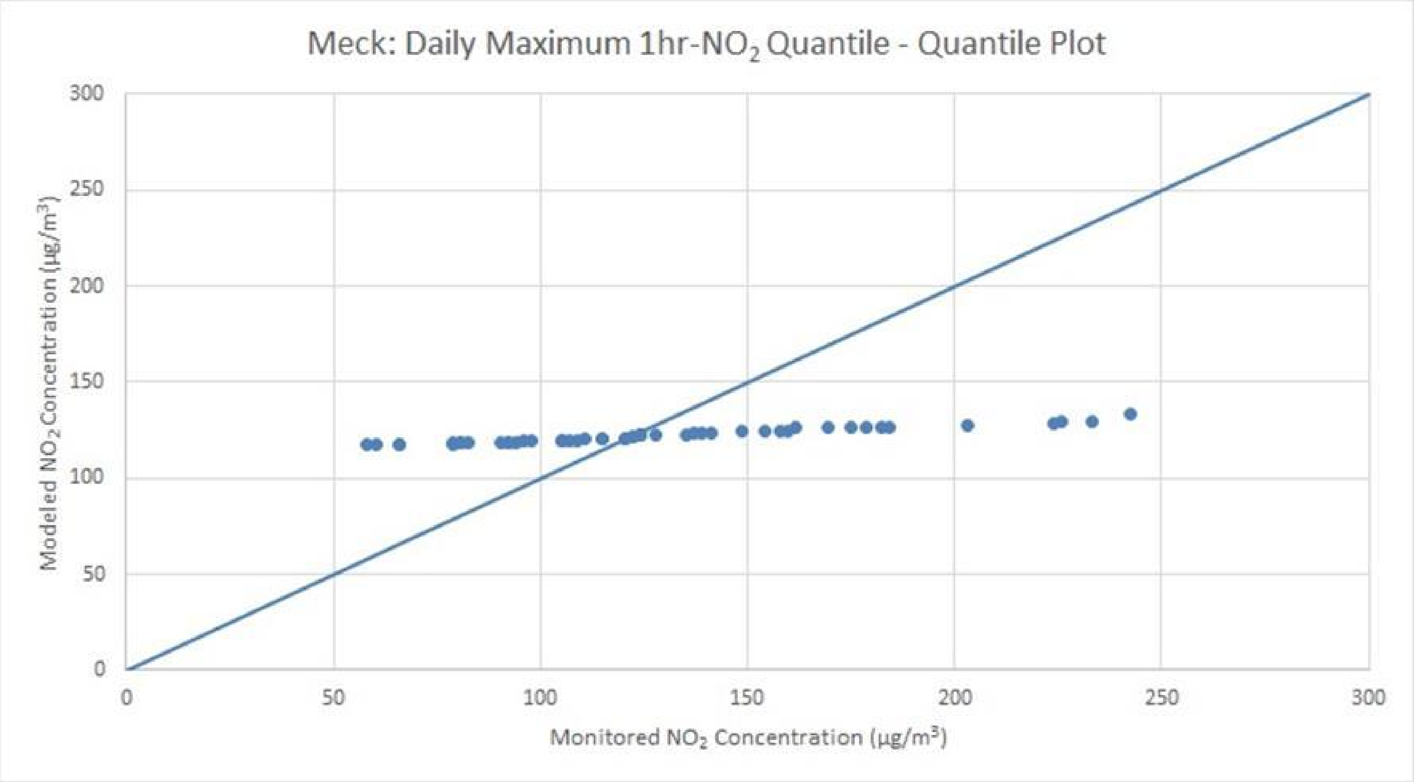


Figure 7-20: Meck - Daily Average 24-Hour $PM_{2.5}$ Monitored and Modeled Concentrations

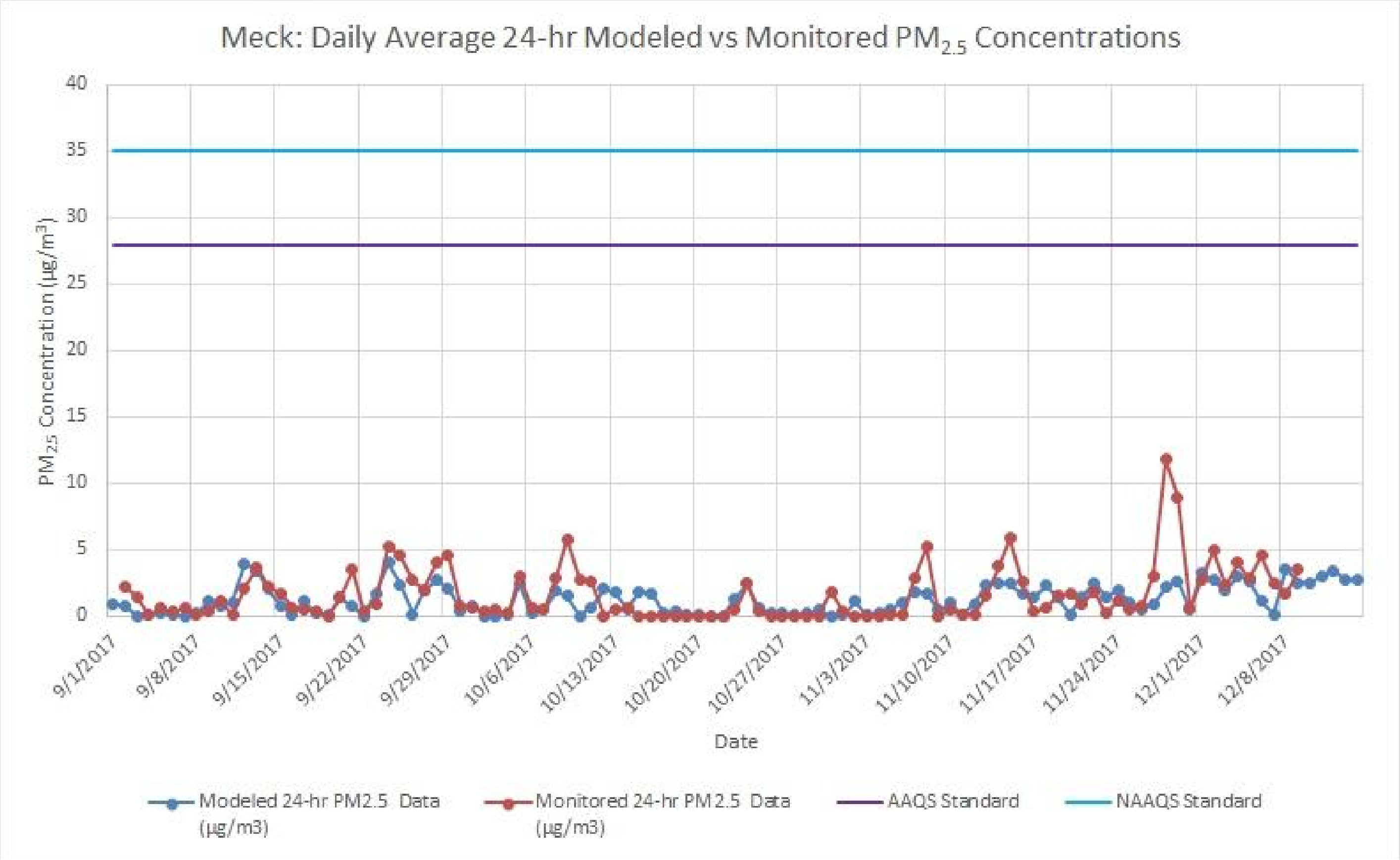


Figure 7-21: Meck - Daily Average 24-Hour $PM_{2.5}$ Quantile-Quantile Plot

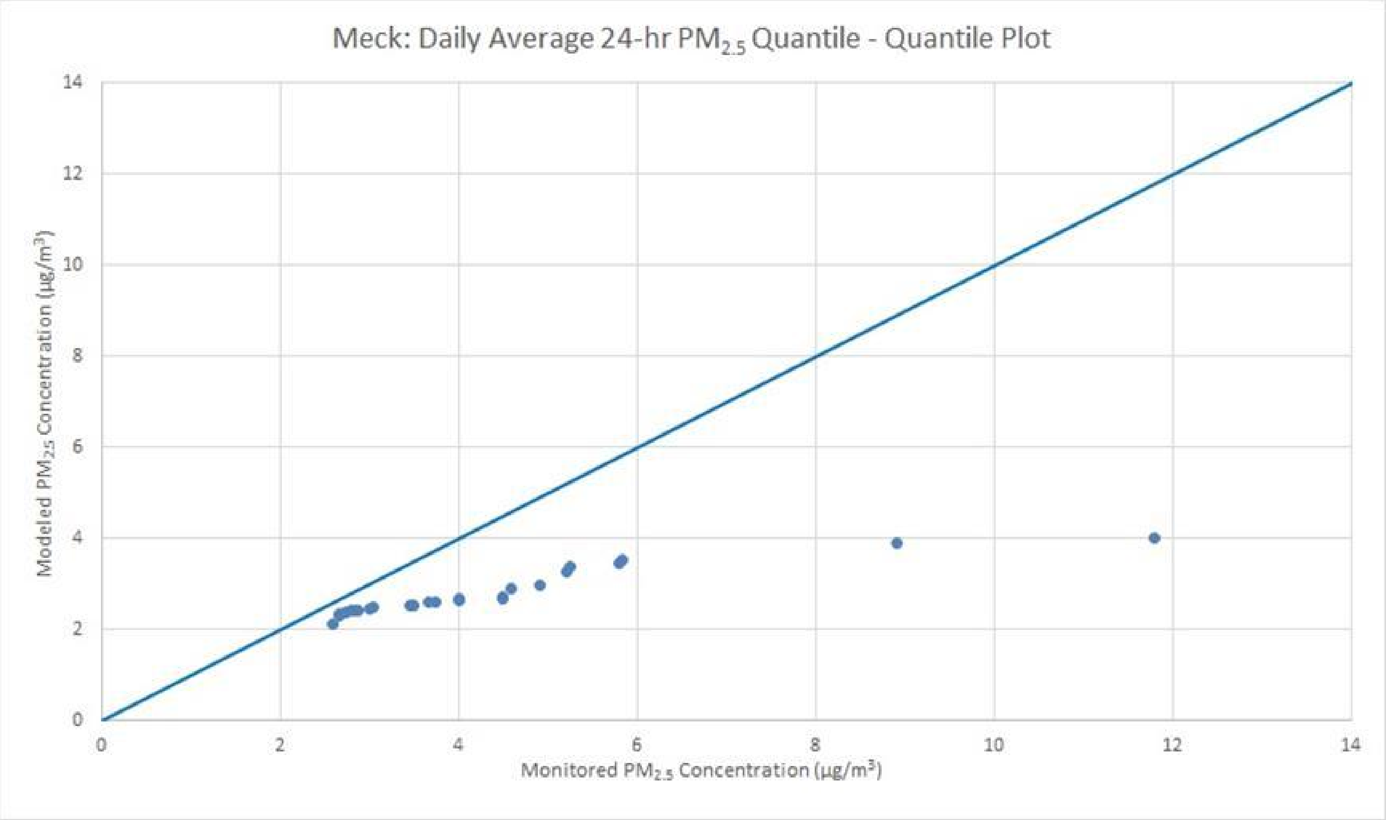
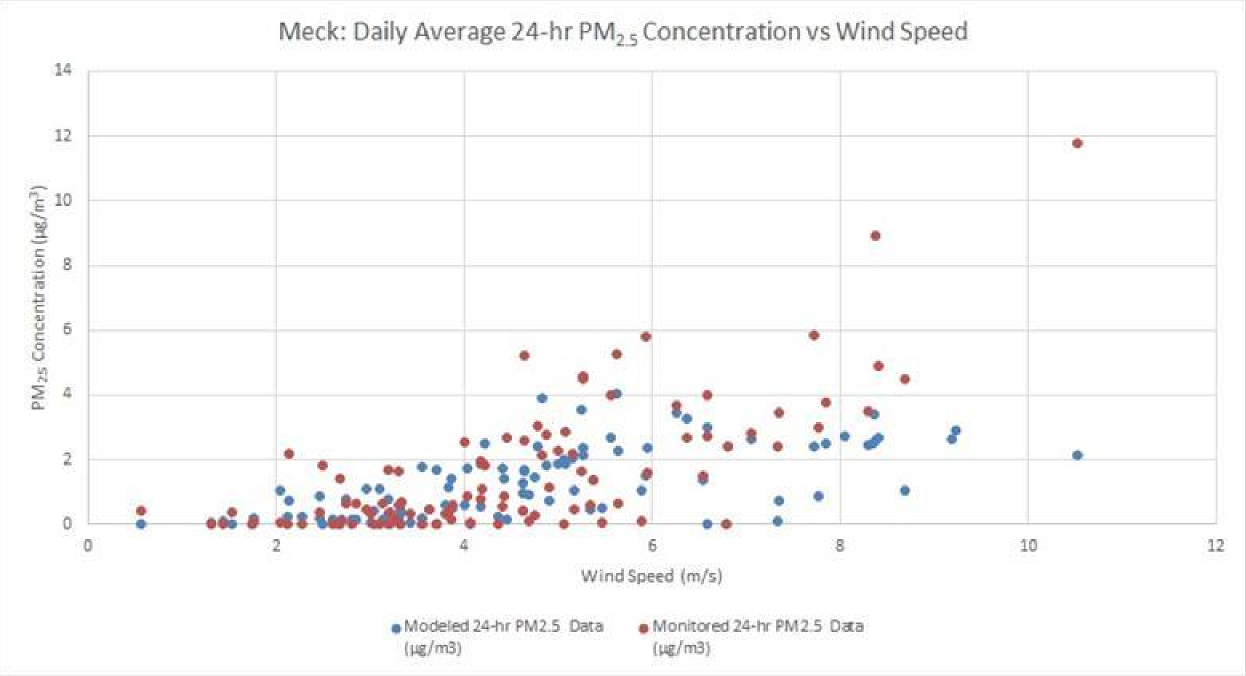


Figure 7-22: Meck - Modeled and Monitored Daily Average 24-Hour $PM_{2.5}$ versus wind speed



8. Conclusions

The subsections below provide a summary of findings and conclusions along with discussion of uncertainties in the analysis.

8.1 Kwajalein

- Dispersion modeling results indicate SO_2 and CO concentrations well below the AAQS.
- Modeled concentrations are above the AAQS for NO_2 (max [275%], normal [186%] and reduced [108%] load) and $PM_{2.5}$ (max [180%] and normal [107%] load).
- Modeled concentrations above the AAQS are limited to the areas adjacent to the main power plant and do not extend to areas where there are residences.
- Monitored $PM_{2.5}$ and SO_2 concentrations are all well below the AAQS, respectively.
- Monitored maximum daily 1-hour NO_2 concentrations are all below the AAQS, except for one day during the program. Since the AAQS is based on the 98th percentile concentration (2nd highest daily maximum concentration given the 90-day sampling program), the AAQS was not exceeded during the monitoring program.
- Note that subsequent to the modeling analysis, it was determined that the Power Plant Annex engines are actually Caterpillar C280-12 units. However, the modeling conducted with the C280-16's should be conservative as impacts are expected to be lower with the C280-12 engines. This is primarily because, as a smaller engine, the emissions for the C280-12's are lower than for the C280-16 engines. In addition, a shorter stack height was modeled for the C280-16's (18.5 meters vs actual stack height of 25 meters). Further, the modeling results documented in Section 5 show that the main power plant emissions dominate the highest modeled concentrations. A comparison of the source parameters for both units is provided in **Appendix F**.
- The AERMOD model may be over-predicting for the following reasons:
  - Use of high ozone concentration data from an urban and industrialized area - Honolulu, HI - to conduct the NO_x to NO_2 calculations in AERMOD. Ozone levels at Kwajalein are expected to be much lower given the isolated location of the Marshall Islands.
  - Building downwash may be overestimated. The stacks are relatively tall with respect to the buildings. The complex building structures, including the sphere, could be resulting in more dispersion than the model is simulating (it can only deal with the effects of one building).
  - AERMOD contains a sub-model, PRIME, that does the building downwash computations. A new version of the PRIME model, PRIME2[8], is currently being developed that may improve the modeling and result in substantially lower concentrations, but that model has not yet been released to the public.
  - There is a tendency for plumes from multiple stacks along a building to be merged by the PRIME downwash model that could lead to over-predictions.
- Modeled formaldehyde and acrolein concentrations are well below the RSLs.

8.2 Roi-Namur

- Dispersion modeling results indicate $PM_{2.5}$, SO_2 and CO concentrations well below the AAQS.
- Modeled concentrations are just above the AAQS for NO_2 (max [106%] and normal [102%] load), but the monitoring shows compliance with the AAQS.

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[8] Ronald L. Petersen, Sergio A. Guerra, 2018. PRIME2: Development and evaluation of improved building downwash algorithms for rectangular and streamlined structures, Journal of Wind Engineering and Industrial Aerodynamics, Volume 173, 67-78, ISSN 0167-6105, https://doi.org/10.1016/j.jweia.2017.11.027. (http://www.sciencedirect.com/science/article/pii/S0167610517306669)

Modeled concentrations above the AAQS are limited to the areas adjacent to the main power plant and do not extend to areas where there are residences.

- NO_2, $PM_{2.5}$ and SO_2 monitored concentrations are all well below the AAQS, respectively.
- For Roi-Namur, the levels of the NO_2 predictions are more dependent upon the ozone background, which could be substantially overstated as noted. We expect that if more representative ozone data were available, the NO_2 model results would be below the AAQS.
- For $PM_{2.5}$ (and NO_2), the highest observations occur during high winds, indicating a potential downwash effect that the model did not appear to respond to.
- The maximum modeled formaldehyde and acrolein concentrations are well below the RSLs.

8.3 Meck

- Dispersion modeling results indicate NO_2, $PM_{2.5}$, SO_2 and CO concentrations are all well below the AAQS.
- $PM_{2.5}$ and SO_2 monitored concentrations are all well below the AAQS, respectively.
- NO_2 monitored concentrations are above the AAQS (the high concentrations occurred during a limited period toward the end of the program in late November into December coincidental with higher winds).
- The NO_2 modeled values are higher than the monitor observations for low wind cases early in the monitoring program, but the higher winds toward the end of the monitoring period result in higher monitored concentrations for NO_2 (as well as $PM_{2.5}$). This is due to the low stacks at the Meck power plant which are particularly susceptible to high wind speed downwash effects which AERMOD cannot properly simulate. The area of the NO_2 AAQS problem is very limited, however.
- AERMOD is not predicting high concentrations comparable to the measured concentrations during the higher wind conditions. This may be due to a known under-prediction tendency (published by Perry and Heist[8]) by AERMOD for low-level, down-washing stacks near elongated buildings.
- The maximum modeled formaldehyde and acrolein concentrations are well below the RSLs.
- The NAAQS, from which the AAQS are defined, were designed by USEPA to protect public health and welfare. We note that while the measured concentrations are above the AAQS, this area is not currently accessible to the general public. We also note that while the magnitude of the modeling results is not consistent with the monitored concentrations, it is expected that concentrations fall off rapidly with distance from the power plant as shown by the isopleth figures.

Additional modeling input uncertainties include:

- Emission rates and stack parameters – operational data available from the power plants during the monitoring period included only fuel use and load data. Emission rates were estimated using published emission factors rather than stack test data, for example. In addition, exhaust flow rate and temperature were estimated as actual data were not available.
- The 0.1 fraction assumed for the in-stack ratio of NO_2/NOx is higher than the reported average of 0.066, resulting in another conservative feature of the modeling approach. There are no stack tests available for the power plant units.

Appendix A – Air Quality Monitoring Results

Kwajalein

SO2[ppb] Matrix: Kwajalein Monthly: 08/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 08/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=1

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
8/1/2017																											
8/2/2017																											
8/3/2017																											
8/4/2017																											
8/5/2017																											
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8/28/2017																											
8/29/2017																											
8/30/2017														0	2	2	2				4	4	4	4	0	4	2
8/31/2017	4	4	5	4	4	4	4	4	4	4	4	4	5	5	6	6	5			4	4	4	4	4	4	6	4
Min	4	4	5	4	4	4	4	4	4	4	4	4	5	0	2	2	2			4	4	4	4	4	0		
Max	4	4	5	4	4	4	4	4	4	4	4	4	5	5	6	6	5			4	4	4	4	4		6	
Avg	4	4	5	4	4	4	4	4	4	4	4	4	5	2	4	4	3			4	4	4	4	4			3

SO2[ppb] Matrix: Kwajalein Monthly: 09/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 09/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=30

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9/3/2017	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	3	4	3
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9/6/2017	3	4	3	4	3	4	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	4	2
9/7/2017	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0
9/8/2017	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/9/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
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9/12/2017	1	1	2	1	2	1	2	1	1	1	1	2	1	2	1	2	1	2	1	2	1	1	1	2	1	2	1
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9/15/2017	2	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
9/16/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/17/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	2	1	1	1	1	2	1
9/18/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/19/2017	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
9/20/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	2	2	2	2	1	2	1
9/21/2017	2	2	1	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
9/22/2017	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
9/23/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	2	2	1	2	1
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Avg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1

SO2[ppb] Matrix: Kwajalein Monthly: 10/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 10/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=31

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10/2/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/3/2017	2	2	2	2	2	2	2	2	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
10/4/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/5/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/6/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/7/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/8/2017	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
10/9/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/10/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/11/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/12/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/13/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/14/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/15/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/16/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/17/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/18/2017	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
10/19/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/20/2017	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
10/21/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	1
10/22/2017	2	1	2	1	2	2	1	1	1	2	1	1	1	2	1	2	2	2	1	2	2	1	2	1	1	2	1
10/23/2017	2	1	2	1	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
10/24/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/25/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/26/2017	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
10/27/2017	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
10/28/2017	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	3	3	1	3	2
10/29/2017	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	3	2
10/30/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/31/2017	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2	1
Min	2	1	1	1	2	2	1	1	1	1	1	1	1	2	1	2	2	2	1	2	2	1	2	1	1		
Max	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	3	3		3	
Avg	2	1	1	1	2	2	1	1	1	1	1	1	1	2	1	2	2	2	1	2	2	1	2	1			1

SO2[ppb] Matrix: Kwajalein Monthly: 11/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 11/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=30

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
11/1/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/2/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/3/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/4/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/5/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/6/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/7/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/8/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/9/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/10/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/11/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/12/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/13/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/14/2017	2	2	2	2	2	2	2	2	2	2			2	2	2	2	2	3	2	2	2	2	3	2	2	3	2
11/15/2017	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	3	2
11/16/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/17/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/18/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/19/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/20/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/21/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/22/2017	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/23/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/24/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/25/2017	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2
11/26/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/27/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	2	2	2	3	2
11/28/2017	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2
11/29/2017	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	3	2
11/30/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Min	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		
Max	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		3	
Avg	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			2

SO2[ppb] Matrix: Kwajalein Monthly: 12/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 12/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=12

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
12/1/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
12/2/2017	2	2	2	2	2	2	2	2	2	2	3	3	2	3	3	3	3	3	3	2	2	2	2	3	2	3	2
12/3/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
12/4/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	3	2
12/5/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3		1	1	1	1	1	1	1	1	1	3	1
12/6/2017	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	0
12/7/2017	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
12/8/2017	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	1	0
12/9/2017	1	1	1	0	1	1	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0
12/10/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12/11/2017	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0
12/12/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12/13/2017	1	1	1	1	1	1	1	1	1																1	1	1
12/14/2017																											
12/15/2017																											
12/16/2017																											
12/17/2017																											
12/18/2017																											
12/19/2017																											
12/20/2017																											
12/21/2017																											
12/22/2017																											
12/23/2017																											
12/24/2017																											
12/25/2017																											
12/26/2017																											
12/27/2017																											
12/28/2017																											
12/29/2017																											
12/30/2017																											
12/31/2017																											
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	2	2	2	2	2	2	2	2	2	2	3	3	2	3	3	3	3	3	3	2	2	2	2	3		3	
Avg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1

NO2[ppb] Matrix: Kwajalein Monthly: 08/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 08/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=1

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
8/ 1/ 2017																											
8/ 2/ 2017																											
8/ 3/ 2017																											
8/ 4/ 2017																											
8/ 5/ 2017																											
8/ 6/ 2017																											
8/ 7/ 2017																											
8/ 8/ 2017																											
8/ 9/ 2017																											
8/ 10/ 2017																											
8/ 11/ 2017																											
8/ 12/ 2017																											
8/ 13/ 2017																											
8/ 14/ 2017																											
8/ 15/ 2017																											
8/ 16/ 2017																											
8/ 17/ 2017																											
8/ 18/ 2017																											
8/ 19/ 2017																											
8/ 20/ 2017																											
8/ 21/ 2017																											
8/ 22/ 2017																											
8/ 23/ 2017																											
8/ 24/ 2017																											
8/ 25/ 2017																											
8/ 26/ 2017																											
8/ 27/ 2017																											
8/ 28/ 2017																											
8/ 29/ 2017																											
8/ 30/ 2017														0	1	0	1				0	0	0	0	0	1	0
8/ 31/ 2017	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0	0	1	0
Min	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0	0		
Max	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1			0	0	0	0	0		1	
Avg	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0			0

NO2[ppb] Matrix: Kwajalein Monthly: 09/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 09/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=27

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
9/1/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/2/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/3/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/5/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	0	0	0	0	0	0	0	0	0	5	0
9/6/2017	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0
9/7/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/8/2017	0	0	0	0	0	6	9	9	4	1	1				2	1	0	0	0	0	0	0	0	0	0	9	1
9/9/2017	0	0	0	0	0	0	0	0	1	1	2	1	1	3	2	1	9	1	0	0	2	2	10	2	0	10	1
9/10/2017	5	3	5	4	4	3	3	3	9	6	5	3	9	0	3	0	0	0	0	0	2	3	1	0	0	9	2
9/11/2017	0	0	0	0	0	0	0	1	1	1	0	2	0	0	0	2	4	0	0	0	0	0	0	1	0	4	0
9/12/2017	0	2	3	3	2	3	3	4	3	8															0	8	3
9/13/2017		9	5	5	4	3	4	5	6	8	7	5	4	4	6	4	11	11							3	11	5
9/14/2017																	9	1	1	8	3	9	2	13	1	13	5
9/15/2017	12	12	8	11	12	9	0	0	1	1	2	5	0	6	1	2	1	1	0	0	0	0	0	0	0	12	3
9/16/2017	0	0	0	0	0	0	0	4	0	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0
9/17/2017	0	0	0	0	0	0	0	0	0	0	0	0					2	2	2	1	1	0	0	0	0	2	0
9/18/2017	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0
9/19/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/20/2017	0	0	0	0	0	0	0	0	3	1	1	0	0	0	1	0	2	1	2	1	1	6	8	0	0	8	1
9/21/2017	3	11	9	21	21	25	20	11	16	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	25	5
9/22/2017	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	1	0	0	1	4	3	2	0	0	4	0
9/23/2017	0	0	0	0	0	0	2	3	4	4	6	10	3	1	0	2	2	0	0	0	0	0	2	8	0	10	1
9/24/2017	4	6	2	5	8	6	1	8	8	6	6	11	11	12	10	13	5	10	5	3	13	11	11	7	1	13	7
9/25/2017	8	14	13	6	4	1	0	4	3	9	8	13	10	5	7	3	1	5	5	1	3	5	6	5	0	14	5
9/26/2017	1	0	4	2	0	0	0	4	5	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
9/27/2017	0	0	1	0	0	0	0	1	3	5	1	7	16	16	23	18	19	11	4	1	6	6	27	19	0	27	7
9/28/2017	14	5	5	0	2	8	4	20	12	24	34	35	30	17	7	1	2	5	1	2	1	5	5	1	0	35	10
9/29/2017	4	2	13	11	5	3	6	8	8	7	4	7	5	3	2	2	1	1	5	9	10	0	0	0	0	13	4
9/30/2017	0	0	0	0	0	0	0	0	0	2	2	0	0	0	4	1	2	1	0	0	0	4	0	0	0	4	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	14	14	13	21	21	25	20	20	16	24	34	35	30	17	23	18	19	11	5	9	13	11	27	19		35	
Avg	1	2	2	2	2	2	1	2	3	3	2	3	3	2	2	2	2	1	0	0	1	1	2	2			2

NO2[ppb] Matrix: Kwajalein Monthly: 10/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 10/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=31

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
10/1/2017	0	0	2	0	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	5	0
10/2/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/3/2017	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
10/4/2017	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
10/5/2017	0	0	0	1	1	3	3	2	3	6	4	2	1	3	2	3	3	1	2	1	0	1	2	1	0	6	1
10/6/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/7/2017	0	0	0	0	0	0	0	0	0	0	14	3	0	0	0	0	0	1	0	0	0	4	4	1	0	14	1
10/8/2017	4	1	0	0	0	0	1	0	0	0	11	12	10	9	12	7	7	10	8	9	5	7	9	6	0	12	5
10/9/2017	4	7	7	3	5	3	4	8	4	7	4	9	5	14	5	2	2	5	0	0	0	0	0	0	0	14	4
10/10/2017	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
10/11/2017	0	0	0	0	0	0	0	0	0	2	4	1	1	0	0	0	0	0	2	2	1	0	0	1	0	4	0
10/12/2017	0	0	0	0	0	0	0	1	3	6	8	6	7	8	8	7	5	7	5	4	6	5	3	6	0	8	3
10/13/2017	5	3	4	7	4	7	7	4	4	3	6	1	0	0	1	0	0	0	0	0	0	0	0	2	0	7	2
10/14/2017	0	0	1	1	4	3	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	4	0
10/15/2017	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2	0	0	1	1	1	0	1	1	1	0	4	0
10/16/2017	0	0	1	0	0	0	1	0	2	2	1	1	1	1	2	3	1	0	0	1	0	0	0	0	0	3	0
10/17/2017	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0
10/18/2017	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0
10/19/2017	0	0	0	4	2	2	1	0	2	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
10/20/2017	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	5	0
10/21/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/22/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/23/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	7	3	1	4	3	7	9	9	0	9	1
10/24/2017	12	5	14	17	12	16	13	11	18	48	95	87	81	90	92	84	85	6	1	1	0	0	0	0	0	95	32
10/25/2017	0	0	1	0	0	0	0	0	2	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	2	0
10/26/2017	0	0	0	0	0	0	0	0	4	1	1	1	0	2	1	0	0	0	0	0	0	0	0	0	0	4	0
10/27/2017	0	0	0	0	0	0	0	1	2	1	3	1	1	0	3	1	1	1	0	0	0	0	0	0	0	3	0
10/28/2017	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	1	0	0	0	2	0	3	4	0	4	0
10/29/2017	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
10/30/2017	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0
10/31/2017	0	0	0	1	0	0	0	0	0	1	0	2	0	1	4	0	0	0	0	0	0	0	0	0	0	4	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	12	7	14	17	12	16	13	11	18	48	95	87	81	90	92	84	85	10	8	9	6	7	9	9		95	
Avg	0	0	1	1	1	1	1	0	1	2	5	4	3	4	4	3	3	1	0	0	0	0	1	1			1

NO2[ppb] Matrix: Kwajalein Monthly: 11/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 11/2017Time Base: 1 Hr. [1 Hr.] Valid Days=22

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
11/1/2017	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
11/2/2017	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	0
11/3/2017	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	2	4	0	4	0
11/4/2017	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	1	0	0	0	0	0	0	1	0
11/5/2017	0	0	0	0	0	0	0	0	0	0	2	3	7	2	0	3	9	1	0	0	0	0	0	0	0	9	1
11/6/2017	0	0	4	5	0	2	2	1	5	7	3	3	11	4	6	0	0	0	5	10	1	0	0	0	0	11	2
11/7/2017	0	0	0	0	1	0	0	1	0	2	5	0	4	4	1	1	3	2	1	3	3		5	4	0	5	1
11/8/2017	2	1	7	3	3	3	1	0	6	7	1	1			4	8	2	1	0	0	1	0	1	0	0	8	2
11/9/2017	0	0	0	0	0	0	0	1	0	1	2	2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
11/10/2017	0	0	0	1	0	0	0	0	2	2	9	1	4	1	3	3	2	11	1	0	0	0	0	0	0	11	1
11/11/2017	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
11/12/2017	0	0	0	0	0	0	0	0	0	10	9	22	35	17	15	20	10	0	0	0	0	0	0	0	0	35	5
11/13/2017	0	0	3	11	0	0	10	6	7	11	0	5	2	5	3	7	13	16	4	27	13	8	4	6	0	27	6
11/14/2017	6	4	38	13	0	0	8	22	28	24	32	18	29	31	26	37	24	44	50	47	41	46	48	36	0	50	27
11/15/2017	26	10	6	4	2	3	1	4	7	15	36	62	55	49	32	36	18	26	34	26	33	30	12	15	1	62	22
11/16/2017	8	10	3	1	0	0	0	3	9	4	3	4	1	5	2	2	0	0	0	0	0	0	0	0	0	10	2
11/17/2017	5	0	0	0	3	1	1	0	0	6	6	5	1	4	6	5	8	9	4	4	0	1	0	1	0	9	2
11/18/2017	1	0	0	0	0	1	0	1	0	1	3	9	5	14	15	4	6	5	1	0	0	1	6	10	0	15	3
11/19/2017	13	12	12	21	13	11	18	24	20	4	8	25	27	5	17	7	16	45	8	10	10	6	0	0	0	45	13
11/20/2017	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	2	0		0	2	0
11/21/2017			1	0	0	0	1	0	2	2	1	1	0	2	1	2	0	0	0	0	0	1	0	0	0	2	0
11/22/2017	0	1	0	1	1	1	0	0	0	2	0	2	1	0	1	1	1	0	0	1	0	0	0	0	0	2	0
11/23/2017	0	0	0	0																					0	0	0
11/24/2017																											
11/25/2017																											
11/26/2017																											
11/27/2017																											
11/28/2017																											
11/29/2017																											
11/30/2017																											
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	26	12	38	21	13	11	18	24	28	24	36	62	55	49	32	37	24	45	50	47	41	46	48	36		62	
Avg	2	1	3	2	1	1	1	2	3	4	5	7	8	7	6	6	5	7	4	5	4	4	3	3			4

NO2[ppb] Matrix: Kwajalein Monthly: 12/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 12/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=7

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
12/1/2017																											
12/2/2017																											
12/3/2017																											
12/4/2017																											
12/5/2017												22	28	35		6	11	7	8	5	3	0	4	1	0	35	10
12/6/2017	5	6	2	0	2	0	0	0	0	9	1	0	0	0	0	0	0	0	0	9	8	12	23	0	0	23	3
12/7/2017	0	0	0	0	0	0	0	3	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
12/8/2017	0	0	0	4	0	0	0	0	0	0	0	0	0	0	2	9	6	5	7	12	20	11	19	7	0	20	4
12/9/2017	6	8	9	11	9	11	14	16	8	16	7	6	13	12	14	25	19	20	23	20	20	23	23	20	6	25	14
12/10/2017	19	17	23	21	20	19	17	25	25	27	31	19	23	21	17	11	12	17	20	19	20	24	14	11	11	31	19
12/11/2017	9	8	13	15	11	16	22	22	16	16	12	13	20	23	32	28	27	33	19	20	30	17	9	8	8	33	18
12/12/2017	16	13	17	15	18	16	18	15	21	25	22	21	28	21	22	22	28	21	17	22	22	17	21	25	13	28	20
12/13/2017	22	20	19	19	19	22	23	19																	19	23	20
12/14/2017																											
12/15/2017																											
12/16/2017																											
12/17/2017																											
12/18/2017																											
12/19/2017																											
12/20/2017																											
12/21/2017																											
12/22/2017																											
12/23/2017																											
12/24/2017																											
12/25/2017																											
12/26/2017																											
12/27/2017																											
12/28/2017																											
12/29/2017																											
12/30/2017																											
12/31/2017																											
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	22	20	23	21	20	22	23	25	25	27	31	22	28	35	32	28	28	33	23	22	30	24	23	25		35	
Avg	9	9	10	10	9	10	11	12	10	13	10	10	14	14	12	12	12	12	11	13	15	13	14	9			11

PM2.5[ug/m3] Matrix: Kwajalein Monthly: 08/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 08/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=1

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
8/1/2017																											
8/2/2017																											
8/3/2017																											
8/4/2017																											
8/5/2017																											
8/6/2017																											
8/7/2017																											
8/8/2017																											
8/9/2017																											
8/10/2017																											
8/11/2017																											
8/12/2017																											
8/13/2017																											
8/14/2017																											
8/15/2017																											
8/16/2017																											
8/17/2017																											
8/18/2017																											
8/19/2017																											
8/20/2017																											
8/21/2017																											
8/22/2017																											
8/23/2017																											
8/24/2017																											
8/25/2017																											
8/26/2017																											
8/27/2017																											
8/28/2017																											
8/29/2017																											
8/30/2017																							0	0	0	0	0
8/31/2017	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Min	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1	
Avg	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

PM2.5[ug/m3] Matrix: Kwajalein Monthly: 09/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 09/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=30

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
9/ 1/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	2	0
9/ 2/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 3/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 4/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 5/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 6/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 7/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 8/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 9/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
9/ 10/ 2017	1	1	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
9/ 11/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0
9/ 12/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9/ 13/ 2017	3	3	2	0	0	0	0	0	0	0	3	2	2	3	2	2	0	0	3	2	0	2	3	3	0	3	1
9/ 14/ 2017	5	3	0	1	2	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
9/ 15/ 2017	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9/ 16/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 17/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 18/ 2017	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9/ 19/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 20/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0
9/ 21/ 2017	1	0	3	2	8	10	10	9	6	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	2
9/ 22/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 23/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 24/ 2017	0	0	0	0	1	1	2	1	0	0	0	0	1	3	4	5	2	0	0	3	1	2	2	4	0	5	1
9/ 25/ 2017	3	4	4	4	2	0	2	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	1	1	0	4	1
9/ 26/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 27/ 2017	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	2	0
9/ 28/ 2017	0	0	1	0	0	0	0	1	1	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0
9/ 29/ 2017	0	0	0	0	3	3	1	0	0	0	3	0	0	1	2	1	0	0	0	0	0	3	1	0	0	3	0
9/ 30/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	5	4	4	4	8	10	10	9	6	6	3	2	3	3	4	5	2	2	3	3	2	3	3	4		10	
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

PM2.5[ug/m3] Matrix: Kwajalein Monthly: 10/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 10/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=31

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
10/1/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/2/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/3/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/5/2017	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0		0	0	2	0
10/6/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/7/2017	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
10/8/2017	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	0	0	0	2	0
10/9/2017	1	2	2	2	0	0	1	2	4	3	4	2	2	4	4	3	0	0	3	4	2	3	0	0	0	4	2
10/10/2017	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	3	0
10/11/2017	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
10/12/2017	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	2	1	0	0	1	0	0	0	0	0	3	0
10/13/2017	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
10/14/2017	0	1	1	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
10/15/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/16/2017	0	2	0	0	0	0	0	0	0	0	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	2	0
10/17/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/18/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/19/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/20/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/21/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/22/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0
10/23/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0	3	4	0	4	0
10/24/2017	8	7	6	8	7	6	7	6	8	7	18	4	5	2	0	11	6	4	0	0	0	0	0	0	0	18	5
10/25/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/26/2017	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
10/27/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/28/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
10/29/2017	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0
10/30/2017	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
10/31/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	8	7	6	8	7	6	7	6	8	7	18	4	5	4	4	11	6	4	3	4	3	3	3	4		18	
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

PM2.5[ug/m3] Matrix: Kwajalein Monthly: 11/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 11/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=30

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
11/1/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/2/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/3/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/5/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
11/6/2017	1	0	0	0	0	1	0	1	2	2	0	1	1	3	4	1	0	0	1	0	0	0	0	0	0	4	0
11/7/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
11/8/2017	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
11/9/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
11/10/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/11/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/12/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	2	1	0	0	0	0	0	0	1	0	3	0
11/13/2017	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	3	4	2	0	0	4	0
11/14/2017	0	1	0	16	3	2	0	0	1	8	6	4	4	3	4	3	6	4	7	6	7	6	7	10	0	16	4
11/15/2017	10	4	1	0	1	0	0	0	0	0	3	4	11	6	12	8	5	2	12	8	5	6	4	2	0	12	4
11/16/2017	2	2	1	2	1	1	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0
11/17/2017	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	2	0	0	0	0	2	0
11/18/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0
11/19/2017	0	0	1	3	4	2	1	3	3	2	2	3	2	2	2	11	6	1	8	5	4	2	0	0	0	11	2
11/20/2017	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11/21/2017	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	2	0	0	0	2	0
11/22/2017	0	0	0	0	0	2	2	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	2	0
11/23/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/24/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/25/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/26/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	2	3	2	0	7	0
11/27/2017	0	0	0	2	0	0	0	6	4	4	0	0	0	0	0	3	4	2	8	17	10	14	16	9	0	17	4
11/28/2017	10	17	19	25	23	22	23	17	23	16	19	16	14	14	18	20	16	14	14	10	14	14	12	12	10	25	16
11/29/2017	13	9	11	10	11	7	8	10	10	8	11	12	9	15	14	12	10	12	11	5	4	3	2	2	2	15	9
11/30/2017	1	1	4	4	0	0	0	0	0	0	1	4	6	4	0	0	0	0	0	3	2	2	0	0	0	6	1
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	13	17	19	25	23	22	23	17	23	16	19	16	14	15	18	20	16	14	14	17	14	14	16	12		25	
Avg	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	2	1	1	1	1			1

PM2.5[ug/m3] Matrix: Kwajalein Monthly: 12/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 12/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=7

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
12/1/2017	0	0	0	0	0	3	3	0	3	4	6	8	2	0	3	2	8	5	4	3	4	5	3	6	0	8	3
12/2/2017	6	5	3	8	5	0	1	7	4	4	7	8	7	8	10	10	11	10	7	6	9	8	11	7	0	11	6
12/3/2017	11	4	0	3	6	4	1	0	0	0	0	1	0	0	0	0	3	5	3	3	7	8	6	8	0	11	3
12/4/2017	7	9	15	0	3	7	6	4	0	6	4	0	2	4	2	2	3	3	2	3	4	6	4	4	0	15	4
12/5/2017	4	2	0	12	0	0	0	0	1	3	5	3	2	4	5	9	7	5	6	8	10	10	12	12	0	12	5
12/6/2017	9	4	2	2	2	6	6	4	3	4	4	4	9	3	1	0	0	0	0	2	2	1	1	9	0	9	3
12/7/2017	5	4	3	4	0	0	0	0	3	2	9	6	4	2	1	1	0	0	0	3	3	2	2	0	0	9	2
12/8/2017	0	1	2	2	1	0	0	0	0	0	0														0	2	0
12/9/2017																											
12/10/2017																											
12/11/2017																											
12/12/2017																											
12/13/2017																											
12/14/2017																											
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12/21/2017																											
12/22/2017																											
12/23/2017																											
12/24/2017																											
12/25/2017																											
12/26/2017																											
12/27/2017																											
12/28/2017																											
12/29/2017																											
12/30/2017																											
12/31/2017																											
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	1	0	0		
Max	11	9	15	12	6	7	6	7	4	6	9	8	9	8	10	10	11	10	7	8	10	10	12	12		15	
Avg	5	3	3	3	2	2	2	1	1	2	4	4	3	3	3	3	4	4	3	4	5	5	5	6			3

Meck

SO2[ppb] Matrix: Meck Monthly: 09/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 09/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=25

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
9/ 1/ 2017																											
9/ 2/ 2017															6	2	1	1	1	1	1	1	1	1	1	6	1
9/ 3/ 2017	1	1	1	1	1	7	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	1
9/ 4/ 2017	1	1	1	1	1	5	1	2	2	2	2	2	2	2	2	2	2	1	1	2	1	2	2	2	1	5	1
9/ 5/ 2017	2	2	2	2	2	3	1	2	2	2	2	2	2	2	2	2									1	3	2
9/ 6/ 2017																											
9/ 7/ 2017																0	0	0	0	0	0	0	0	0	0	0	0
9/ 8/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 9/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 10/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 11/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 12/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0
9/ 13/ 2017	0	1	1	0	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	1	0	0	1	1	0	1	0
9/ 14/ 2017	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9/ 15/ 2017	0	0	0	0	1	0	0	0	1			1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0
9/ 16/ 2017	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	0	1	0
9/ 17/ 2017	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	1	0
9/ 18/ 2017	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9/ 19/ 2017	0	0	0	1	1	0	0	0	1	0	0			1	1	1	1	1	1	1	1	1	1	1	0	1	0
9/ 20/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/ 21/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/ 22/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/ 23/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/ 24/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/ 25/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/ 26/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/ 27/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/ 28/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9/ 29/ 2017	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
9/ 30/ 2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	2	2	2	2	2	7	2	2	2	2	2	2	2	2	6	2	2	1	1	2	1	2	2	2		7	
Avg	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

SO2[ppb] Matrix: Meck Monthly: 10/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 10/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=29

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
10/1/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10/2/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10/3/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10/4/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	4	1
10/5/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10/6/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10/7/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10/8/2017	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1	2	1	1	1	2	1
10/9/2017	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
10/10/2017	1	1	1	1	1																				1	1	1
10/11/2017											1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10/12/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10/13/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1
10/14/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10/15/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	1	2	2	2	1	1	2	1
10/16/2017	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	1	1	1	2	2	2	1	2	1
10/17/2017	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
10/18/2017	1	1	1	1	1	1	2	1	1	1	2	1	2	1	1	2	1	2	2	2	1	1	1	1	1	2	1
10/19/2017	1	1	2	1	2	1	2	1	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
10/20/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/21/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/22/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/23/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/24/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/25/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/26/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/27/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/28/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/29/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/30/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10/31/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2	2	3	2
Min	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Max	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	3	3	2	2	2	2	2	2	2		4	
Avg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1

SO2[ppb] Matrix: Meck Monthly: 11/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 11/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=30

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
11/1/2017	2	2	2	2	3	2	2	2	2	2	3	2	2	3	2	2	2	2	2	3	2	3	3	3	2	3	2
11/2/2017	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2
11/3/2017	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
11/4/2017	3	3	3	3	3	3	3	3	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
11/5/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/6/2017	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11/7/2017	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0
11/8/2017	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0
11/9/2017	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0
11/10/2017	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1
11/11/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11/12/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11/13/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11/14/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11/15/2017	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1
11/16/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11/17/2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	1
11/18/2017	1	1	1	1	1	1	1	1	1		2	1	2	2	2	2	1	1	1	1	1	1	1	2	1	2	1
11/19/2017	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
11/20/2017	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1	1	1	2	1
11/21/2017	1	1	1	1	1	1	2	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	2	2	1	2	1
11/22/2017	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1
11/23/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	1	2	1
11/24/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/25/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/26/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/27/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/28/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11/29/2017	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	2	3	2	2	2	2	2	2	2	2	3	2
11/30/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	3	3	3	3	3	3	3	3	3	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3		5	
Avg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1

SO2[ppb] Matrix: Meck Monthly: 12/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 12/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=13

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
12/1/2017	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	3	2
12/2/2017	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	3	2
12/3/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	3	2
12/4/2017	2	2	3	2	3	2	3	3	3	2	2	2	2	3	3	3	3	3	3	2	3	2	2	2	2	3	2
12/5/2017	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2
12/6/2017	3	3	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2
12/7/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
12/8/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
12/9/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
12/10/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3	2
12/11/2017	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	3	2
12/12/2017	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	3	3	3	2	2	2	2	2	2	2	3	2
12/13/2017	2	2	2	2	2	2	2	2	2	3	2	2	3	3	3	3	3	3	3	2	3	2	2	2	2	3	2
12/14/2017	2	2	2	2	2	2	2	2	2																2	2	2
12/15/2017																											
12/16/2017																											
12/17/2017																											
12/18/2017																											
12/19/2017																											
12/20/2017																											
12/21/2017																											
12/22/2017																											
12/23/2017																											
12/24/2017																											
12/25/2017																											
12/26/2017																											
12/27/2017																											
12/28/2017																											
12/29/2017																											
12/30/2017																											
12/31/2017																											
Min	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		
Max	3	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		3	
Avg	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			2

NO2[ppb] Matrix: Meck Monthly: 09/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 09/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=8

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
9/ 1/ 2017																											
9/ 2/ 2017																0	1	0	1	0	1	0	0	0	0	1	0
9/ 3/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 4/ 2017	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9/ 5/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	2	0
9/ 6/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0
9/ 7/ 2017	0	0	0	0	0	0	0																		0	0	0
9/ 8/ 2017																											
9/ 9/ 2017																											
9/ 10/ 2017																											
9/ 11/ 2017																											
9/ 12/ 2017																											
9/ 13/ 2017																											
9/ 14/ 2017																											
9/ 15/ 2017												0	0	5	4	3	3	43	12	0	0	0	0	0	0	43	5
9/ 16/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	31	2	0	0	0	0	33	24	0	44	5
9/ 17/ 2017	0	0	0	0	0	0	0	2	1	2	3	7	6	14	19	19	35	21	11	11	8	14	15	4	0	35	8
9/ 18/ 2017	7	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
9/ 19/ 2017	0	0	0	13	0	0	0	0	0	0	0														0	13	1
9/ 20/ 2017																											
9/ 21/ 2017																											
9/ 22/ 2017																											
9/ 23/ 2017																											
9/ 24/ 2017																											
9/ 25/ 2017																											
9/ 26/ 2017																											
9/ 27/ 2017																											
9/ 28/ 2017																											
9/ 29/ 2017														57	47	41	32	27	51	43	38	21	2	0	0	57	32
9/ 30/ 2017	0	8	0	0	0	0	0	0	6	0	0	0	0	8	5	5	20	9	2	0	0	0	0	0	0	20	2
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	7	8	0	13	1	0	0	2	6	2	3	7	6	57	47	44	35	43	51	43	38	21	33	24		57	
Avg	0	0	0	1	0	0	0	0	0	0	0	0	0	8	7	10	11	9	7	5	4	3	4	2			3

NO2[ppb] Matrix: Meck Monthly: 10/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix   Avg Type: AVG

Date & Time: 10/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=31

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
10/1/2017	0	0	0	0	0	0	0	0	1	4	2	12	13	4	0	0	0	4	16	8	4	1	0	0	0	16	2
10/2/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
10/3/2017	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0
10/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	0	1	0
10/5/2017	9	7	23	46	27	30	56	43	47	54	40	41	46	50	45	43	25	13	12	21	10	5	12	7	5	56	29
10/6/2017	7	8	8	3	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	8	1
10/7/2017	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	10	30	13	21	0	30	3
10/8/2017	1	7	0	0	0	0	0	0	25	56	59	61	58	70	74	51	54	20	18	40	42	59	37	20	0	74	31
10/9/2017	50	28	15	49	61	37	48	49	66	28	27	51	61	46	40	28	13	0	0	0	0	0	0	0	0	66	29
10/10/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/11/2017	0	0	0	0	1	0	0	0	0	8	12	13	49	20	18	6	4	6	13	28	22	8	13	10	0	49	9
10/12/2017	3	0	4	2	0	4	1	18	22	18	58	58	50	53	45	34	46	42	25	39	48	51	42	37	0	58	29
10/13/2017	30	26	32	39	46	44	41	44	38	21	4	2	0	0	0	4	13	6	12	22	27	46	51	44	0	51	24
10/14/2017	49	50	40	49	27	21	5	12	24	21	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	50	12
10/15/2017	0	0	0	0	1	0	0	0	15	15	5	8	20	23	39	52	43	39	25	36	40	43	39	39	0	52	20
10/16/2017	34	28	38	31	13	8	0	0	8	14	4	24	32	31	34	20	37	23	11	3	0	33	49	46	0	49	21
10/17/2017	31	31	10	13	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	4
10/18/2017	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
10/19/2017	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
10/20/2017	0	1	0	1	1	0	0	0	1	3	0	0	13	0	0	10	4	0	0	2	1	7	4	0	0	13	2
10/21/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/22/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/23/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	16	34	58	63	62	59	64	0	64	15
10/24/2017	65	59	57	52	64	40	51	48	41	23	4	0	7	16	32	52	49	37	26	41	39	23	28	5	0	65	35
10/25/2017	6	7	6	6	2	3	1	1		6	9	5	7	7	4	4	2	0	0	0	2	2	3	7	0	9	3
10/26/2017	9	22	11	5	0	2	3	8	3	2	1	0	2	0	0	0	0	0	0	0	0	0	16	20	0	22	4
10/27/2017	5	0	0	1	0	0	0	0	0	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0	0	6	0
10/28/2017	0	0	0	0	0	0	0	0	0	6	11	0	0	0	0	0	1	3	0	0	0	0	0	0	0	11	0
10/29/2017	0	0	0	0	0	0	2	0	2	2	6	25	1	4	3	2	0	0	0	0	2	3	2	0	0	25	2
10/30/2017	1	1	0	0	0	0	0	0	0	12	5	3	6	15	23	12	15	11	25	15	24	12	0	0	0	25	7
10/31/2017	0	0	0	0	0	0	1	1	0	0	2	13	0	0	3	0	0	0	0	0	0	0	0	0	0	13	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	65	59	57	52	64	44	56	49	66	56	59	61	61	70	74	52	54	42	34	58	63	62	59	64		74	
Avg	9	8	7	9	8	6	6	7	9	9	8	10	11	11	11	10	10	7	7	10	10	12	11	10			9

NO2[ppb] Matrix: Meck Monthly: 11/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 11/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=30

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
11/1/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	20	0	20	0
11/2/2017	13	5	16	16	8	2	1	20	31	24	14	19	20	6	1	0	0	0	0	0	0	0	0	0	0	31	8
11/3/2017	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	3	0
11/4/2017	0	0	3	0	20	8	5	5	6		1	1	9	17	7	5	21	6	0	5	1	0	2	0	0	21	5
11/5/2017	7	15	13	0	0	14	0	0	0	6	22	16	3	2	19	9	5	0	0	0	0	0	0	0	0	22	5
11/6/2017	0	0	0	1	1	0	7	16	17	29	30	42	21	13	2	0	0	0	0	2	0	0	0	0	0	42	7
11/7/2017	0	4	19	37	28	21	0	0	0	5	0	23	21	15	30	28	42	61	52	33	49	48	37	53	0	61	25
11/8/2017	41	48	33	43	27	45	45	25	31	1	0	11	0	26	26	37	23	44	46	40	31	11	10	1	0	48	26
11/9/2017	0	0	0	0	0	0	2	0	1	1	0	0	0	9	0	1	3	20	0	1	0	6	9	18	0	20	2
11/10/2017	0	0	0	4	5	0	14	9	14	18	0	0	0	0	22	7	13	23	24	15	30	31	16	13	0	31	10
11/11/2017	6	14	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	1
11/12/2017	0	0	0	0	0	0	5	32	18	28	5	22	24	7	4	10	4	1	0	9	8	9	10	8	0	32	8
11/13/2017	0	1	3	9	40	56	41	47	39	56	49	41	47	43	38	43	51	50	28	11	50	52	56	51	0	56	37
11/14/2017	49	53	53	42	17	27	57	57	65	57	53	57	52	46	53	49	53	49	38	13	39	30	57	51	13	65	46
11/15/2017	56	56	50	59	44	39	34	39	53	52		59	49	44	50	73	62	63	34	39	43	42	32	41	32	73	48
11/16/2017	37	43	42	53	56	22	18	37	38	14	8	26	15	22	21	7	0	0	0	0	0	0	0	0	0	56	19
11/17/2017	0	0	0	0	1	15	5	12	0	15	11	27	40	43	46	64	56	52	50	48	23	20	0	6	0	64	22
11/18/2017	0	8	3	12	38	31	24	19		16	58	61	63	65	59	58	34	7	16	17	13	17	26	66	0	66	30
11/19/2017	66	56	28	45	25	20	20	4	6	10	0	1	12	3	26	49	40	34	10	10	38	0	0	0	0	66	20
11/20/2017	0	0	0	5	8	3	0	0	0	0	0	6	58	71	75	64	55	52	45	3	1	0	0	0	0	75	18
11/21/2017	0	0	0	0	0	9	43	27	17	9	11	28	16	2	1	4	3	3	17	1	1	7	14	36	0	43	10
11/22/2017	23	59	44	49	48	54	43	39	41	35	13	22	15	46	44	52	38	56	39	50	46	40	51	35	13	59	40
11/23/2017	34	12	13	15	2	1	1	9	18	10	18	22	35	24	19	15	7	5	1	0	0	0	1	1	0	35	10
11/24/2017	21	32	25	18	28	40	68	30	6	18	22	14	11	36	33	32	25	46	35	39	36	18	27	0	0	68	27
11/25/2017	9	38	35	18	5	2	42	22	0	0	0	0	0	0	0	0	1	11	11	8	12	4	1	0	0	42	9
11/26/2017	0	2	1	0	0	0	0	0	0	0	0	0	0	0	2	5	42	52	14	3	53	55	56	72	0	72	14
11/27/2017	79	63	19	3	13	0	0	9	3	26	6	19	6	4	12	7	39	8	4	1	19	35	57	48	0	79	20
11/28/2017	67	63	58	45	67	57	31	65	68	48	67	64	37	49	88	76	95	72	90	86	84	88	84	81	31	95	67
11/29/2017	84	79	73	79	93	72	87	84	63	84	102	100	124	117	122	105	115	93	93	1	0	0	0	0	0	124	73
11/30/2017	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	20	0	20	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	84	79	73	79	93	72	87	84	68	84	102	100	124	117	122	105	115	93	93	86	84	88	84	81		124	
Avg	19	21	17	18	19	17	19	20	18	19	16	22	22	23	26	26	27	27	21	14	19	17	18	20			20

NO2[ppb] Matrix: Meck Monthly: 12/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 12/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=13

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
12/1/2017	15	38	33	12	23	22	39	13	40	7	15	74	113	124	129	83	50	25	24	22	29	33	60	74	7	129	45
12/2/2017	89	80	44	41	47	51	65	75	88	108	120	108	110	78	81	42	22	6	18	8	1	4	10	24	1	120	55
12/3/2017	34	39	2	0	0	0	0	0	0	0	0	0	0	0	10	17	60	64	42	68	76	73	93	108	0	108	28
12/4/2017	42	77	90	52	55	41	84	82	71	51	30	24	23	76	85	74	80	86	88	62	68	33	19	14	14	90	58
12/5/2017	1	21	1	67	14	1	19	5	4	0	0	0	86	119	73	63	86	92	95	105	77	96	48	83	0	119	48
12/6/2017	85	78	11	13	11	2	0	0		2	3	1	0	0	0	0	0	0	2	5	2	3	13	1	0	85	10
12/7/2017	1	0	2	0	0	17	4	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	1
12/8/2017	0	12	44	3	0	0	0	0	0	37	43	60	40	50	82	86	73	60	73	44	14	18	29	44	0	86	33
12/9/2017	59	45	49	71	22	36	32	10	1	17	2	36	38	56	88	88	69	85	93	79	56	64	62	83	1	93	51
12/10/2017	65	73	44	57	75	71	82	82	76	66	72	58	53	63	89	79	71	25	20	56	50	47	53	97	20	97	63
12/11/2017	72	42	39	83	34	49	81	69	71	49	68	71	93	98	91	95	39	31	25	36	33	40	30	17	17	98	56
12/12/2017	19	30	38	57	61	53	48	60	71	42	44	51	54	48	58	82	79	61	37	15	27	12	31	33	12	82	46
12/13/2017	52	45	60	50	43	28	54	64	59	52	54	44	46	70	84	82	79	69	61	55	54	47	62	54	28	84	57
12/14/2017	27	19	8	10	58	61	23	3	8																3	61	24
12/15/2017																											
12/16/2017																											
12/17/2017																											
12/18/2017																											
12/19/2017																											
12/20/2017																											
12/21/2017																											
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12/24/2017																											
12/25/2017																											
12/26/2017																											
12/27/2017																											
12/28/2017																											
12/29/2017																											
12/30/2017																											
12/31/2017																											
Min	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	89	80	90	83	75	71	84	82	88	108	120	108	113	124	129	95	86	92	95	105	77	96	93	108		129	
Avg	40	42	33	36	31	30	37	33	37	33	34	40	50	60	66	60	54	46	44	42	37	36	39	48			42

PM2.5[ug/m3] Matrix: Meck Monthly: 09/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 09/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=28

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
9/1/2017																											
9/2/2017										2	1	0	2	2	0	1	4	3	12	3	1	2	0	0	0	12	2
9/3/2017	0	3	1	0	3	4	2	0	12	4	2	0	0	0	0	0	0	0	0	0	0	0	1	2	0	12	1
9/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
9/5/2017	1	2	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	2	2	0	0	4	0	4	0
9/6/2017	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0
9/7/2017	6	4	2	0	0	0	0	0	0	0	0	0	0					0	0	0	0	0	0	0	0	6	0
9/8/2017	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9/9/2017	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	2	2	1	0	0	2	0
9/10/2017	1	1	0	2	2	0	2	2	2	2	3	2	0	2	2	2	2	1	0	0	0	0	0	0	0	3	1
9/11/2017				0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0				0	0	1	0
9/12/2017	0	2	3	2	2	0	0	1	1	3	1	0	1	3	4	2	2	3	4	4	2	3	4	4	0	4	2
9/13/2017	3	6	5	5	4	4	2	2	6	5	5	5	3	2	1	0	2	3	2	4	4	7	5	3	0	7	3
9/14/2017	3	4	4	5	4	1	1	0	3	4	4	1	0	3	2	2	3	2	2	0	0	1	2	2	0	5	2
9/15/2017	3	3	3	7	5	2	0	0	0	1	2	2	1	0	0	4	1	0	2	2	2	0	0	0	0	7	1
9/16/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	3	2	0	0	0	0	0	6	0
9/17/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	2	0	2	1	0	0	4	0
9/18/2017	0	3	1	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
9/19/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/20/2017	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	2	6	3	3	4	4	4	4	0	6	1
9/21/2017	4	4	5	4	3	4	3	4	6	6	7	4	4	5	3	4	4	4	0	0	1	1	2	1	0	7	3
9/22/2017	0	0	0	0	0	0	0	0	0	4	4				0	0	0	0	0	0	0	0	0	0	0	4	0
9/23/2017	1	0	0	2	2	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	4	4	4	0	4	0
9/24/2017	5	8	5	6	5	8	6	4	6	8	7	5	3	4	4	5	6	5	4	4	4	2	4	8	2	8	5
9/25/2017	4	4	6	6	4	2	4	6	2	4	6	5	4	4	4	6	4	6	5	4	7	4	4	3	2	7	4
9/26/2017	6	3	0	3	3	2	2	4	3	1	0	3	7	16	0	0	4	2	1	0	0	0	2	2	0	16	2
9/27/2017	0	0	0	0	0	1	1	0	2	2	1	2	4	2	0	1	3	3	4	4	4	5	4	4	0	5	1
9/28/2017	7	5	4	5	2	1	4	5	5	3	0	3	3	2	4	4	4	4	4	3	2	6	11	5	0	11	4
9/29/2017	6	4	5	4	6	7	4	3	4	4	4	10	9	6	6	3	2	2	4	4	4	3	4	2	2	10	4
9/30/2017	4	4	2	2	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	7	8	6	7	6	8	6	6	12	8	7	10	9	16	6	6	6	6	12	4	7	7	11	8		16	
Avg	2	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1

PM2.5[ug/m3] Matrix: Meck Monthly: 10/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 10/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=31

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
10/1/2017	1	0	0	0	0	4	1	2	0	0	1	0	0	0	0	0	0	1	1	1	2	0	1	0	0	4	0
10/2/2017	0	0	2	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
10/3/2017	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	6	0
10/4/2017	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0
10/5/2017	0	1	0	0	5	4	1	4	4	5	5	4	3	2	3	4	3	3	1	2	4	6	5	4	0	6	3
10/6/2017	4	5	3	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	0
10/7/2017	0	0	0	0	0	1	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	3	3	0	3	0
10/8/2017	0	2	2	0	0	0	0	0	3	0	7	5	5	6	4	6	4	5	3	0	2	4	7	4	0	7	2
10/9/2017	2	3	6	4	2	4	9	12	10	11	6	3	5	6	8	6	5	9	5	5	6	4	3	5	2	12	5
10/10/2017	4	4	7	5	4	3	4	6	3	1	1	0	0	1	2	2	1	1	1	1	2	3	5	5	0	7	2
10/11/2017	3	2	5	4	4	4	3	6	4	4	7							0	0	0	0	0	0	0	0	7	2
10/12/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/13/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	6	0	7	0
10/14/2017	4	3	4	2	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
10/15/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/16/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/17/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/18/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/19/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/20/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/21/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/22/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/23/2017	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	3	2	0	3	0
10/24/2017	3	4	4	5	6	3	1	1	2	0	0	0	0	0	0	2	3	5	4	4	4	4	3	0	0	6	2
10/25/2017	0	4	3	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
10/26/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/27/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/28/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/29/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/30/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/31/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	7	11	4	4	9	0	11	1
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	6	5	7	5	6	4	9	12	10	11	7	5	5	6	8	6	5	9	9	7	11	6	7	9		12	
Avg	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1			0

PM2.5[ug/m3] Matrix: Meck Monthly: 11/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 11/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=30

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
11/1/2017	2	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
11/2/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/3/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/5/2017	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11/6/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0
11/7/2017	0	0	0	0	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	0	0	0	0	57	2
11/8/2017	1	5	5	3	3	85	5	0	0	3	3	0	0	0	0	3	3	0	0	0	2	3	1	0	0	85	5
11/9/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/10/2017	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	2	1	0	0	2	1	0	0	0	0	3	0
11/11/2017	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11/12/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	2	0
11/13/2017	0	0	0	0	0	3	3	2	2	4	7	3	0	0	0	1	3	2	1	0	0	0	3	4	0	7	1
11/14/2017	4	5	3	5	4	3	3	3	7	7	5	3	2	5	6	4	3	2	3	2	0	3	3	5	0	7	3
11/15/2017	5	7	7	5	8	7	6	4	4	6	9	6	5	6	7	5	10	7	6	7	5	4	3	1	1	10	5
11/16/2017	1	4	6	4	5	4	6	5	4	5	5	2	3	2	2	2	2	0	0	0	0	0	0	0	0	6	2
11/17/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	1	0	0	0	4	0
11/18/2017	0	0	0	0	0	0	3	2	0	0	0	1	0	0	5	3	2	0	0	0	0	0	0	0	0	5	0
11/19/2017	2	3	2	0	0	1	1	0	0	0	0	0	0	2	2	0	5	3	2	4	4	5	0	0	0	5	1
11/20/2017	0	0	0	0	0	0	0	0	0	0	0	0	2	3	6	6	9	4	3	4	2	0	0	0	0	9	1
11/21/2017	0	0	0	0	0	0	0	1	2	4	3	4	4	2	0	0	0	0	0	0	0	0	1	0	0	4	0
11/22/2017	0	2	3	4	6	3	2	2	3	1	0	0	0	0	3	2	0	1	3	6	3	0	0	0	0	6	1
11/23/2017	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11/24/2017	0	0	1	0	0	0	1	3	3	0	0	0	0	0	0	2	2	2	4	4	3	1	0	0	0	4	1
11/25/2017	0	0	0	1	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	2	4	1	0	0	4	0
11/26/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	6	3	0	0	0	2	2	0	6	0
11/27/2017	2	3	0	0	0	2	0	0	0	1	1	1	3	1	0	4	3	8	7	8	6	6	9	7	0	9	3
11/28/2017	12	12	8	7	11	7	9	13	8	17	15	15	14	14	12	12	12	15	9	15	10	14	12	10	7	17	11
11/29/2017	11	5	7	10	12	10	8	9	8	8	7	9	14	17	13	16	13	9	9	10	5	3	1	0	0	17	8
11/30/2017	4	3	0	0	0	0	0	0	0	1	1	0	0	0	3	1	0	1	0	0	0	0	0	0	0	4	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	12	12	8	10	57	85	9	13	8	17	15	15	14	17	13	16	13	15	9	15	10	14	12	10		85	
Avg	1	1	1	1	3	4	1	1	1	1	2	1	1	1	2	2	2	2	1	2	1	1	1	0			1

PM2.5[ug/m3] Matrix: Meck Monthly: 12/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 12/2017Time Base: 1 Hr. [1 Hr.] Valid Days=8

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
12/1/2017	0	0	0	0	0	0	0	1	1	0	0	0	4	9	7	6	7	5	1	0	1	11	7	4	0	11	2
12/2/2017	7	7	6	5	2	2	5	4	4	5	5	10	9	9	6	4	5	4	3	5	5	2	2	2	2	10	4
12/3/2017	1	1	3	3	1	3	2	0	0	0	0	0	4	3	1	1	4	5	5	3	3	4	4	4	0	5	2
12/4/2017	4	3	5	5	4	5	4	4	3	5	3	1	1	0	7	7	6	5	4	7	6	5	2	0	0	7	4
12/5/2017	0	0	0	0	0	2	2	1	1	1	1	0	0	2	4	7	6	6	6	4	9	7	4	5	0	9	2
12/6/2017	5	8	7	3	3	3	2	3	2	3	5	2	2	7	7	1	0	4	7	4	4	8	12	6	0	12	4
12/7/2017	4	5	4	2	6	3	1	0	3	4	4	4	3	2	7	5	1	0	0	0	0	0	0	0	0	7	2
12/8/2017	0	0	0	3	2	0	0	0	0	0	0	0	4	3	2	5	4	3	3	4	3	2	1	0	0	5	1
12/9/2017	2	4	5	3	2	4	4	4																	2	5	3
12/10/2017																											
12/11/2017																											
12/12/2017																											
12/13/2017																											
12/14/2017																											
12/15/2017																											
12/16/2017																											
12/17/2017																											
12/18/2017																											
12/19/2017																											
12/20/2017																											
12/21/2017																											
12/22/2017																											
12/23/2017																											
12/24/2017																											
12/25/2017																											
12/26/2017																											
12/27/2017																											
12/28/2017																											
12/29/2017																											
12/30/2017																											
12/31/2017																											
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0		
Max	7	8	7	5	6	5	5	4	4	5	5	10	9	9	7	7	7	6	7	7	9	11	12	6		12	
Avg	2	3	3	2	2	2	2	1	1	2	2	2	3	4	5	4	4	4	3	3	3	4	4	2			3

Roi-Namur

SO2[ppb] Matrix: Roi Namur Monthly: 09/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 09/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=18

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
9/ 1/ 2017																											
9/ 2/ 2017																											
9/ 3/ 2017																											
9/ 4/ 2017																											
9/ 5/ 2017																											
9/ 6/ 2017																											
9/ 7/ 2017																											
9/ 8/ 2017																											
9/ 9/ 2017																											
9/ 10/ 2017																											
9/ 11/ 2017																											
9/ 12/ 2017																	0	0	0	0	0	0	0	0	0	0	0
9/ 13/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 14/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 15/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 16/ 2017	0	0	0	0	0	0	0	0	0	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 17/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 18/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 19/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 20/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 21/ 2017	0	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 22/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 23/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 24/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 25/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 26/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 27/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 28/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 29/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/ 30/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

SO2[ppb] Matrix: Roi Namur Monthly: 10/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 10/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=31

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
10/1/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/2/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/3/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/5/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/6/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/7/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/8/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/9/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/10/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/11/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/12/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/13/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/14/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/15/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/16/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/17/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/18/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/19/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/20/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/21/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/22/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/23/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/24/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/25/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/26/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/27/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/28/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/29/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/30/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/31/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

SO2[ppb] Matrix: Roi Namur Monthly: 11/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 11/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=30

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
11/1/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/2/2017	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/3/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/5/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/6/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/7/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/8/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/9/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/10/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/11/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/12/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/13/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/14/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/15/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/16/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/17/2017	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/18/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/19/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/20/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/21/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/22/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/23/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/24/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/25/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/26/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/27/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/28/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/29/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

SO2[ppb] Matrix: Roi Namur Monthly: 12/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 12/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=14

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
12/ 1/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 2/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 3/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 4/ 2017	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 5/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 6/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 7/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 8/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 9/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 10/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 11/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 12/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 13/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 14/ 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/ 15/ 2017	0	0	0	0	0	0	0	0	0	0															0	0	0
12/ 16/ 2017																											
12/ 17/ 2017																											
12/ 18/ 2017																											
12/ 19/ 2017																											
12/ 20/ 2017																											
12/ 21/ 2017																											
12/ 22/ 2017																											
12/ 23/ 2017																											
12/ 24/ 2017																											
12/ 25/ 2017																											
12/ 26/ 2017																											
12/ 27/ 2017																											
12/ 28/ 2017																											
12/ 29/ 2017																											
12/ 30/ 2017																											
12/ 31/ 2017																											
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

NO2[ppb] Matrix: Roi Namur Monthly: 09/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 09/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=7

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
9/1/2017																											
9/2/2017																											
9/3/2017																											
9/4/2017																											
9/5/2017																											
9/6/2017																											
9/7/2017																											
9/8/2017																											
9/9/2017																											
9/10/2017																											
9/11/2017																											
9/12/2017																											
9/13/2017																											
9/14/2017																											
9/15/2017																											
9/16/2017														0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/17/2017	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
9/18/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/19/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/20/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/21/2017	0	0	0	0	0	1	9	6	4	5	1	5	2	13	0	0	0	1	0	0	6	0	0	0	0	13	2
9/22/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/23/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/24/2017	0	0	0	0																					0	0	0
9/25/2017																											
9/26/2017																											
9/27/2017																											
9/28/2017																											
9/29/2017																											
9/30/2017																											
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	0	0	2	0	0	1	9	6	4	5	1	5	2	13	0	0	0	1	0	0	6	0	0	0		13	
Avg	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0			0

NO2[ppb] Matrix: Roi Namur Monthly: 10/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 10/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=28

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
10/1/2017																											
10/2/2017																											
10/3/2017													0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/5/2017	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	4	0
10/6/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/7/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/8/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/9/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	1	0	0	1	0	0	0	3	0
10/10/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/11/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0
10/12/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/13/2017	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0
10/14/2017	0	0	0	0	0	2	2	4	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
10/15/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/16/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/17/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/18/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/19/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/20/2017	0	0	0	0	0	0	0	0	0	0							2	2	0	0	0	0	0	0	0	2	0
10/21/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
10/22/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/23/2017	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0
10/24/2017	0	1	0	0	2	0	0	0	0	0	2	4	0	0	0	1	0	0	0	0	0	0	0	0	0	4	0
10/25/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/26/2017	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
10/27/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
10/28/2017	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
10/29/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
10/30/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/31/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	0	1	0	0	2	2	2	4	1	4	4	4	2	0	1	1	2	3	1	0	0	1	0	0		4	
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

NO2[ppb] Matrix: Roi Namur Monthly: 11/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 11/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=16

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
11/1/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/2/2017	0	0	0	0	0	0	0	0	0	0	0			1	0	0	1	0	0	0	0	0	0	0	0	1	0
11/3/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0
11/5/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	5	2	2	0	0	0	0	0	0	0	5	0
11/6/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	3	0
11/7/2017	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
11/8/2017	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
11/9/2017	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
11/10/2017	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11/11/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/12/2017	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0
11/13/2017	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
11/14/2017	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	1	0	0	0	0	0	3	0
11/15/2017	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11/16/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/17/2017	0	0	0	0	0	0	0	0																	0	0	0
11/18/2017																											
11/19/2017																											
11/20/2017																											
11/21/2017																											
11/22/2017																											
11/23/2017																											
11/24/2017																											
11/25/2017																											
11/26/2017																											
11/27/2017																											
11/28/2017																											
11/29/2017																											
11/30/2017													0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	0	1	3	0	2	2	0	0	1	1	1	1	3	3	4	5	2	2	0	1	0	0	0	2		5	
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0

NO2[ppb] Matrix: Roi Namur Monthly: 12/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 12/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=14

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
12/1/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/2/2017	0	0	0	0	0	0	0	0	3	5	3	4	0	1	0	8	2	14	0	2	0	2	3	0	0	14	1
12/3/2017	0	0	0	2	0	0	0	0	0	0	0	0	0	0	9	4	0	0	0	0	0	0	0	0	0	9	0
12/4/2017	0	0	0	0	0	2	0	6	1	4	4	4		1	4	0	0	2	0	2	2	1	0	2	0	6	1
12/5/2017	2	2	5	0	3	0	6	4	0	1	2	0	0	2	2	2	0	0	4	0	0	0	0	0	0	6	1
12/6/2017	2	0	2	0	0	1	4	0	8	9	7	7	13	7	5	0	7	2	11	4	13	6	9	11	0	13	5
12/7/2017	7	0	8	0	8	4	8	10	6	3	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	2
12/8/2017	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	2	4	4	0	7	0
12/9/2017	5	9	6	6	11	5	9	16	13	18	13	10	5	4	3	1	0	0	3	5	8	2	2	4	0	18	6
12/10/2017	6	6	11	7	12	10	9	3	3	5	5	7	11	4	4	5	4	11	8	8	2	5	10	4	2	12	6
12/11/2017	0	2	0	0	6	3	1	3	4	1	8	8	5	16	8	7	5	23	14	4	6	10	8	8	0	23	6
12/12/2017	8	14	9	1	6	7	7	5	13	2	9	3	12	13	15	14	0	0	2	12	5	10	12	7	0	15	7
12/13/2017	3	5	3	7	4	11	0	2	3	0	4	6	2	7	5	3	0	3	6	10	2	1	0	2	0	11	3
12/14/2017	6	0	1	5	6	1	0	11	12	3	3	0	0	0	0	5	3	2	6	2	3	0	2	1	0	12	3
12/15/2017	0	0	2	2	1	0	0	5	8	8															0	8	2
12/16/2017																											
12/17/2017																											
12/18/2017																											
12/19/2017																											
12/20/2017																											
12/21/2017																											
12/22/2017																											
12/23/2017																											
12/24/2017																											
12/25/2017																											
12/26/2017																											
12/27/2017																											
12/28/2017																											
12/29/2017																											
12/30/2017																											
12/31/2017																											
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	8	14	11	7	12	11	9	16	13	18	13	10	13	16	15	14	7	23	14	12	13	10	12	11		23	
Avg	2	2	3	2	3	2	2	4	4	3	4	3	3	3	3	3	1	4	3	3	3	2	3	3			3

PM2.5[ug/m3] Matrix: Roi Namur Monthly: 09/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 09/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=18

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
9/ 1/ 2017																											
9/ 2/ 2017																											
9/ 3/ 2017																											
9/ 4/ 2017																											
9/ 5/ 2017																											
9/ 6/ 2017																											
9/ 7/ 2017																											
9/ 8/ 2017																											
9/ 9/ 2017																											
9/ 10/ 2017																											
9/ 11/ 2017																											
9/ 12/ 2017																	5	3	0	0	0	0	0	1	0	5	1
9/ 13/ 2017	2	3	2	0	0	3	5	3	2	2	1	0	1	1	5	4	4	5	3	3	3	3	3	5	0	5	2
9/ 14/ 2017	5	1	1	4	4	4	5	4	2	2	4	4	3	3	3	3	3	1	3	4	3	1	5	4	1	5	3
9/ 15/ 2017	2	2	0	1	2	1	4	1	0	1	1	2	2	3	2	1	0	0	1	0	1	0	0	0	0	4	1
9/ 16/ 2017	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	0	0	0	1	0
9/ 17/ 2017	0	0	0	0	0	0	0	1	1	0	0	31	0	0	0	0	0	0	1	1	0	0	2	3	0	31	1
9/ 18/ 2017	1	2	4	2	1	1	0	26	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	0	0	26	1
9/ 19/ 2017	0	1	2	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
9/ 20/ 2017	0	0	0	0	0	0	0	0	0	1	1	0	3	2	2	1	0	1	2	2	2	4	3	3	0	4	1
9/ 21/ 2017	2	0			1	6	6	6	4	6	5	6	6	4	2	1	23	4	3	3	1	2	4	3	0	23	4
9/ 22/ 2017	3	2	0	0	0	2	1	0	1	2	1	0	0	0	0	0	42	7	3	0	0	0	0	0	0	42	2
9/ 23/ 2017	0	0	1	1	0	0	1	4	3			0	0	0	0	0	1	1	1	0	4	7	7	4	0	7	1
9/ 24/ 2017	1	3	3	1	0	3	4	4	2	2	2	5	4	3	2	2	1	2	3	3	4	6	4	5	0	6	2
9/ 25/ 2017	5	4	3	2	1	0	0	2	5	13	7	1	0	15	0	1	1	2	5	5	6	5	9	7	0	15	4
9/ 26/ 2017	8	5	3	2	3	5	5	4	7	6	4	4	3	2	4	1	0	0	0	0	2	1	0	1	0	8	2
9/ 27/ 2017	1	1	0	0	1	1	1	3	4	3	1	0	0	0	2	1	1	1	2	3	4	5	3	5	0	5	1
9/ 28/ 2017	3	3	3	1	1	0	0	5	5	3	0	3	3	3	20	0	0	3	4	2	1	2	4	2	0	20	2
9/ 29/ 2017	31	21	3	1	2	2	2	23	1	1	3	18	3	4	3	1	4	2	20	9	7	6	6	7	1	31	7
9/ 30/ 2017	4	2	1	0	30	1	0	6	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	2	0	30	2
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	31	21	4	4	30	6	6	26	7	13	7	31	6	15	20	4	42	7	20	9	7	7	9	7		42	
Avg	3	2	1	0	2	1	1	5	2	2	1	4	1	2	2	0	4	1	2	2	2	2	2	2			2

PM2.5[ug/m3] Matrix: Roi Namur Monthly: 10/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 10/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=31

DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
10/1/2017	2	2	0	0	0	3	0	0	0	0	0	1	0	0	2	1	0	0	38	6	3	1	2	3	0	38	2
10/2/2017	3	4	3	1	0	0	0	0	0	27	0	0	0	0	0	0	1	0	7	4	1	2	2	7	0	27	2
10/3/2017	3	0	40	1	0	0	0	1	0	0	0	0	0	0	2	1	0	0	34	1	0	0	0	0	0	40	3
10/4/2017	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	5	3	4	36	2	1	0	36	3
10/5/2017	3	2	0	2	4	3	2	3	3	3	46	2	1	2	16	7	3	44	1	2	3	3	5	3	0	46	6
10/6/2017	1	1	1	6	6	5	3	0	0	3	0	0	0	0	0	0	0	0	0	2	3	2	1	2	0	6	1
10/7/2017	3	3	1	0	0	0	2	1	1	1	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	3	0
10/8/2017	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	3	1	0	0	3	3	1	1	0	0	3	0
10/9/2017	3	5	3	2	3	5	3	3	3	6	6	9	6	4	30	1	2	2	4	9	10	9	8	9	1	30	6
10/10/2017	7	8	7	9	8	6	5	4	5	4	1	2	3	2	0	1	3	3	4	7	5	1	0	3	0	9	4
10/11/2017	3	1	2	3	1	3	5	2	3	3	1	2	0	0	0	1	1	0	0	1	3	3	1	0	0	5	1
10/12/2017	1	4	3	3	5	4	1	1	4	2	3	4	2	0	1	1	0	0	0	1	3	1	0	0	0	5	1
10/13/2017	2	2	0	4	5	3	1	1	1	2	2	0	0	1	1	1	2	2	2	3	7	9	9	5	0	9	2
10/14/2017	3	2	0	3	3	4	5	7	8	5	3	2	0	0	0	0	0	0	7	4	0	0	2	2	0	8	2
10/15/2017	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	0	0	2	0
10/16/2017	0	1	0	0	0	3	5	3	1	3	5	2	1	3	2	5	2	1	4	2	3	3	5	3	0	5	2
10/17/2017	4	3	1	3	4	4	4	2	2	2	2	1	1	1	0	0	0	2	3	5	4	0	0	0	0	5	2
10/18/2017	0	0	0	0	0	2	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
10/19/2017	0	1	3	2	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0
10/20/2017	0	1	0	0	0	0	0	1	2	4	4	1	0	0	0	0	0	0	0	1	1	3	4	2	0	4	1
10/21/2017	1	1	0	0	0	2	1	0	0	2	1	0	0	0	0	0	0	0	1	1	1	2	3	2	0	3	0
10/22/2017	1	1	1	1	1	0	12	7	34	0	0	1	3	2	1	0	0	5	3	0	4	3	0	0	0	34	3
10/23/2017	1	3	1	1	46	1	4	4	2	2	1	0	0	0	0	0	0	0	1	3	4	4	3	3	0	46	3
10/24/2017	6	7	6	4	4	6	4	6	5			4	5	4	2	4	5	4	4	5	4	3	1	1	1	7	4
10/25/2017	5	4	2	2	2	3	2	1	2	4	5	2	3	3	2	2	0	1	2	2	1	2	2	1	0	5	2
10/26/2017	1	1	0	1	1	1	5	4	1	1	0	1	1	0	0	0	0	0	0	0	2	5	6	3	0	6	1
10/27/2017	4	3	0	0	0	2	1	0	0	0	1	1	0	0	0	0	0	2	1	1	2	1	2	1	0	4	0
10/28/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
10/29/2017	1	1	0	0	1	3	1	0	0	0	0	0	0	0	0	0	1	0	0	2	1	0	1	1	0	3	0
10/30/2017	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	0	3	0
10/31/2017	0	0	0	1	2	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	7	8	40	9	46	6	12	7	34	27	46	9	6	4	30	7	5	44	38	9	10	36	9	9		46	
Avg	1	1	2	1	3	2	2	1	2	2	2	1	0	0	1	0	0	3	3	2	2	3	1	1			2

PM2.5[ug/m3] Matrix: Roi Namur Monthly: 11/2017 Type: HourOfDay 1 Hr. [1 Hr.]

Report Type: Matrix Avg Type: AVG

Date & Time: 11/2017Time Base: 1 Hr. [1 Hr.] Valid Days=30

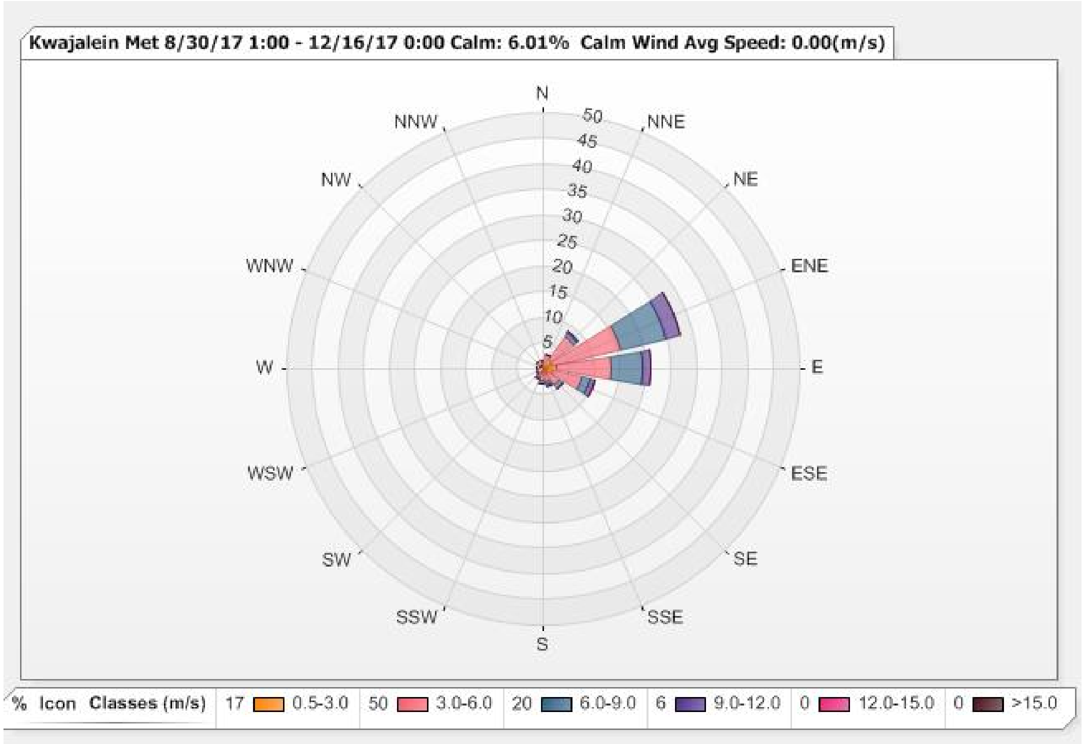
DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
11/1/2017	0	0	0	0	0	0	1	0	0	1	2	3	1	0	0	0	0	4	3	0	0	0	0	1	0	4	0
11/2/2017	1	0	0	0	0	4	4	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	4	0
11/3/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/4/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/5/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/6/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/7/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/8/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/9/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/10/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/11/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	23	0
11/12/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
11/13/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/14/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	4	2	1	0	0	0	4	0
11/15/2017	2	2	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0
11/16/2017	0	0	1	2	2	2	1	3	5	4	2	0	0	0	0	0	0	0	1	4	2	1	3	3	0	5	1
11/17/2017	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0
11/18/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
11/19/2017	0	0	0	0	0	0	0	0	0	1	1	1	0	0	6	6	7	4	0	0	2	3	1	1	0	7	1
11/20/2017	0	0	0	0	0	1	1	1	1	0	0	0	2	2	0	0	3	3	2	6	9	5	3	10	0	10	2
11/21/2017	6	5	5	0	0	1	3	2	0	0				3	3	3	1	3	3	4	3	0	0	1	0	6	2
11/22/2017	3	2	1	28	4	0	0	0	1	1	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	28	1
11/23/2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
11/24/2017	0	0	2	1	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	4	1	0	0	0	0	4	0
11/25/2017	0	0	0	0	0	0	0	0	0	4	2	0	1	3	2	1	0	0	0	5	4	4	1	0	0	5	1
11/26/2017	0	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	3	0
11/27/2017	3	0	2	3	3	1	3	3	4	3	0	0	0	1	2	5	3	1	8	9	8	5	9	7	0	9	3
11/28/2017	10	7	6	7	9	6	6	7	6	6	12	7	10	8	6	11	9	9	7	11	7	5	9	8	5	12	7
11/29/2017	13	8	14	8	5	5	5	3	9	7	7	5	8	6	5	5	7	6	9	7	7	4	6	2	2	14	6
11/30/2017	0	0	0	41	0	0	0	0	1	1	47	4	17	4	5	7	4	4	7	3	1	0	6	3	0	47	6
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	13	8	14	41	9	6	6	7	9	7	47	7	17	8	6	11	23	9	9	11	9	5	9	10		47	
Avg	1	0	1	3	0	0	0	0	0	0	2	0	1	0	1	1	1	1	1	1	1	0	1	1			1

PM2.5[ug/m3] Matrix: Roi Namur Monthly: 12/2017 Type: HourOfDay 1 Hr. [1 Hr.]
Report Type: Matrix Avg Type: AVG
Date & Time: 12/2017 Time Base: 1 Hr. [1 Hr.] Valid Days=11

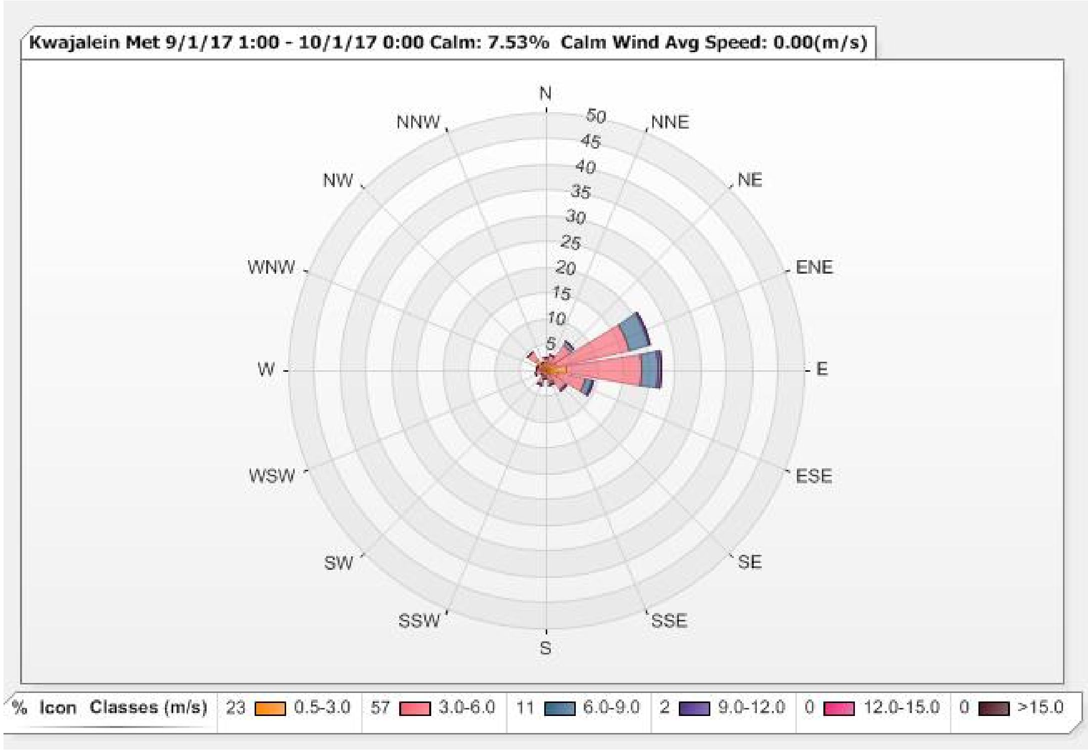
DateTime	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Min	Max	Avg
12/1/2017	1	0	0	7	5	3	1	0	0	0	2	1	0	0	9	5	0	4	1	0	0	0	0	1	0	9	1
12/2/2017	0	8	11	7	4	3	3	8	6	1	0	1	2	3	1	0	0	1	5	3	1	2	2	5	0	11	3
12/3/2017	10	10	9	10	5	2	3	4	4	0	0	0	0	0	0	0	2	3	2	1	1	5	2	2	0	10	3
12/4/2017	5	7	7	4	8	3	0	0	4	6	3	2	2	1	1	0	0	4	5	0	0	0	91	9	0	91	6
12/5/2017	8	6	4	2	1	0	0	1	1	1	5	3	4	3	2	0	4	2	3	3	5	5	4	2	0	8	2
12/6/2017	6	2	5	3	3	4	1	2	2	3	4	13	9	6	4	2	1	0	4	4	16	11	11	7	0	16	5
12/7/2017	5	7	15	4	10	7	2	5	5	5	10	9	6	6	4	0	0	4	3	4	3	1	0	0	0	15	4
12/8/2017	0	2	1	1	1	1	1	5	3	0	0	2	5	3	0	0	3	0	0	0	0	3	3	3	0	5	1
12/9/2017	3	1	0	0	4	5	9	6	7	5	1	4	5	6	6	12	0	0	17	17	11	12	10	9	0	17	6
12/10/2017	16	9	6	5	11	9	9	7	9	11	10	11	10	14	16	9	6	6	7	14	8	14	12	11	5	16	10
12/11/2017	15	7	9	9	14	11	6	3	8	8	13	12	11	8	6	7	9	9	9	5	10	10	8	8	3	15	8
12/12/2017	6	12	12	7	2	6	6	2	8	10	7	6													2	12	7
12/13/2017																											
12/14/2017																											
12/15/2017																											
12/16/2017																											
12/17/2017																											
12/18/2017																											
12/19/2017																											
12/20/2017																											
12/21/2017																											
12/22/2017																											
12/23/2017																											
12/24/2017																											
12/25/2017																											
12/26/2017																											
12/27/2017																											
12/28/2017																											
12/29/2017																											
12/30/2017																											
12/31/2017																											
Min	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Max	16	12	15	10	14	11	9	8	9	11	13	13	11	14	16	12	9	9	17	17	16	14	91	11		91	
Avg	6	5	6	4	5	4	3	3	4	4	4	5	4	4	4	3	2	3	5	4	5	5	13	5			5

Appendix B – Wind Roses

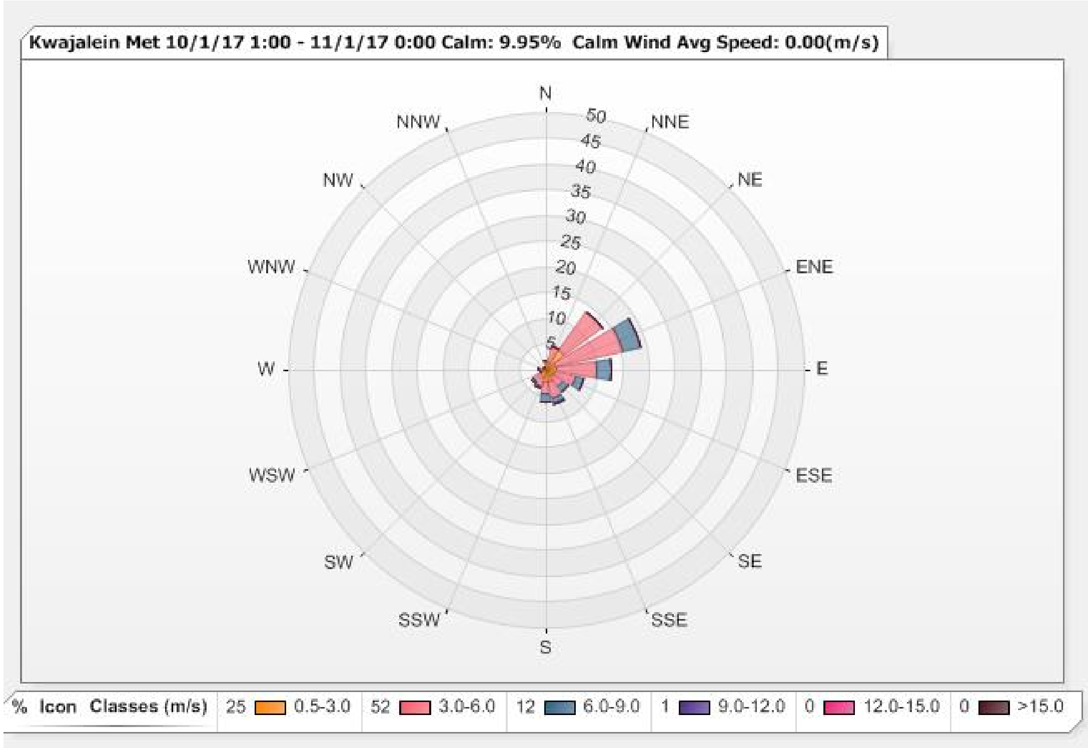
Program - August 30, 2017 - December 15, 2017



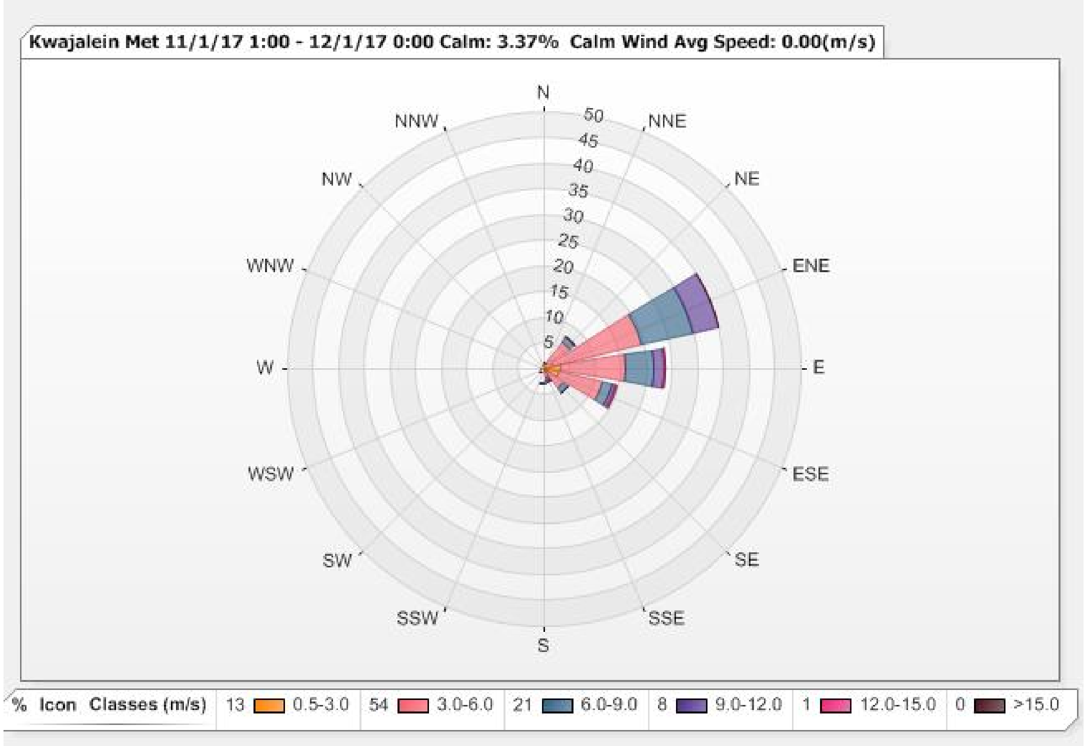
September 2017



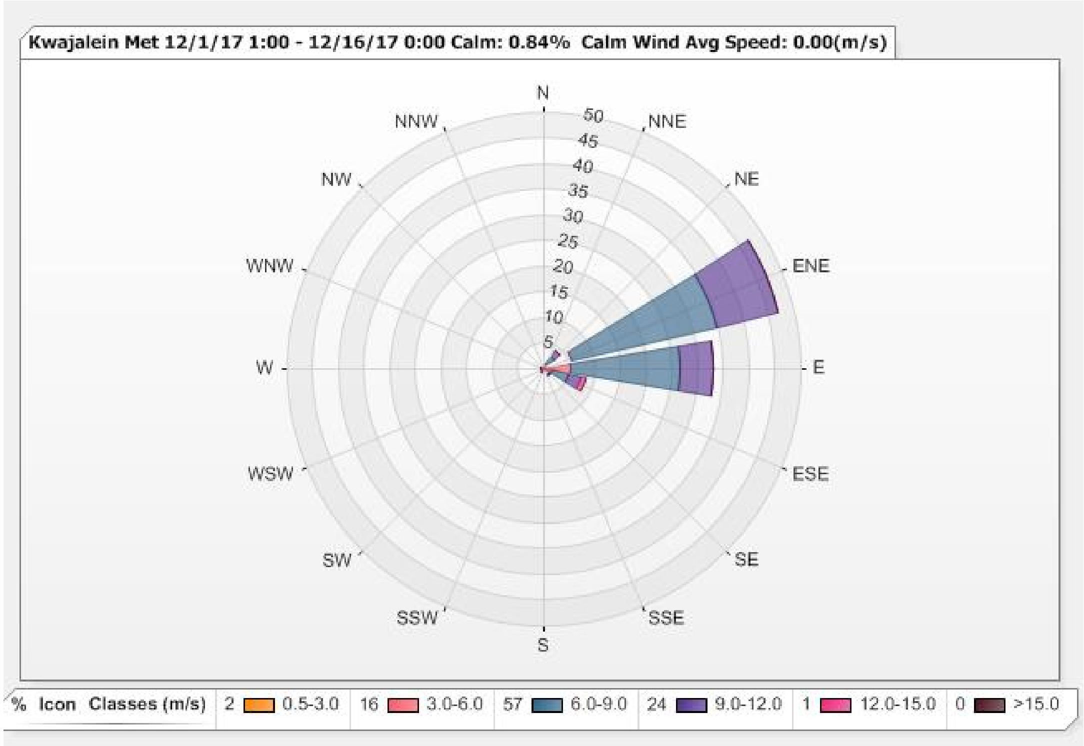
October 2017



November 2017



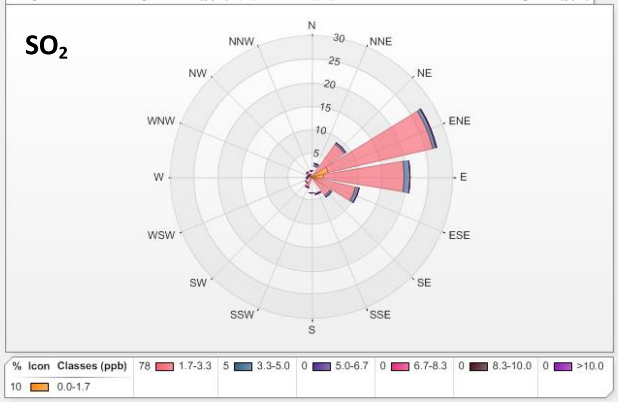
December 2017 (December 1 – 15)



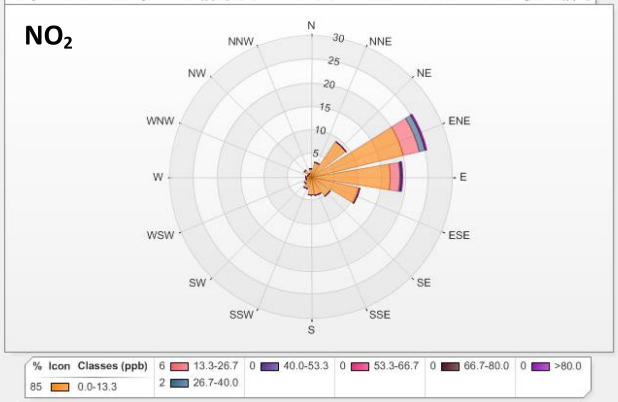
Appendix C – Pollution Roses

Air Monitoring Station Location and Pollution Roses - Kwajalein

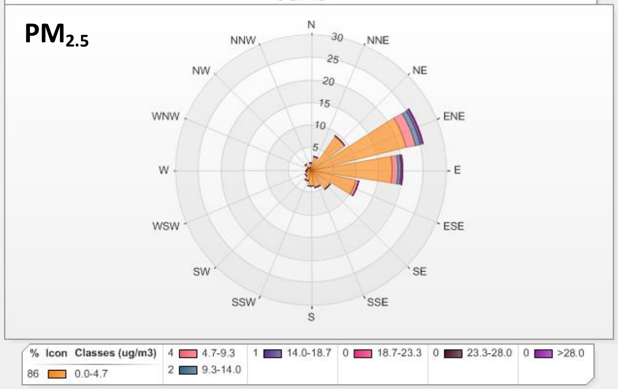
Kwajalein Met Poll.: Kwajalein-SO2[ppb] 8/1/17 1:00 - 1/1/18 0:00 Calm: 6.23% Calm Poll Avg: 2.28[ppb]



Kwajalein Met Poll.: Kwajalein-NO2[ppb] 8/1/17 1:00 - 1/1/18 0:00 Calm: 7.05% Calm Poll Avg: 0.60[ppb]

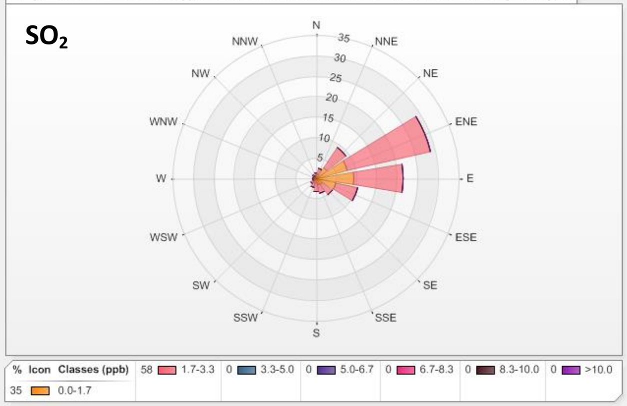


Kwajalein Met Poll.: Kwajalein-PM2.5[ug/m3] 8/1/17 1:00 - 1/1/18 0:00 Calm: 6.53% Calm Poll Avg: -0.06 [ug/m3]

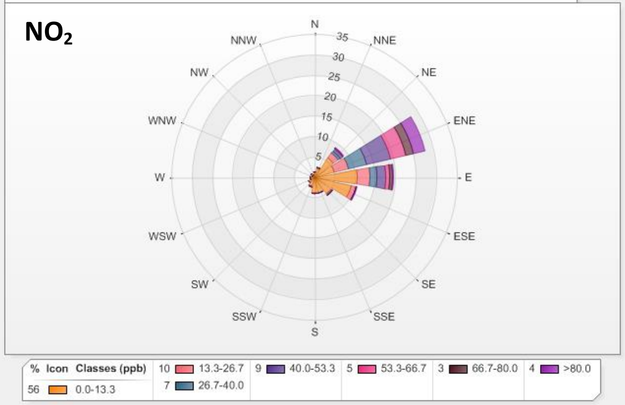


Air Monitoring Station Location and Pollution Roses - Meck

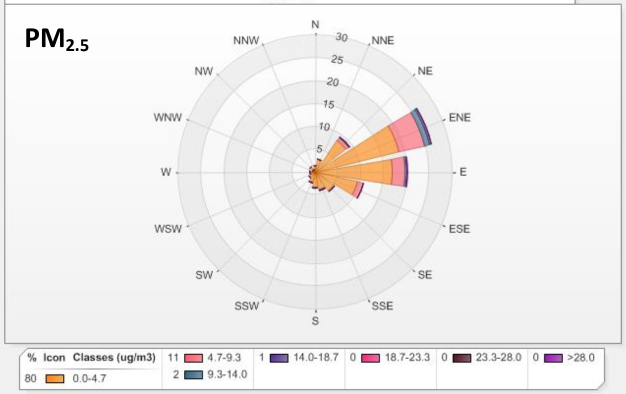
Kwajalein Met Poll.: Meck-SO2[ppb] 8/1/17 1:00 - 1/1/18 0:00 Calm: 6.08% Calm Poll Avg: 1.80[ppb]



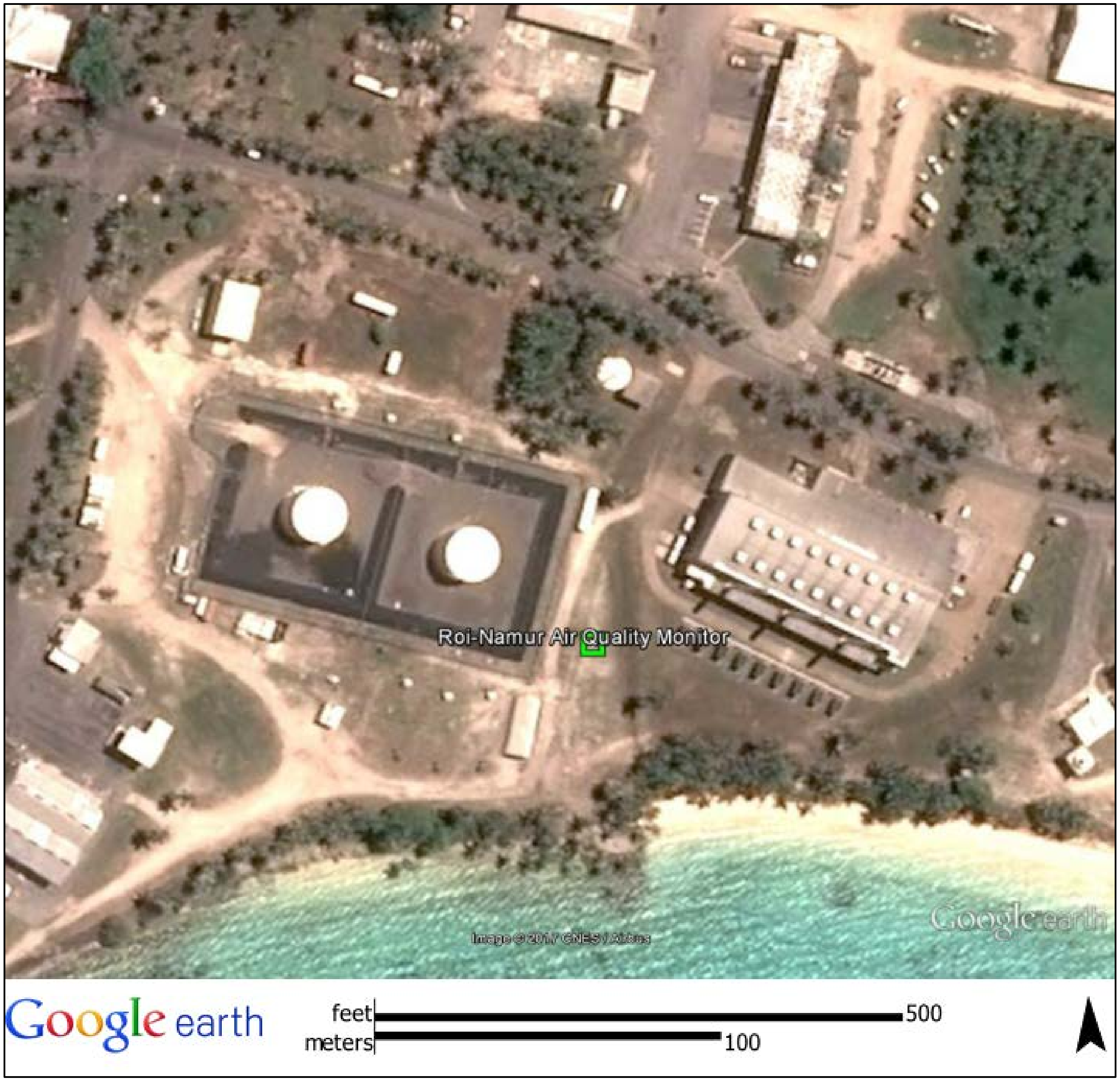
Kwajalein Met Poll.: Meck-NO2[ppb] 8/1/17 1:00 - 1/1/18 0:00 Calm: 6.17% Calm Poll Avg: 1.90[ppb]

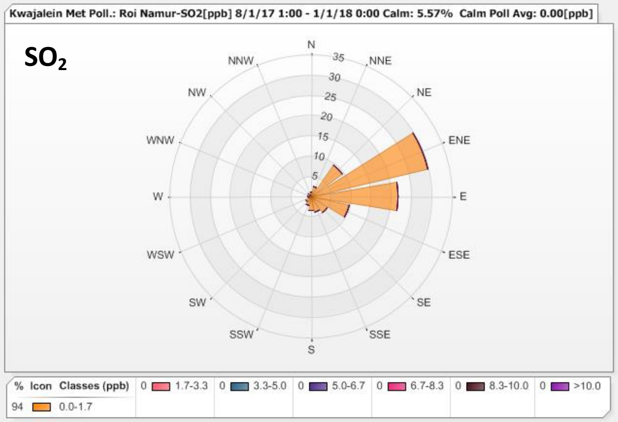


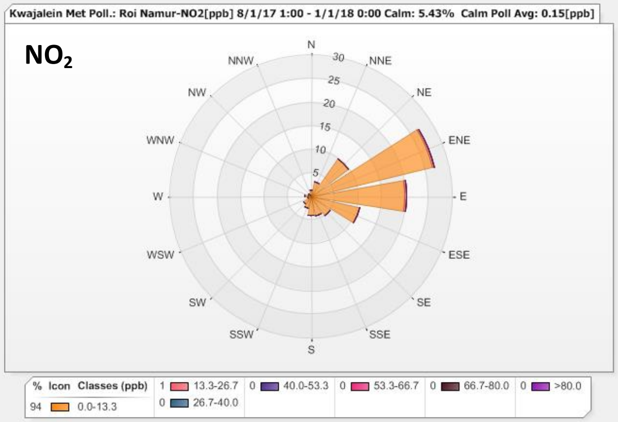
Kwajalein Met Poll.: Meck-PM2.5[ug/m3] 8/1/17 1:00 - 1/1/18 0:00 Calm: 6.43% Calm Poll Avg: 0.53 [ug/m3]

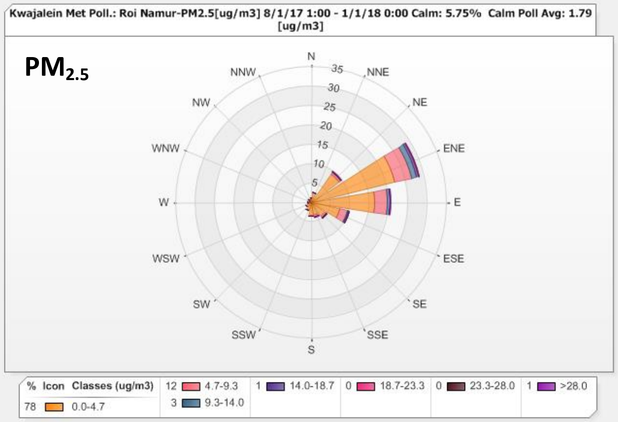


Air Monitoring Station Location and Pollution Roses – Roi-Namur









Appendix D – Elevated Hourly NO_2 Concentrations

Kwajalein – NO_2 AAQS Exceedance Summary

Date/Time	Hourly Concentrations Measured Greater than 80 ppb	Wind Conditions
10/24/17 10:00AM	95	E – 15.0 mph
10/24/17 11:00AM	87	E – 13.9 mph
10/24/17 12:00PM	81	ENE – 13.9 mph
10/24/17 1:00PM	90	E – 13.9 mph
10/24/17 2:00PM	92	ENE – 12.8 mph
10/24/17 3:00PM	84	ENE – 13.9 mph
10/24/17 4:00PM	85	ENE – 12.8 mph

Definitions:

AAQS – Ambient Air Quality Standard
NO_2 – nitrogen dioxide
ppb – parts per billion

Notes:

- The USAKA AAQS are set to 80% of the U.S. NAAQS.
- The 1-hour primary standard is met when the three-year average of the annual (99th percentile) of the daily maximum 1-hour concentrations is less than or equal to 80 ppb, as determined in accordance with 40 CFR 50 Appendix S.

Meck – NO_2 AAQS Exceedance Summary

Date/Time	Hourly Concentrations Measured Greater than 80 ppb	Wind Conditions
11/28/17 2:00PM	88	ENE – 21.9 mph
11/28/17 4:00PM	95	ENE – 20.8 mph
11/28/17 6:00PM	90	ENE – 23.0 mph
11/28/17 7:00PM	86	NE – 23.0 mph
11/28/17 8:00PM	84	ENE – 23.0 mph
11/28/17 9:00PM	88	ENE – 25.3 mph
11/28/17 10:00PM	84	ENE – 26.4 mph
11/28/17 11:00PM	81	ENE – 19.7 mph
11/29/17 12:00AM	84	ENE – 19.7 mph
11/29/17 4:00AM	93	ENE – 24.2 mph
11/29/17 6:00AM	87	ENE – 20.8 mph
11/29/17 7:00AM	84	ENE – 21.9 mph
11/29/17 9:00AM	84	ENE – 19.7 mph
11/29/17 10:00AM	102	NE – 18.3 mph
11/29/17 11:00AM	100	ENE – 20.8 mph
11/29/17 12:00PM	124	ENE – 20.8 mph
11/29/17 1:00PM	117	NE – 21.9 mph
11/29/17 2:00PM	122	ENE – 18.3 mph
11/29/17 3:00PM	105	ENE – 20.8 mph
11/29/17 4:00PM	115	ENE – 20.8 mph
11/29/17 5:00PM	93	ESE – 19.7 mph
11/29/17 6:00PM	93	E – 13.9 mph
12/1/17 12:00PM	113	ENE – 17.2 mph
12/1/17 1:00PM	124	ENE – 17.2 mph
12/1/17 2:00PM	129	NE – 18.3 mph
12/1/17 3:00PM	83	ENE – 17.2 mph
12/2/17 12:00AM	89	NE – 21.9 mph
12/2/17 8:00AM	88	ENE – 23.0 mph
12/2/17 9:00AM	108	ENE – 19.7 mph
12/2/17 10:00AM	120	ENE – 20.8 mph
12/2/17 11:00AM	108	ENE – 19.7 mph
12/2/17 12:00PM	110	ENE – 19.7 mph
12/2/17 2:00PM	81	E – 19.7 mph
12/3/17 10:00PM	93	ENE – 16.1 mph
12/3/17 11:00PM	108	ENE – 17.2 mph
12/4/17 2:00AM	90	ENE – 13.9 mph
12/4/17 6:00AM	84	ENE – 16.1 mph
12/4/17 7:00AM	82	ENE – 18.3 mph

Meck – NO_2 AAQS Exceedance Summary (continued)

Date/Time	Hourly Concentrations Measured Greater than 80 ppb	Wind Conditions
12/4/17 2:00PM	85	ENE – 13.9 mph
12/4/17 5:00PM	86	ESE – 16.1 mph
12/4/17 6:00PM	88	ESE – 12.8 mph
12/5/17 12:00PM	86	ENE – 17.2 mph
12/5/17 1:00PM	119	E – 18.3 mph
12/5/17 4:00PM	86	ENE – 16.1 mph
12/5/17 5:00PM	92	ENE – 18.3 mph
12/5/17 6:00PM	95	ENE – 16.1 mph
12/5/17 7:00PM	105	E – 16.1 mph
12/5/17 9:00PM	96	ENE – 15.0 mph
12/5/17 11:00PM	83	E – 13.9 mph
12/6/17 12:00AM	85	E – 17.2 mph
12/8/17 2:00PM	82	ENE – 12.8 mph
12/8/17 3:00PM	86	ENE – 9.2 mph
12/9/17 2:00PM	88	ENE – 20.8 mph
12/9/17 3:00PM	88	ENE – 19.7 mph
12/9/17 5:00PM	85	ENE – 21.9 mph
12/9/17 6:00PM	93	ENE – 20.8 mph
12/9/17 11:00PM	83	ENE – 21.9 mph
12/10/17 6:00AM	82	ENE – 20.8 mph
12/10/17 7:00AM	82	ENE – 17.2 mph
12/10/17 2:00PM	89	ENE – 16.1 mph
12/10/17 11:00PM	97	ENE – 16.1 mph
12/11/17 3:00AM	83	ENE – 24.2 mph
12/11/17 6:00AM	81	ENE – 23.0 mph
12/11/17 12:00PM	93	ENE – 21.9 mph
12/11/17 1:00PM	98	ENE – 20.8 mph
12/11/17 2:00PM	91	ENE – 21.9 mph
12/11/17 3:00PM	95	ENE – 20.8 mph
12/13/17 2:00PM	82	ENE – 19.7 mph
12/13/17 3:00PM	84	ENE – 19.7 mph

Definitions:

AAQS – Ambient Air Quality Standard
NO_2 – nitrogen dioxide
ppb – parts per billion

Notes:

- The USAKA AAQS are set to 80% of the U.S. NAAQS.
- The 1-hour primary standard is met when the three-year average of the annual (99th percentile) of the daily maximum 1-hour concentrations is less than or equal to 80 ppb, as determined in accordance with 40 CFR 50 Appendix S.

Appendix E – Quality Assurance Quality Control Documentation

Kwajalein

Kwajalein Calibration Checks

Parameter	Calibration Check	Date Completed
SO_2	Startup Calibration	8/30/17
	Precision/Level 1	9/8/17
	Precision/Level 1	9/17/17
	Precision/Level 1	10/8/17
	Precision/Level 1	10/23/17
	Precision/Level 1	11/2/17
	Precision/Level 1	11/14/17
	Multi-point Verification	11/22/17
	Precision/Level 1	12/5/17
	Shutdown Multi-point Verification	12/13/17
NO_2	Startup Calibration	8/30/17
	Precision/Level 1	9/8/17
	Multi-point Verification	9/14/17
	Precision/Level 1	9/17/17
	Precision/Level 1	10/8/17
	Precision/Level 1	10/23/17
	Multi-point Calibration	11/8/17
	Precision/Level 1	11/14/17
	Multi-point Verification	11/20/17
	Multi-point Calibration	12/5/17
	Shutdown Multi-point Verification	12/13/17
$PM_{2.5}$	One-point flow rate verification	8/30/17
	One-point flow rate verification	10/23/17
	Zero Check	12/8/17 – 12/10/17
	One-point Flow Rate Verification	12/13/17

Definitions:

NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
SO_2 – sulfur dioxide (measured in parts per billion)

SO2 StarTup

(KRS)

Gas Dilution Calibration

Network: Marshall Islands **Site:** Kwaj **Instrument:** Thermo 43A **S/N:** 31270-240 **Date:** 8/30/17

Calibrator: Thermo 143 **S/N:** 14023-144 **Cal Date:** 8/30/17 **Cylinder S/N:** N/A **Conc.(ppm)** N/A **Date:** N/A

permeation Tube 33-52577 rate 2631.74

Initial: Zero Pot 0.70 Span Pot 2.20

Final: Zero Pot 0.76 Span Pot 2.90

Precision and Level One Check ☐

Multipoint Calibration StarTup ☒

Other ☐

DAS: Campbell Scientific

Strip Chart: N/A

Time Off: ____ **On:** ____

Flow Setting Ball HT.		SS Flow (cc/min)		Input	Initial Analyzer DAS Response			Final Analyzer DAS Response		Strip Chart Percent Full Scale		Final Δ%
Span	Dilution	Span	Dilution	(ppm)	(Vdc)	(ppm) B	Δ %	(Vdc)	(ppm)	Initial	Final	(≤ 10%)
ZERO	= charcoal	purifill	canister	00.0	0.02	2.0						0.4%
	2.65		2,234	450	4.51	4.51	start up			N/A		0.2%
	4.96		4468	225	2.28	228					1.3	~~2.8%~~ 4N
	12.8		11,910	84	81	81						-3.6%
	SS Ball HT											

Average Δ% ~~+2.2%~~ -0.7%

Standards Comparison

Network Calibrator: Metronics **S/N:** 885 **Cal Date:** 5/2/16

perm tube ~~Cylinder~~: 2522.21 ug **S/N:** 33-52576 **Cal Date:** ____

	Reference Calibrator			Network Calibrator			
Input	Span	Dilution	Response	Span	Dilution	Response	Δ%
	N/A			134	10.4	134	0
					Top		

Signature:

QC Review: 9/15/17

Accepted ☑ Rejected ☐

SO2

(KRS) P&L

Gas Dilution Calibration

Network: Marshall Islands **Site:** Kwaj **Instrument:** Thermo 43A **S/N:** 31270-240 **Date:** 9/8/17

Calibrator: Thermo 143 **S/N:** 14023-144 **Cal Date:** 8/30/17 Perm tube ~~**Gylinder S/N:**~~ ______ **Conc.(ppm)** ______ **Date:** ______

Initial: Zero Pot 2.91 Span Pot 0.71

Final: Zero Pot 2.91 Span Pot 1.46

Precision and Level One Check ☒

Multipoint Calibration ☐

Other ☐

DAS: Camp Bell Scientific

Strip Chart: N/A

Time Off: 11:00 **On:** ______

Flow Ball Setting HT.		Flow (cc/min)		Input ppB	Initial Analyzer DAS Response			Final Analyzer DAS Response		Strip Chart Percent Full Scale		Final Δ%
Span	Dilution	Span	Dilution	~~(ppm)~~	(Vdc)	~~(ppm)~~ B	Δ %	(Vdc)	(ppm)	Initial	Final	(≤ 10%)
SS Ball	12.8	Top	11,910	84	0.81	81	-3.6					-3.6 ✓
ZERO	charcoal purcifull		0.5cc/m	0.00	0.01	1						
SS	2.65	Tol	2,234.05	450	4.40	440	-2.2					-2.2 ✓
Ball								450	450			0
								adjusted				

Average Δ% -2.9

Standards Comparison

Network Calibrator: ______ **S/N:** ______ **Cal Date:** ______

Cylinder: ______ **S/N:** ______ **Cal Date:** ______

	Reference Calibrator			Network Calibrator			
Input	Span	Dilution	Response	Span	Dilution	Response	Δ%
			N/A				

Signature: Robert [illegible]

QC Review: William [illegible] 9/15/17

Accepted ☒ **Rejected** ☐

AECOM
325 Ayer Road Harvard, MA. 01451
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SO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Kwajalein **Date:** 9/17/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 31270-240

	Initial	Final	
Backgrnd	2.9	2.9	
Span Coef	1.43	1.43	
Flow	0.425	0.425	LPM
Vacuum	19.8	19.8	in/Hg
Lamp Volts	N/A	N/A	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 10/2/2017 **SN:** 14023-144
Glass M= **0.5471** B= **-0.2866**
Steel M= **0.9850** B= **-0.5533**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 33-52577 **Rate:** 2631.74
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 12:38 **Time On:** 13:31
DAS: CR1000 S/N: 20103
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		SO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	N/A	N/A	n/a	.0020	0.014	n/a	**N/A**	**N/A**
2,234	**2.23**	**4.61**	**2.83**	.4500	N/A	N/A	n/a	.4515	4.646	n/a	**N/A**	**0.3%**
4,468	**4.47**	**8.69**	**5.10**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
8,378	**8.38**	**15.84**	**9.07**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
12,186	**12.19**	**22.80**	**12.93**	.0825	N/A	N/A	n/a	.0825	0.783	n/a	**N/A**	**0.0%**

	Initial		Final
M =	**#DIV/0!**	M =	**1.00047**
B =	**#DIV/0!**	B =	**0.00108**
Corr. =	**#DIV/0!**	Corr. =	**0.99999**

Average %
N/A **0.1%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/10/17

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Kwajalein	**Date:**	10/8/2017	**Initial / Final:**		**QTR 1234**

Instrument:	Thermo Scientific Model 43A		
SN:	31270-240		
	Initial	Final	
Backgrnd	N/A	2.9	
Span Coef	N/A	1.43	
Flow	N/A	0.425	LPM
Vacuum	N/A	19.8	in/Hg
Lamp Volts	N/A	N/A	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	10/2/2017	**SN:**	14023-144
Glass M=	0.5471	B=	-0.2866
Steel M=	0.9850	B=	-0.5533
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	33-52577	**Rate:**	2631.74
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	19:55	**Time On:**	20:15
DAS:	CR1000	S/N:	20103
Strip Chart:		S/N:	
Precision & Level One:	X		
Multipoint Calibration:			
Audit:	X		
Other:			

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	N/A	N/A	n/a	.0010	0.010	n/a	**N/A**	**N/A**
2,234	**2.23**	**4.61**	**2.83**	.4500	N/A	N/A	n/a	.4700	4.705	n/a	**N/A**	**4.4%**
4,468	**4.47**	**8.69**	**5.10**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
8,378	**8.38**	**15.84**	**9.07**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
12,186	**12.19**	**22.80**	**12.93**	.0825	N/A	N/A	n/a	.0770	0.771	n/a	**N/A**	**-6.7%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 11/21/17

M =	**#DIV/0!**	M =	**1.05048**
B =	**#DIV/0!**	B =	**-0.00379**
Corr. =	**#DIV/0!**	Corr. =	**0.99977**

Average %

N/A	**-0.6%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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SO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Kwajalein	**Date:**	10/23/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	31270-240		
	Initial	**Final**	
Backgrnd	2.9	2.9	
Span Coef	1.43	1.43	
Flow	0.425	0.425	LPM
Vacuum	19.8	19.8	in/Hg
Lamp Volts	N/A	N/A	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	10/2/2017	**SN:**	14023-144
Glass M=	**0.5471**	B=	**-0.2866**
Steel M=	**0.9850**	B=	**-0.5533**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	33-52577	**Rate:**	2631.74
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**12:38**	**Time On:**	**13:31**
DAS:	CR1000	S/N:	20103
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	N/A	N/A	n/a	.0014	0.014	n/a	**N/A**	**N/A**
2,234	**2.23**	**4.61**	**2.83**	.4500	N/A	N/A	n/a	.4646	4.646	n/a	**N/A**	**3.2%**
4,468	**4.47**	**8.69**	**5.10**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
8,378	**8.38**	**15.84**	**9.07**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
12,186	**12.19**	**22.80**	**12.93**	.0825	N/A	N/A	n/a	.0783	0.783	n/a	**N/A**	**-5.1%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 11/21/17

.

M =	**#DIV/0!**	M =	**1.03595**
B =	**#DIV/0!**	B =	**-0.00244**
Corr. =	**#DIV/0!**	Corr. =	**0.99985**

Average %	
N/A	**-0.9%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

Gas Dilution Calibration

Network: Kwajalein Atoll **Site:** Kwaj **Instrument:** Teco 43A **S/N:** 31270-240 **Date:** 11-2-2017

Calibrator: 143 **S/N:** 14023-144 **Cal Date:** ______ **Cylinder S/N:** ______ **Conc.(ppm)** ______ **Date:** ______

~~**Initial:** **Zero Pot**~~ ______ **Span Pot** ______

Final: **Zero Pot** 2.9 **Span Pot** 1.44

Precision and Level One Check ☒

Multipoint Calibration ☐

Other ☐

DAS: ______

Strip Chart: ______

Time Off: 0645 **On:** 0700

Flow Setting		Flow (cc/min)		Input	Initial Analyzer DAS Response			Final Analyzer DAS Response		Strip Chart Percent Full Scale		Final Δ%
Span	Dilution	Span	Dilution	(ppm)	(Vdc)	(ppm)	Δ %	(Vdc)	(ppm)	Initial	Final	(≤ 10%)
steel Ball	13.0 top of Ball			.082		.076	-7.3 AC	0.765	.0764			-6.8 AC
glass Ball	4.6 Top of Ball			.450				4.497	.4499			-0.0

Average Δ% ______

Standards Comparison

Network Calibrator: ______ **S/N:** ______ **Cal Date:** ______

Cylinder: ______ **S/N:** ______ **Cal Date:** ______

	Reference Calibrator			Network Calibrator			
Input	Span	Dilution	Response	Span	Dilution	Response	Δ%

Signature: Tim Mierop AC

QC Review: Arthur Carpenter 12/21/17

Accepted ☑ **Rejected** ☐

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SO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Kwajalein **Date:** 11/14/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 31270-240

	Initial	Final	
Backgrnd	2.9	2.9	
Span Coef	1.43	1.43	
Flow	0.425	0.425	LPM
Vacuum	19.8	19.8	in/Hg
Lamp Volts	N/A	958	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 10/2/2017 **SN:** 14023-144
Glass M= **0.5471** B= **-0.2866**
Steel M= **0.9850** B= **-0.5533**

DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 33-52577 **Rate:** 2631.74
Perm. Oven Temp: 35 **Expiration:**

Comments: ot to down channel, need to use 1 min
Time Off: 9:45 **Time On:** 10:10
DAS: CR1000 **S/N:** 20103
Strip Chart: **S/N:**
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	N/A	N/A	n/a	.0017	0.028	n/a	**N/A**	**N/A**
2,234	**2.23**	**4.61**	**2.83**	.4500	N/A	N/A	n/a	.4534	4.500	n/a	**N/A**	**0.8%** ✓
4,468	**4.47**	**8.69**	**5.10**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
8,378	**8.38**	**15.84**	**9.07**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
12,186	**12.19**	**22.80**	**12.93**	.0825	N/A	N/A	n/a	.0796	0.792	n/a	**N/A**	**-3.5%** ✓

	Initial	Final
M =	**#DIV/0!**	**1.00784**
B =	**#DIV/0!**	**-0.00066**
Corr. =	**#DIV/0!**	**0.99994**

Average %

N/A	~~**-0.7%**~~

-1.4%

Operator: Tim Mierop

QC Review: 12/21/17

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

AECOM

SO2 PERMEATION CALIBRATION

AECOM
325 Ayer Road Harvard, MA. 01451
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www.aecom.com

Network: Kwajalein Range Svcs **Site:** Kwajalein **Date:** 11/22/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 31270-240

	Initial	Final	
Backgrnd	N/A	2.9	
Span Coef	N/A	1.43	
Flow	N/A	0.425	LPM
Vacuum	N/A	19.8	in/Hg
Lamp Volts	N/A	958	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 11/20/2017 **SN:** 14023-144
Glass M= 0.5690 B= -0.4127
Steel M= 1.0041 B= -0.6030
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 33-52577 **Rate:** 2631.74
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 11:30 **Time On:** 11:50
m
DAS: CR1000 S/N: 20103
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.73**	**0.60**	.0000	N/A	N/A	n/a	.0021	0.020	n/a	**N/A**	**N/A**
2,234	**2.23**	**4.65**	**2.83**	.4500	N/A	N/A	n/a	.4515	4.510	n/a	**N/A**	**0.3%**
4,468	**4.47**	**8.58**	**5.05**	.2250	N/A	N/A	n/a	.2075	2.076	n/a	**N/A**	**-7.8%**
8,378	**8.38**	**15.45**	**8.94**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
12,186	**12.19**	**22.14**	**12.74**	.0825	N/A	N/A	n/a	.0802	0.805	n/a	**N/A**	**-2.8%**

Operator: Tim Mierop

QC Review:

M =	**#DIV/0!**	M =	**0.99670**
B =	**#DIV/0!**	B =	**-0.00343**
Corr. =	**#DIV/0!**	Corr. =	**0.99892**

Average %

N/A	~~**-2.6%**~~

-3.4%

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

SO2 PERMEATION CALIBRATION

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Network:	Kwajalein Range Svcs	**Site:**	Kwajalein	**Date:**	12/5/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	31270-240		
	Initial	**Final**	
Backgrnd	N/A	2.9	
Span Coef	N/A	1.43	
Flow	N/A	0.425	LPM
Vacuum	N/A	19.8	in/Hg
Lamp Volts	N/A	958	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	11/20/2017	**SN:**	14023-144
Glass M=	**0.5690**	B=	**-0.4127**
Steel M=	**1.0041**	B=	**-0.6030**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	33-52577	**Rate:**	2631.74
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**14:05**	**Time On:**	**14:36**
	m		
DAS:	CR1000	S/N:	20103
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.73**	**0.60**	.0000	N/A	N/A	n/a	.0023	0.023	n/a	**N/A**	**N/A**
2,234	**2.23**	**4.65**	**2.83**	.4500	N/A	N/A	n/a	.4515	4.510	n/a	**N/A**	**0.3%**
4,468	**4.47**	**8.58**	**5.05**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
8,378	**8.38**	**15.45**	**8.94**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
12,186	**12.19**	**22.14**	**12.74**	.0825	N/A	N/A	n/a	.0767	0.767	n/a	**N/A**	**-7.0%**

Operator: Robert Sicard

QC Review: William Van Eck 12/21/17

M =	**#DIV/0!**	M =	**1.00480**
B =	**#DIV/0!**	B =	**-0.00152**
Corr. =	**#DIV/0!**	Corr. =	**0.99984**

Average %	
N/A	**-3.3%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

AECOM

SO2 PERMEATION CALIBRATION

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Network:	Kwajalein Range Svcs	**Site:**	Kwajalein	**Date:**	12/13/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	31270-240		
	Initial	**Final**	
Backgrnd	N/A	2.9	
Span Coef	N/A	1.43	
Flow	N/A	0.425	LPM
Vacuum	N/A	19.8	in/Hg
Lamp Volts	N/A	958	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	11/20/2017	**SN:**	14023-144
Glass M=	**0.5690**	B=	**-0.4127**
Steel M=	**1.0041**	B=	**-0.6030**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	33-52577	**Rate:**	2631.74
Perm. Oven Temp:	35	**Expiration:**	

Comments:	Final take down Calibration		
Time Off:	**8:45**	**Time On:**	**9:10**
	m		
DAS:	CR1000	S/N:	20103
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:	X		
Audit:	X		
Other:			

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.73**	**0.60**	.0000	N/A	N/A	n/a	.0010	0.061	n/a	**N/A**	**N/A**
2,234	**2.23**	**4.65**	**2.83**	.4500	N/A	N/A	n/a	.4590	4.590	n/a	**N/A**	**2.0%**
4,468	**4.47**	**8.58**	**5.05**	.2250	N/A	N/A	n/a	.2210	2.213	n/a	**N/A**	**-1.8%**
8,378	**8.38**	**15.45**	**8.94**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
12,186	**12.19**	**22.14**	**12.74**	.0825	N/A	N/A	n/a	.0765	0.765	n/a	**N/A**	**-7.3%**

Operator: Robert Sicard

QC Review: William Van Eck 12/21/17

M =	**#DIV/0!**	M =	**1.02279**
B =	**#DIV/0!**	B =	**-0.00432**
Corr. =	**#DIV/0!**	Corr. =	**0.99970**

Average %	
N/A	**-2.4%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

NO2 StarTup

(KRS)

Gas Dilution Calibration

Network: Marshall Island **Site:** Kwaj **Instrument:** Thermo 42 **S/N:** 42981-268 **Date:** 8/30/17

Calibrator: Thermo 143 **S/N:** 14023-144 **Cal Date:** 8/30/17 Perm Tube ~~**Cylinder**~~ **S/N:** 1739.84 ng/min ~~**Conc.(ppm)**~~ ____ **Date:** ____

Initial: Zero Pot ____ Span Pot ____ NA

Final: Zero Pot ____ Span Pot ____ NA

Precision and Level One Check ☐

Multipoint Calibration StarTup ☒

Other ☐

DAS: CampBell Scientific

Strip Chart: NA

Time Off: ____ **On:** ____

Flow Setting SS Ball		Flow (cc/min)		PPB Input	Initial Analyzer DAS Response			Final Analyzer DAS Response		Strip Chart Percent Full Scale		Final Δ%
Span	Dilution	Span	Dilution	(ppm) B	(Vdc)	(ppm)	Δ %	(Vdc)	(ppm)	Initial	Final	(≤ 10%)
ZERO	Charcoal port fill	Instrument canister	500cc/min	0.00	0.01	0.1						
SS ball	2.47		2,036.88	450	4.54	454						0.9%
Top	4.59		4,113.76	225	2.26	226						0.4%
	12.28		11,569.94	080	0.81	81						1.3%

Average Δ% +0.9%

Standards Comparison

Network Calibrator: M-885 **S/N:** Metronics **Cal Date:** 8/30/17

Perm Tube **Cylinder:** 1739.84 **S/N:** 5952582 **Cal Date:** ____

	Reference Calibrator			Network Calibrator			
Input	Span	Dilution	Response	Span	Dilution	Response	Δ%

Signature:

QC Review: 9/15/17

Accepted ☑ Rejected ☐

P&L NO2

Gas Dilution Calibration

Network: Marshall Islands **Site:** Kwaj **Instrument:** Thermo 42 **S/N:** 42981-268 **Date:** 9/8/17

Calibrator: Thermo 143 **S/N:** 14023-144 **Cal Date:** 8/30/17 Perm Tube ~~**Cylinder S/N:**~~ 1739.84 **Conc.(ppm)** NA **Date:**

Initial: Zero Pot NA Span Pot N/A

Final: Zero Pot Span Pot

Precision and Level One Check ☒

Multipoint Calibration ☐

Other ☐

DAS:

Strip Chart: N/A

Time Off: 11:40 **On:** 12:00

Flow Setting		Flow (cc/min)		PPB Input	Initial Analyzer DAS Response			Final Analyzer DAS Response		Strip Chart Percent Full Scale		Final Δ%
Span	Dilution	Span	Dilution	(ppm) B	(Vdc)	(ppm)	Δ %	(Vdc)	(ppm)	Initial	Final	(≤ 10%)
SS Ball	12.28		11,569.94	80	0.84	84						5.0% ✓
top	charcoal / purafill	Canister	ZERO	0.00	0.03	.3						
	12.47		2,056.88	450	4.64	464						3.1% ✓
	2.47											

Average Δ% 4.1

Standards Comparison

Network Calibrator: **S/N:** **Cal Date:**

Cylinder: **S/N:** **Cal Date:**

	Reference Calibrator			Network Calibrator			
Input	Span	Dilution	Response	Span	Dilution	Response	Δ%
			N/A				

Signature:

QC Review: Willi Vald 9/15/17

Accepted ☑ **Rejected** ☐

AECOM

NO2 PERMEATION CALIBRATION

AECOM
325 Ayer Road Harvard, MA. 01451
T 978.772.2345 F 978.772.4956
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Network: Kwajalein Range Svcs **Site:** Kwajalein **Date:** 9/14/2017 **Initial / Final:** QTR 1234

Instrument:	Thermo Scientific Model 42		
SN:			
	Initial	Final	
Backgrnd		b16.4, b26.6	
Span Coef		sf 1, bf0.976	
Flow			LPM
Vacuum			mm/Hg
Lamp Volts			(800-1200)
PMT Volts			

Calibrator:	Thermo 143		
Cert. Date:	10/2/2017	**SN:**	0
Glass M=	**0.5471**	B=	**-0.2866**
Steel M=	**0.9850**	B=	**-0.5533**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52582	**Rate:**	1739.84
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	13:03	**Time On:**	13:48
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	N/A	N/A	n/a	.0000	0.000	n/a	**N/A**	**N/A**
2,057	**2.06**	**4.28**	**2.65**	.4500	N/A	N/A	n/a	.4550	5.000	n/a	**N/A**	**1.1%**
4,628	**4.63**	**8.98**	**5.26**	.2000	N/A	N/A	n/a	.1940	2.267	n/a	**N/A**	**-3.0%**
7,713	**7.71**	**14.62**	**8.39**	.1200	N/A	N/A	n/a	.1160	N/A	n/a	**N/A**	**-3.3%**
11,570	**11.57**	**21.67**	**12.31**	.0800	N/A	N/A	n/a	.0780	0.768	n/a	**N/A**	**-2.5%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/10/17

M =	**#DIV/0!**	M =	**1.01347**
B =	**#DIV/0!**	B =	**-0.00369**
Corr. =	**#DIV/0!**	Corr. =	**0.99980**

Average %

N/A	**-1.9%**

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

AECOM
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NO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Kwajalein **Date:** 9/17/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN:

	Initial	Final	
Backgrnd		b16.4, b26.6	
Span Coef		sf 1, bf0.976	
Flow			LPM
Vacuum			mm/Hg
Lamp Volts			(800-1200)
PMT Volts			

Calibrator: Thermo 143
Cert. Date: 10/2/2017 **SN:** 0
Glass M= **0.5471** B= **-0.2866**
Steel M= **0.9850** B= **-0.5533**

DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52582 **Rate:** 1739.84
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 13:03 **Time On:** 13:48
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	.0002	N/A	n/a	.0000	0.000	n/a	**N/A**	**N/A**
2,057	**2.06**	**4.28**	**2.65**	.4500	.7330	N/A	n/a	.4500	5.000	n/a	**62.9%**	**0.0%**
4,628	**4.63**	**8.98**	**5.26**	.2000	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,713	**7.71**	**14.62**	**8.39**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,570	**11.57**	**21.67**	**12.31**	.0800	.0830	N/A	n/a	.0910	0.768	n/a	**3.8%**	**13.8%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/10/17

Initial		Final	
M =	**1.66826**	M =	**0.99078**
B =	**-0.02266**	B =	**0.00530**
Corr. =	**0.99795**	Corr. =	**0.99969**

Average %

16.7%	**3.4%**

1234 Data Entry **.500** Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation <u>Underlined</u> Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Kwajalein	**Date:**	10/8/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 42		
SN:			
	Initial	Final	
Backgrnd			
Span Coef			
Flow			LPM
Vacuum			mm/Hg
Lamp Volts			(800-1200)
PMT Volts			

Calibrator:	Thermo 143		
Cert. Date:	10/2/2017	**SN:**	0
Glass M=	**0.5471**	B=	**-0.2866**
Steel M=	**0.9850**	B=	**-0.5533**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52582	**Rate:**	1739.84
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**20:15**	**Time On:**	**21:03**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	N/A	N/A	n/a	.0000	0.000	n/a	**N/A**	**N/A**
2,057	**2.06**	**4.28**	**2.65**	.4500	N/A	N/A	n/a	.5000	5.000	n/a	**N/A**	**11.1%**
4,114	**4.11**	**8.04**	**4.74**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,713	**7.71**	**14.62**	**8.39**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,570	**11.57**	**21.67**	**12.31**	.0800	N/A	N/A	n/a	.0830	0.831	n/a	**N/A**	**3.8%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 11/21/17

M =	**#DIV/0!**	M =	**1.11605**
B =	**#DIV/0!**	B =	**-0.00284**
Corr. =	**#DIV/0!**	Corr. =	**0.99993**

Average %	
N/A	**7.4%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Kwajalein	**Date:**	10/23/2017	**Initial / Final:**		**QTR 1234**

Instrument:	Thermo Scientific Model 42		
SN:			
	Initial	**Final**	
Backgrnd	b16.4, b26.6		
Span Coef	sf 1, bf0.976		
Flow			LPM
Vacuum			mm/Hg
Lamp Volts			(800-1200)
PMT Volts			

Calibrator:	Thermo 143		
Cert. Date:	10/2/2017	**SN:**	0
Glass M=	**0.5471**	B=	**-0.2866**
Steel M=	**0.9850**	B=	**-0.5533**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52582	**Rate:**	1739.84
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**13:03**	**Time On:**	**13:48**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	N/A	N/A	n/a	.0000	0.000	n/a	**N/A**	**N/A**
2,057	**2.06**	**4.28**	**2.65**	.4500	N/A	N/A	n/a	.5000	5.000	n/a	**N/A**	**11.1%**
4,114	**4.11**	**8.04**	**4.74**	.2250	N/A	N/A	n/a	.2267	2.267	n/a	**N/A**	**0.8%**
7,713	**7.71**	**14.62**	**8.39**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,570	**11.57**	**21.67**	**12.31**	.0800	N/A	N/A	n/a	.0768	0.768	n/a	**N/A**	**-4.0%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 11/21/17

M =	**#DIV/0!**	M =	**1.11513**
B =	**#DIV/0!**	B =	**-0.00960**
Corr. =	**#DIV/0!**	Corr. =	**0.99872**

Average %

N/A	**2.6%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

AECOM

NO2 PERMEATION CALIBRATION

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Network: Kwajalein Range Svcs **Site:** Kwajalein **Date:** 11/8/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN: 42981-268/38807-258

	Initial	Final
B1	6.4	6.0
B3	8.6	9.3
SF	1.000	0.745
BF	0.976	1.384
CE	100.00	100.00
CT	335	341

Calibrator: Thermo 143
Cert. Date: 10/2/2017 **SN:** 14023-144
Glass M= **0.5471** B= **-0.2866**
Steel M= **0.9850** B= **-0.5533**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52582 **Rate:** 1739.84
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 12:00 **Time On:** 13:00
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One:
Multipoint Calibration: X
Audit: X
Other:

Flows and Settings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	.0010	0.009	n/a	.0005	0.005	n/a	**N/A**	**N/A**
2,057	**2.06**	**4.28**	**2.65**	.4500	.5000	5.000	n/a	.4732	4.737	n/a	**11.1%**	**5.2%**
4,114	**4.11**	**8.04**	**4.74**	.2250	.2218	2.220	n/a	.2088	2.073	n/a	**-1.4%**	**-7.2%**
7,713	**7.71**	**14.62**	**8.39**	.1200	.1170	1.170	n/a	.1153	1.148	n/a	**-2.5%**	**-3.9%**
11,570	**11.57**	**21.67**	**12.31**	.0800	.0751	0.752	n/a	.0734	0.729	n/a	**-6.2%**	**-8.3%**

	Initial	Final
M =	**1.11628**	**1.05275**
B =	**-0.01237**	**-0.01000**
Corr. =	**0.99804**	**0.99803**

Average %

0.3% ✓	**-3.6%** ✓

Operator: Tim Mierop

QC Review: 12/21/17

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Kwajalein	**Date:**	11/14/2017	**Initial / Final:**	QTR 1234

Instrument: Thermo Scientific Model 42
SN: 42981-268/38807-258

	Initial	Final
B1	N/A	6.0
B3	N/A	9.3
SF	N/A	0.745
BF	N/A	1.384
CE	N/A	100.00
CT	N/A	341

Calibrator: Thermo 143
Cert. Date: 10/2/2017 **SN:** 14023-144
Glass M= **0.5471** B= **-0.2866**
Steel M= **0.9850** B= **-0.5533**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52582 **Rate:** 1739.84
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 10:20 **Time On:** 10:30
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.52**	**0.56**	.0000	N/A	N/A	n/a	.0005	0.005	n/a	**N/A**	**N/A**
2,057	**2.06**	**4.28**	**2.65**	.4500	N/A	N/A	n/a	.4595	4.590	n/a	**N/A**	**2.1%**
4,114	**4.11**	**8.04**	**4.74**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,713	**7.71**	**14.62**	**8.39**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,570	**11.57**	**21.67**	**12.31**	.0800	N/A	N/A	n/a	.0838	0.837	n/a	**N/A**	**4.7%**

Operator: Tim Mierop

QC Review: William Va

M =	**#DIV/0!**	M =	**1.01862**
B =	**#DIV/0!**	B =	**0.00129**
Corr. =	**#DIV/0!**	Corr. =	**0.99999**

Average %

N/A	~~**1.7%**~~

3,4%

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation <u>Underlined</u> Linked Cells

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NO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Kwajalein **Date:** 11/20/2017 **Initial / Final:** QTR 1234

Instrument:	Thermo Scientific Model 42	
SN:	38807-258	
	Initial	Final
B1	N/A	6.0
B3	N/A	9.3
SF	N/A	0.745
BF	N/A	1.384
CE	N/A	100.00
CT	N/A	325

Calibrator: Thermo 143
Cert. Date: 11/20/2017 **SN:** 14023-144
Glass M= **0.5690** B= **-0.4127**
Steel M= **1.0041** B= **-0.6030**

DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52582 **Rate:** 1739.84
Perm. Oven Temp: 35 **Expiration:**

Comments:

Time Off:	22:05	**Time On:**	01:05
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.73**	**0.60**	.0000	N/A	N/A	n/a	-.0005	0.000	n/a	**N/A**	**N/A**
2,057	**2.06**	**4.34**	**2.65**	.4500	N/A	N/A	n/a	.5000	5.005	n/a	**N/A**	**11.1%**
4,628	**4.63**	**8.86**	**5.21**	.2000	N/A	N/A	n/a	.2246	2.248	n/a	**N/A**	**12.3%**
7,713	**7.71**	**14.28**	**8.28**	.1200	N/A	N/A	n/a	.1256	1.257	n/a	**N/A**	**4.7%**
11,570	**11.57**	**21.06**	**12.12**	.0800	N/A	N/A	n/a	.0774	0.776	n/a	**N/A**	**-3.3%**

Operator: Tim Mierop

QC Review:

M =	**#DIV/0!**	M =	**1.12439**
B =	**#DIV/0!**	B =	**-0.00573**
Corr. =	**#DIV/0!**	Corr. =	**0.99961**

Average %

N/A	**6.2%** ✓

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Kwajalein	**Date:**	12/5/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 42	
SN:	38807-258	
	Initial	**Final**
B1	N/A	5.4
B3	N/A	7.2
SF	N/A	0.784
BF	N/A	1.210
CE	N/A	100.00
CT	N/A	325

Calibrator:	Thermo 143		
Cert. Date:	11/20/2017	**SN:**	14023-144
Glass M=	**0.5690**	B=	**-0.4127**
Steel M=	**1.0041**	B=	**-0.6030**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52582	**Rate:**	1739.84
Perm. Oven Temp:	35	**Expiration:**	

Comments:	Pump failure		
Time Off:	**13:40**	**Time On:**	**14:05**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:	X		
Audit:			
Other:	pump failure		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.73**	**0.60**	.0000	-.0034	0.034	n/a	.0010	0.010	n/a	**N/A**	**N/A**
2,057	**2.06**	**4.34**	**2.65**	.4500	.2738	2.745	n/a	.4290	4.299	n/a	**-39.2%**	**-4.7%**
4,114	**4.11**	**7.96**	**4.70**	.2250	.1577	1.578	n/a	.2166	2.168	n/a	**-29.9%**	**-3.7%**
7,713	**7.71**	**14.28**	**8.28**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,570	**11.57**	**21.06**	**12.12**	.0800	.0422	0.422	n/a	.0764	0.765	n/a	**-47.3%**	**-4.5%**

Operator: Robert Sicard

.

QC Review: William Van Eck 12/21/17

M =	**0.62644**	M =	**0.95225**
B =	**-0.00068**	B =	**0.00101**
Corr. =	**0.99547**	Corr. =	**0.99999**

Average %	
-38.8%	-4.3%

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

NO2 PERMEATION CALIBRATION

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Network:	Kwajalein Range Svcs	**Site:**	Kwajalein	**Date:**	12/13/2017	**Initial / Final:**	**QTR 1234**

Instrument:	Thermo Scientific Model 42	
SN:	38807-258	
	Initial	**Final**
B1	N/A	6.0
B3	N/A	9.3
SF	N/A	0.745
BF	N/A	1.384
CE	N/A	100.00
CT	N/A	325

Calibrator:	Thermo 143		
Cert. Date:	11/20/2017	**SN:**	14023-144
Glass M=	**0.5690**	B=	**-0.4127**
Steel M=	**1.0041**	B=	**-0.6030**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52582	**Rate:**	1739.84
Perm. Oven Temp:	35	**Expiration:**	

Comments:	Final take down Calibration		
Time Off:	**8:10**	**Time On:**	**8:45**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**0.73**	**0.60**	.0000	N/A	N/A	n/a	.0000	0.000	n/a	**N/A**	**N/A**
2,057	**2.06**	**4.34**	**2.65**	.4500	N/A	N/A	n/a	.4440	4.442	n/a	**N/A**	**-1.3%**
4,114	**4.11**	**7.96**	**4.70**	.2250	N/A	N/A	n/a	.2140	2.146	n/a	**N/A**	**-4.9%**
7,713	**7.71**	**14.28**	**8.28**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,570	**11.57**	**21.06**	**12.12**	.0800	N/A	N/A	n/a	.0756	0.756	n/a	**N/A**	**-5.5%**

Operator: Robert Sicard

QC Review: William Van Eck 12/21/17

.

M =	**#DIV/0!**	M =	**0.98729**
B =	**#DIV/0!**	B =	**-0.00295**
Corr. =	**#DIV/0!**	Corr. =	**0.99981**

Average %	
N/A	**-3.9%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

One-Point Flow Rate Verification Check Data Sheet
For Met One BAM Particulate Monitors

Date & Time: 8/30/17 **Operator :** R. Sicard

Location : Kwajalein site **Network :** KRS -Marshall Islands

BAM S/N : T15029

Reference Standard: Delta Cal

Flows – Model: 1020 **S/N:** 850 5/18/17

Temperature – Model: 4243 telo Temp **S/N:** 170423458 / 300907

Barometric Pressure – Model: AIR-HB-1L **S/N:** 5K3194 Cal Date 6/15/17

Verification Specifications	Display (BAM)	Audit (deltaCal)	Difference
Amb. Temperature (^{0}C)	AT= 24°C	Ta = 23.9	AT-Ta = -0.1 ✓
Amb. Pressure (mm Hg)	BP_D = 756	BP_A = 756	BP_D-BP_A = 0.0 ✓
Flow Rate (1) (LPM)	Flow Rate = 16.7	Qa = 16.7	$\frac{Flow-Qa}{Qa}*100\%$ = 0.0
Flow Rate (2) (LPM)	N/A		$\frac{Qa-16.7}{16.7}*100\%$ = 0.0
Leak Check (LPM)	Flow Rate = 0.6	1.0	Pass: [✓ Yes ☒] No ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : **Temperature within +/- 2 ^{0}C**
Barometric Pressure within +/- 10 mm Hg
Flow Rate (1) – Display is within +/- 4% of Reference Standard
Flow Rate (2) – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)
Leak Check – Display must be less than 1.0 LPM.

Comments:
Looks Good

Rev 9/5/17

One-Point Flow Rate Verification Check Data Sheet
For Met One BAM Particulate Monitors

Date & Time: 10-23-2017 1340

Operator : AECOM

Location : Kwaj

Network : Kwajalein Atoll - KRS

BAM S/N : T13029

Reference Standard:

Flows – Model: Δ Cal **S/N:** 805

Temperature – Model: **S/N:**

Barometric Pressure – Model: **S/N:**

Verification Specifications	Display (BAM)	Audit (deltaCal)	Difference
Amb. Temperature (^{0}C)	AT= 30.0	Ta = 30.1	AT-Ta = -0.1
Amb. Pressure (mm Hg)	BP_D = 759	BP_A = 759	BP_D-BP_A = -2
Flow Rate (1) (LPM)	Flow Rate = 16.7	Qa = 16.63	$\frac{Flow-Qa}{Qa}*100\%=$ 0.4%
Flow Rate (2) (LPM)	**N/A**		$\frac{Qa-16.7}{16.7}*100\%=$
Leak Check (LPM)	Flow Rate = 0.4	**1.0**	**Pass: Yes** ☒ **No** ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : **Temperature within +/- 2 ^{0}C**

Barometric Pressure within +/- 10 mm Hg

Flow Rate (1) – Display is within +/- 4% of Reference Standard

Flow Rate (2) – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)

Leak Check – Display must be less than 1.0 LPM.

Comments:

One-Point Flow Rate Verification Check Data Sheet
For Met One BAM Particulate Monitors

Date & Time: 12/13/17 10:10	**Operator :** R. Sicard
Location : Kwajolein site	**Network :** KRS - Marshall Islands
BAM S/N : T15029	

Reference Standard:

Flows – Model: Delta Cal **S/N:** 850 5/18/17

Temperature – Model: 4243 Telatemp **S/N:** 170423458 / 300907

Barometric Pressure – Model: Air-HB-1A **S/N:** 5K3194 6/15/17

Verification Specifications	**Display (BAM)**	**Audit (deltaCal)**	**Difference**
Amb. Temperature (^{0}C)	AT= 29.9	Ta = 29.8	AT-Ta = -0.1
Amb. Pressure (mm Hg)	BP_D = 756.2	BP_A = 756.1	BP_D-BP_A = 0.0
Flow Rate (1) (LPM)	Flow Rate = 16.7	Qa = 16.7	$\frac{Flow-Qa}{Qa}*100\%=$ 0
Flow Rate (2) (LPM)	**N/A**		$\frac{Qa-16.7}{16.7}*100\%=$ 0
Leak Check (LPM)	Flow Rate = 20.2	**1.0**	**Pass:** Yes ☒ No ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : **Temperature within +/- 2 ^{0}C**
Barometric Pressure within +/- 10 mm Hg
Flow Rate (1) – Display is within +/- 4% of Reference Standard
Flow Rate (2) – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)
Leak Check – Display must be less than 1.0 LPM.

Comments:

Looks Good

Meck

Meck Calibration Checks

Parameter	Calibration Check	Date Completed
SO_2	Startup Calibration	9/2/17
	Precision/Level 1	9/7/17
	Precision/Level 1	9/19/17
	Precision/Level 1	10/11/17
	Precision/Level 1	10/25/17
	Precision/Level 1	11/4/17
	Multi-point Verification	11/15/17
	Multi-point Verification	11/18/17
	Precision/Level 1	12/6/17
	Shutdown Multi-point Verification	12/14/17
NO_2	Startup Calibration	9/2/17
	Multi-point Calibration	9/15/17
	Precision/Level 1	9/19/17
	Multi-point Calibration	9/29/17
	Precision/Level 1	10/11/17
	Precision/Level 1	10/25/17
	Precision/Level 1	11/4/17
	Multi-point Verification	11/15/17
	Multi-point Calibration	11/18/17
	Multi-point Verification	12/6/17
	Shutdown Multi-point Verification	12/14/17
$PM_{2.5}$	One-point flow rate verification	8/31/17
	One-point flow rate verification	10/14/17
	One-point Flow Rate Verification	12/14/17
	Zero Check	12/14/17

Definitions:

NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
SO_2 – sulfur dioxide (measured in parts per billion)

StarTup

(KRS)

Gas Dilution Calibration SO2

Network: Marshall Island **Site:** Meck Island **Instrument:** Thermo 43A **S/N:** 29731-236 **Date:** 9/2/17

Calibrator: thermo 143 **S/N:** 9600-109 **Cal Date:** 9/2/17 permTube ~~**Cylinder S/N:**~~ 2425.02 ng/min **Conc.(ppm)** N/A **Date:** ____

Initial: Zero Pot 1.02 Span Pot 4.87

Final: Zero Pot 1.02 Span Pot 3.26

Precision and Level One Check ☐

Multipoint Calibration StarTup ☒

Other ☐

DAS: CampBell

Strip Chart: N/A

Time Off: ____ **On:** ____

Flow Setting Ball HT.		Flow (cc/min)		PPB Input	Initial Analyzer DAS Response			Final Analyzer DAS Response		Strip Chart Percent Full Scale		Final Δ%
Span	Dilution	Span	Dilution	(ppm) B	(Vdc)	(ppm) B	Δ %	(Vdc)	(ppm)	Initial	Final	(≤ 10%)
ZERO	charcoal / purcd fil	canister		0.00	0.01	1.0						
SS	2.81	cc/min	2058.57	450	4.52	452						0.4%
top	4.82		4,117.15	225	2.28	228						1.3%
	12.14		11,579.5	80	0.83	83						3.8%

Average Δ% +1.8%

Standards Comparison

Network Calibrator: Metronics **S/N:** M-900 **Cal Date:** 2/10/16

Cylinder: ____ **S/N:** ____ **Cal Date:** ____

	Reference Calibrator			Network Calibrator			
Input	Span	Dilution	Response	Span	Dilution	Response	Δ%

Signature:

QC Review:

Accepted ☒ Rejected ☐

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SO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Meck **Date:** 9/7/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 29731-236

	Initial	Final	
Backgrnd	1.02	1.02	
Span Coef	4.87	3.26	
Flow	0.48	0.48	LPM
Vacuum	-18.5	-18.5	in/Hg
Lamp Volts	N/A	N/A	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 10/4/2017 **SN:** 0
Glass M= **0.5983** B= **-1.0101**
Steel M= **1.0187** B= **-0.9172**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 33-52579 **Rate:** 2425.02
Perm. Oven Temp: 35 **Expiration:**

Comments: Startup
Time Off: 8:47 **Time On:** 9:12
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		SO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.69**	**0.90**	.0000	N/A	N/A	n/a	.0024	0.002	n/a	**N/A**	**N/A**
2,059	**2.06**	**5.13**	**2.92**	.4500	N/A	N/A	n/a	.4480	4.457	n/a	**N/A**	**-0.4%**
4,117	**4.12**	**8.57**	**4.94**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,720	**7.72**	**14.59**	**8.48**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,579	**11.58**	**21.04**	**12.27**	.0800	N/A	N/A	n/a	.0760	0.736	n/a	**N/A**	**-5.0%**

Operator: Robert Sicard

QC Review: Arthur Carpenito 10/10/17

	Initial		Final
M =	**#DIV/0!**	M =	**0.99493**
B =	**#DIV/0!**	B =	**-0.00030**
Corr. =	**#DIV/0!**	Corr. =	**0.99992**

Average %
N/A **-1.4%**

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Meck **Date:** 9/19/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 29731-236

	Initial	Final	
Backgrnd	1.02	1.02	
Span Coef	4.87	3.26	
Flow	0.48	0.48	LPM
Vacuum	-18.5	-18.5	in/Hg
Lamp Volts	N/A	N/A	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 10/4/2017 **SN:** 0
Glass M= 0.5983 B= -1.0101
Steel M= 1.0187 B= -0.9172
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 33-52579 **Rate:** 2425.02
Perm. Oven Temp: 35 **Expiration:**

Comments: Startup
Time Off: 8:47 **Time On:** 9:12
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		SO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.69**	**0.90**	.0000	N/A	N/A	n/a	.0024	0.002	n/a	**N/A**	**N/A**
2,059	**2.06**	**5.13**	**2.92**	.4500	N/A	N/A	n/a	.4340	4.457	n/a	**N/A**	**-3.6%**
4,117	**4.12**	**8.57**	**4.94**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,720	**7.72**	**14.59**	**8.48**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,579	**11.58**	**21.04**	**12.27**	.0800	N/A	N/A	n/a	.0745	0.736	n/a	**N/A**	**-6.9%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/10/17

	Initial		Final
M =	**#DIV/0!**	M =	**0.96299**
B =	**#DIV/0!**	B =	**0.00017**
Corr. =	**#DIV/0!**	Corr. =	**0.99994**

Average %
N/A **-5.2%**

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Meck	**Date:**	10/11/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	29731-236		
	Initial	**Final**	
Backgrnd	1.02	1.02	
Span Coef	4.87	3.26	
Flow	0.48	0.48	LPM
Vacuum	-18.5	-18.5	in/Hg
Lamp Volts	N/A	N/A	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	10/4/2017	**SN:**	0
Glass M=	**0.5983**	B=	**-1.0101**
Steel M=	**1.0187**	B=	**-0.9172**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	33-52579	**Rate:**	2425.02
Perm. Oven Temp:	35	**Expiration:**	

Comments:	Startup		
Time Off:	**10:30**	**Time On:**	**11:13**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.69**	**0.90**	.0000	N/A	N/A	n/a	.0020	0.020	n/a	**N/A**	**N/A**
2,059	**2.06**	**5.13**	**2.92**	.4500	N/A	N/A	n/a	.4299	4.300	n/a	**N/A**	**-4.5%**
4,117	**4.12**	**8.57**	**4.94**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,720	**7.72**	**14.59**	**8.48**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,579	**11.58**	**21.04**	**12.27**	.0800	N/A	N/A	n/a	.0741	0.742	n/a	**N/A**	**-7.4%**

M =	**#DIV/0!**	M =	**0.95412**
B =	**#DIV/0!**	B =	**0.00009**
Corr. =	**#DIV/0!**	Corr. =	**0.99996**

Average %

N/A	**-5.9%**

Operator: Aaron Wilson

QC Review: Arthur Carpenito 11/21/17

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

SO2 PERMEATION CALIBRATION

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Network:	Kwajalein Range Svcs	**Site:**	Meck	**Date:**	10/25/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	29731-236		
	Initial	**Final**	
Backgrnd	1.02	1.02	
Span Coef	4.87	3.26	
Flow	0.48	0.48	LPM
Vacuum	-18.5	-18.5	in/Hg
Lamp Volts	N/A	N/A	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	10/4/2017	**SN:**	0
Glass M=	**0.5983**	B=	**-1.0101**
Steel M=	**1.0187**	B=	**-0.9172**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	33-52579	**Rate:**	2425.02
Perm. Oven Temp:	35	**Expiration:**	

Comments:		Startup	
Time Off:	**8:47**	**Time On:**	**9:12**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.69**	**0.90**	.0000	N/A	N/A	n/a	.0024	0.002	n/a	**N/A**	**N/A**
2,059	**2.06**	**5.13**	**2.92**	.4500	N/A	N/A	n/a	.4457	4.457	n/a	**N/A**	**-1.0%**
4,117	**4.12**	**8.57**	**4.94**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,720	**7.72**	**14.59**	**8.48**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,579	**11.58**	**21.04**	**12.27**	.0800	N/A	N/A	n/a	.0736	0.736	n/a	**N/A**	**-8.0%**

Operator: Aaron Wilson

QC Review: Arthur Carpenito 11/21/17

M =	**#DIV/0!**	M =	**0.99149**
B =	**#DIV/0!**	B =	**-0.00126**
Corr. =	**#DIV/0!**	Corr. =	**0.99985**

Average %	
N/A	**-4.5%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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SO2 PERMEATION CALIBRATION

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Network: Kwajalein Range Svcs **Site:** Meck **Date:** 11/4/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 29731-236

	Initial	Final	
Backgrnd	0.57	0.57	
Span Coef	5.58	9.95	
Flow	0.48	0.48	LPM
Vacuum	-18.5	-18.5	in/Hg
Lamp Volts	N/A	N/A	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 10/4/2017 **SN:** 0
Glass M= **0.5983** B= **-1.0101**
Steel M= **1.0187** B= **-0.9172**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 33-52579 **Rate:** 2425.02
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 7:45 **Time On:** 8:22
DAS: CR1000 **S/N:**
Strip Chart: **S/N:**
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.69**	**0.90**	.0000	.0024	0.020	n/a	.0005	0.009	n/a	**N/A**	**N/A**
2,059	**2.06**	**5.13**	**2.92**	.4500	.3963	3.976	n/a	.4598	4.595	n/a	**-11.9%** ✓	**2.2%** ✓
4,117	**4.12**	**8.57**	**4.94**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,720	**7.72**	**14.59**	**8.48**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,579	**11.58**	**21.04**	**12.27**	.0800	.0715	0.712	n/a	.0802	0.801	n/a	**-10.6%** ✓	**0.2%** ✓

Operator: Tim Mierop

QC Review: Arthur Carpenter 12/26/17

	Initial		Final
M =	**0.87611**	M =	**1.02230**
B =	**0.00195**	B =	**-0.00044**
Corr. =	**1.00000**	Corr. =	**0.99999**

Average %

Initial	Final
-11.3% ✓	**1.2%** ✓

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Meck **Date:** 11/15/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 29731-236

	Initial	Final	
Backgrnd		0.7	
Span Coef		9.95	
Flow		0.48	LPM
Vacuum		-20.0	in/Hg
Lamp Volts		888	(800-1200)
PMT Volts		N/A	

Calibrator: Thermo 143
Cert. Date: 11/14/2017 **SN:** 6638-86
Glass M= 0.6076 B= -1.0992
Steel M= 1.0747 B= -1.2486
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 33-52579 **Rate:** 2425.02
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 9:45 **Time On:** 10:10
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.81**	**1.16**	.0000	N/A	N/A	n/a	.0017	0.015	n/a	**N/A**	**N/A**
2,059	**2.06**	**5.20**	**3.08**	.4500	N/A	N/A	n/a	.4493	4.493	n/a	**N/A**	**-0.2%**
4,117	**4.12**	**8.59**	**4.99**	.2250	N/A	N/A	n/a	.2272	2.271	n/a	**N/A**	**1.0%**
7,720	**7.72**	**14.51**	**8.34**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,579	**11.58**	**20.87**	**11.94**	.0800	N/A	N/A	n/a	.0799	0.802	n/a	**N/A**	**-0.1%**

	Initial		Final
M =	**#DIV/0!**	M =	**0.99647**
B =	**#DIV/0!**	B =	**0.00144**
Corr. =	**#DIV/0!**	Corr. =	**0.99998**

Average %

N/A	**0.2%**

Operator: Tim Mierop

QC Review:

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Meck **Date:** 11/18/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 29731-236

	Initial	Final	
Backgrnd		0.7	
Span Coef		9.95	
Flow		0.48	LPM
Vacuum		-20.0	in/Hg
Lamp Volts		888	(800-1200)
PMT Volts		N/A	

Calibrator: Thermo 143
Cert. Date: 11/14/2017 **SN:** 6638-86
Glass M= **0.6076** B= **-1.0992**
Steel M= **1.0747** B= **-1.2486**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 33-52579 **Rate:** 2425.02
Perm. Oven Temp: 35 **Expiration:**

Comments:

Time Off:	9:00	**Time On:**	9:18
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.81**	**1.16**	.0000	N/A	N/A	n/a	.0017	0.015	n/a	**N/A**	**N/A**
2,059	**2.06**	**5.20**	**3.08**	.4500	N/A	N/A	n/a	.4467	4.468	n/a	**N/A**	**-0.7%**
4,117	**4.12**	**8.59**	**4.99**	.2250	N/A	N/A	n/a	.2315	2.301	n/a	**N/A**	**2.9%**
7,720	**7.72**	**14.51**	**8.34**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,579	**11.58**	**20.87**	**11.94**	.0800	N/A	N/A	n/a	.0838	0.834	n/a	**N/A**	**4.7%**

Operator: Tim Mierop

QC Review: Will V. for 12/21/17

	Initial		Final	
M =	**#DIV/0!**	M =	**0.98839**
B =	**#DIV/0!**	B =	**0.00436**
Corr. =	**#DIV/0!**	Corr. =	**0.99984**

Average %

N/A	**2.3%** ✓

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Meck	**Date:**	12/6/2017	**Initial / Final:**		**QTR 1234**

Instrument:	Thermo Scientific Model 43A		
SN:	29731-236		
	Initial	**Final**	
Backgrnd		0.7	
Span Coef		9.95	
Flow		0.5	LPM
Vacuum		-20.0	in/Hg
Lamp Volts		885	(800-1200)
PMT Volts		N/A	

Calibrator:	Thermo 143		
Cert. Date:	11/14/2017	**SN:**	6638-86
Glass M=	**0.6076**	B=	**-1.0992**
Steel M=	**1.0747**	B=	**-1.2486**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	33-52579	**Rate:**	2425.02
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**8:01**	**Time On:**	**8:33**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:	X		
Multipoint Calibration:			
Audit:	X		
Other:			

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.81**	**1.16**	.0000	N/A	N/A	n/a	.0019	0.019	n/a	**N/A**	**N/A**
2,059	**2.06**	**5.20**	**3.08**	.4500	N/A	N/A	n/a	.4282	4.281	n/a	**N/A**	**-4.8%**
4,117	**4.12**	**8.59**	**4.99**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,720	**7.72**	**14.51**	**8.34**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,579	**11.58**	**20.87**	**11.94**	.0800	N/A	N/A	n/a	.0809	0.802	n/a	**N/A**	**1.1%**

Operator: Robert Sicard

QC Review: William Van Eck 12/21/17

M =	**#DIV/0!**	M =	**0.94468**
B =	**#DIV/0!**	B =	**0.00343**
Corr. =	**#DIV/0!**	Corr. =	**0.99997**

Average %	
N/A	**-1.9%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

SO2 PERMEATION CALIBRATION

AECOM
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Network:	Kwajalein Range Svcs	**Site:**	Meck	**Date:**	12/14/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	29731-236		
	Initial	**Final**	
Backgrnd		0.7	
Span Coef		9.95	
Flow		0.48	LPM
Vacuum		-20.0	in/Hg
Lamp Volts		888	(800-1200)
PMT Volts		N/A	

Calibrator:	Thermo 143		
Cert. Date:	11/14/2017	**SN:**	6638-86
Glass M=	**0.6076**	B=	**-1.0992**
Steel M=	**1.0747**	B=	**-1.2486**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	33-52579	**Rate:**	2425.02
Perm. Oven Temp:	35	**Expiration:**	

Comments:	Final take down Calibration		
Time Off:	**8:04**	**Time On:**	**8:33**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:	X		
Audit:	X		
Other:			

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.81**	**1.16**	.0000	N/A	N/A	n/a	.0028	0.028	n/a	**N/A**	**N/A**
2,059	**2.06**	**5.20**	**3.08**	.4500	N/A	N/A	n/a	.4397	4.397	n/a	**N/A**	**-2.3%**
4,117	**4.12**	**8.59**	**4.99**	.2250	N/A	N/A	n/a	.2249	2.249	n/a	**N/A**	**0.0%**
7,720	**7.72**	**14.51**	**8.34**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,579	**11.58**	**20.87**	**11.94**	.0800	N/A	N/A	n/a	.0857	0.857	n/a	**N/A**	**7.1%**

Operator: Robert Sicard .

QC Review: William Van Eck 12/21/17

M =	**#DIV/0!**	M =	**0.96721**
B =	**#DIV/0!**	B =	**0.00570**
Corr. =	**#DIV/0!**	Corr. =	**0.99991**

Average %

N/A	**1.6%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

Startup

(KRS)

Gas Dilution Calibration NO2

Network: Marshall Island **Site:** Meck Island **Instrument:** Thermo 42 **S/N:** 43019-268 3 **Date:** 9/2/17

Calibrator: Thermo 143 **S/N:** 14023-144 **Cal Date:** 9/2/17 Perm Tube ~~**Cylinder S/N:**~~ 1548.32 **Conc.(ppm)** N/A **Date:** NO2

Initial: Zero Pot N/A Span Pot N/A

Final: Zero Pot ______ Span Pot ______

Precision and Level One Check ☐

Multipoint Calibration Startup ☒

Other ☐

DAS: Camp Bell Scientific

Strip Chart: N/A

Time Off: ______ **On:** ______

Flow Setting Ball Ht.		Flow (cc/min)		PPB Input	Initial Analyzer DAS Response			Final Analyzer DAS Response		Strip Chart Percent Full Scale		Final Δ%
Span	Dilution	Span	Dilution	(ppm) B	(Vdc)	(ppm)	Δ %	(Vdc)	(ppm)	Initial	Final	(≤ 10%)
ZERO	charcoal purifill	conister		0.00	0.00	0.00						
SS	2.58		1,830.46	450	4.54	454						0.9%
Top of Ball	4.38		3660.92	225	2.29	229						1.8%
	10.88		10,296.33	80	0.79	79						-1.3%
	Ball Ht.											

Average Δ% +0.5%

Standards Comparison

Network Calibrator: ______ **S/N:** ______ **Cal Date:** ______

Cylinder: ______ **S/N:** ______ **Cal Date:** ______

	Reference Calibrator			Network Calibrator			
Input	Span	Dilution	Response	Span	Dilution	Response	Δ%

Signature:

QC Review: William Va

Accepted ☑ Rejected ☐

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Network: Kwajalein Range Svcs **Site:** Meck **Date:** 9/15/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN: 43019-268

	Initial	Final	
Backgrnd 3	9.7	8	
Span Coef	0.922	0.095	
Balance Fct	0.644	3.586	
Vacuum	20.8	20.2	in/Hg
Backgrnd 1	14.9	1.4	(800-1200)
PMT Volts			

Calibrator: Thermo 143
Cert. Date: 9/2/2017 **SN:** 0
Glass M= **0.6192** B= **-1.0844**
Steel M= **1.0205** B= **-0.8053**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52584 **Rate:** 1548.32
Perm. Oven Temp: 35 **Expiration:**

Comments: Instrument swap new SN:38816-258
Time Off: 6:45 **Time On:** 8:40
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One:
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.75**	**0.79**	.0000	.0000	N/A	n/a	.0008	0.000	n/a	**N/A**	**N/A**
1,830	**1.83**	**4.71**	**2.58**	.4500	.0002	N/A	n/a	.4567	4.567	n/a	**-100.0%**	**1.5%**
3,661	**3.66**	**7.66**	**4.38**	.2250	.0004	N/A	n/a	.2208	2.208	n/a	**-99.8%**	**-1.9%**
6,864	**6.86**	**12.84**	**7.52**	.1200	-.0005	N/A	n/a	.1209	1.209	n/a	**-100.4%**	**0.7%**
10,296	**10.30**	**18.38**	**10.88**	.0800	.0002	N/A	n/a	.0795	0.795	n/a	**-99.8%**	**-0.6%**

Operator: Timothy Mierop

QC Review: Arthur Carpenito 10/18/17

	Initial		Final
M =	**0.00069**	M =	**1.01234**
B =	**-0.00006**	B =	**-0.00142**
Corr. =	**0.34969**	Corr. =	**0.99983**

Average %

-100.0%	**-0.1%**

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Meck **Date:** 9/19/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN: 38816-258

	Initial	Final	
Backgrnd 3	4.6	8	
Span Coef	0.067	0.095	
Balance Fct	4.274	3.586	
Vacuum	21.5	20.2	in/Hg
Backgrnd 1	1	1.4	(800-1200)
PMT Volts			

Calibrator: Thermo 143
Cert. Date: 10/4/2017 **SN:** 0
Glass M= **0.5983** B= **-1.0101**
Steel M= **1.0187** B= **-0.9172**

DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52584 **Rate:** 1548.32
Perm. Oven Temp: 35 **Expiration:**

Comments:

Time Off:	8:02	**Time On:**	8:42
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.69**	**0.90**	.0000	N/A	N/A	n/a	.0083	0.000	n/a	**N/A**	**N/A**
1,830	**1.83**	**4.75**	**2.70**	.4500	N/A	N/A	n/a	.3846	3.846	n/a	**N/A**	**-14.5%**
3,661	**3.66**	**7.81**	**4.49**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
6,864	**6.86**	**13.16**	**7.64**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
10,296	**10.30**	**18.90**	**11.01**	.0800	N/A	N/A	n/a	.0683	0.683	n/a	**N/A**	**-14.6%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/10/17

M =	**#DIV/0!**	M =	**0.85427**
B =	**#DIV/0!**	B =	**0.00015**
Corr. =	**#DIV/0!**	Corr. =	**1.00000**

Average %

N/A	**-14.6%**

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Meck	**Date:**	9/29/2017	**Initial / Final:**	QTR 1234

Instrument:	Thermo Scientific Model 42	
SN:	38816-258	
	Initial	Final
Backgrnd 3	4.6	8
Span Coef	0.067	0.095
Balance Fct	4.274	3.586
Vacuum	21.5	20.2 in/Hg
Backgrnd 1	1	1.4 (800-1200)
PMT Volts		

Calibrator:	Thermo 143		
Cert. Date:	10/4/2017	**SN:**	0
Glass M=	**0.5983**	B=	**-1.0101**
Steel M=	**1.0187**	B=	**-0.9172**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52584	**Rate:**	1548.32
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	8:02	**Time On:**	8:50
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows and Settings				Initial Readings				Final Readings				Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL				Initial	Final
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt		Chart%	% Error	% Error
0.00	**0.00**	**1.69**	**0.90**	.0000	N/A	N/A	n/a	.0003	0.000		n/a	**N/A**	**N/A**
1,830	**1.83**	**4.75**	**2.70**	.4500	.5460	N/A	n/a	.4550	4.550		n/a	**21.3%**	**1.1%**
3,661	**3.66**	**7.81**	**4.49**	.2250	.2880	N/A	n/a	.2330	N/A		n/a	**28.0%**	**3.6%**
6,864	**6.86**	**13.16**	**7.64**	.1200	N/A	N/A	n/a	N/A	N/A		n/a	**N/A**	**N/A**
10,296	**10.30**	**18.90**	**11.01**	.0800	.1060	N/A	n/a	.0900	0.900		n/a	**32.5%**	**12.5%**

M =	**1.18552**	M =	**1.00386**
B =	**0.01498**	B =	**0.00510**
Corr. =	**0.99969**	Corr. =	**0.99978**

Average %

27.3%	**5.7%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/10/17

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Meck	**Date:**	10/11/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 42		
SN:	38816-258		
	Initial	**Final**	
Backgrnd 3	9.7	8	
Span Coef	0.922	0.095	
Balance Fct	0.644	3.586	
Vacuum	20.8	20.2	in/Hg
Backgrnd 1	14.9	1.4	(800-1200)
PMT Volts			

Calibrator:	Thermo 143		
Cert. Date:	10/4/2017	**SN:**	0
Glass M=	**0.5983**	B=	**-1.0101**
Steel M=	**1.0187**	B=	**-0.9172**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52584	**Rate:**	1548.32
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**11:00**	**Time On:**	**12:15**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.69**	**0.90**	.0000	N/A	N/A	n/a	.0029	0.030	n/a	**N/A**	**N/A**
1,830	**1.83**	**4.75**	**2.70**	.4500	N/A	N/A	n/a	.4712	4.711	n/a	**N/A**	**4.7%**
3,661	**3.66**	**7.81**	**4.49**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
6,864	**6.86**	**13.16**	**7.64**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
10,296	**10.30**	**18.90**	**11.01**	.0800	N/A	N/A	n/a	.0855	0.883	n/a	**N/A**	**6.9%**

Operator: Aaron Wilson

QC Review: Arthur Carpenito 11/21/17

M =	**#DIV/0!**	M =	**1.04121**
B =	**#DIV/0!**	B =	**0.00259**
Corr. =	**#DIV/0!**	Corr. =	**1.00000**

Average %	
N/A	**5.8%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Meck	**Date:**	10/25/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 42		
SN:	38816-258		
	Initial	**Final**	
Backgrnd 3	4.6	8	
Span Coef	0.067	0.095	
Balance Fct	4.274	3.586	
Vacuum	21.5	20.2	in/Hg
Backgrnd 1	1	1.4	(800-1200)
PMT Volts			

Calibrator:	Thermo 143		
Cert. Date:	10/4/2017	**SN:**	0
Glass M=	**0.5983**	B=	**-1.0101**
Steel M=	**1.0187**	B=	**-0.9172**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52584	**Rate:**	1548.32
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**8:02**	**Time On:**	**8:30**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.69**	**0.90**	.0000	N/A	N/A	n/a	.0003	0.000	n/a	**N/A**	**N/A**
1,830	**1.83**	**4.75**	**2.70**	.4500	N/A	N/A	n/a	.4757	4.759	n/a	**N/A**	**5.7%**
3,661	**3.66**	**7.81**	**4.49**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
6,864	**6.86**	**13.16**	**7.64**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
10,296	**10.30**	**18.90**	**11.01**	.0800	N/A	N/A	n/a	.0775	0.775	n/a	**N/A**	**-3.1%**

Operator: Aaron Wilson

QC Review: Arthur Carpenito 11/21/17

M =	**#DIV/0!**	M =	**1.06258**
B =	**#DIV/0!**	B =	**-0.00322**
Corr. =	**#DIV/0!**	Corr. =	**0.99988**

Average %	
N/A	**1.3%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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NO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Meck **Date:** 11/4/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN: 38816-258

	Initial	Final	
Backgrnd 3	4.6	4.6	
Span Coef	0.067	0.067	
Balance Fct	4.274	4.274	
Vacuum	21.5	21.0	in/Hg
Backgrnd 1	1	1	(800-1200)
PMT Volts			

Calibrator: Thermo 143
Cert. Date: 10/4/2017 **SN:** 0
Glass M= **0.5983** B= **-1.0101**
Steel M= **1.0187** B= **-0.9172**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52584 **Rate:** 1548.32
Perm. Oven Temp: 35 **Expiration:**

Comments:

Time Off:	8:26	**Time On:**	9:10
DAS:	CR1000	**S/N:**	
Strip Chart:		**S/N:**	
Precision & Level One:	X		
Multipoint Calibration:			
Audit:	X		
Other:			

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow CCM	LPM	**Glass Ball** Read Top of Ball	**Steel Ball**	**Input** NO2 (ppm)	**INITIAL** DAS	Volt	Chart%	**FINAL** DAS (ppm)	Volt	Chart%	**Initial** % Error	**Final** % Error
0.00	**0.00**	**1.69**	**0.90**	.0000	N/A	N/A	n/a	-.0003	0.000	n/a	**N/A**	**N/A**
1,830	**1.83**	**4.75**	**2.70**	.4500	N/A	N/A	n/a	.4391	4.392	n/a	**N/A**	**-2.4%** ✓
3,661	**3.66**	**7.81**	**4.49**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
6,864	**6.86**	**13.16**	**7.64**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
10,296	**10.30**	**18.90**	**11.01**	.0800	N/A	N/A	n/a	.0771	0.772	n/a	**N/A**	**-3.6%** ✓

Operator: Tim Mierop

QC Review: Arthur Carpenito 12/26/17

M =	**#DIV/0!**	M =	**0.97704**
B =	**#DIV/0!**	B =	**-0.00064**
Corr. =	**#DIV/0!**	Corr. =	**1.00000**

Average %

0.0%	**-3.0%** ✓

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Meck **Date:** 11/15/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN: 43019-268

	Initial	Final
B1		1.0
B3		4.6
Span CF		0.067
Balance F		4.274
Conv. Effc		100.4
Vac		-21.0 in/Hg

Calibrator: Thermo 143
Cert. Date: 11/14/2017 **SN:** 6638-86
Glass M= **0.6076** B= **-1.0992**
Steel M= **1.0747** B= **-1.2486**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52584 **Rate:** 1548.32
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 10:15 **Time On:** 11:15
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		N ~~S~~O2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.81**	**1.16**	.0000	N/A	N/A	n/a	-.0004	0.000	n/a	**N/A**	**N/A**
1,830	**1.83**	**4.82**	**2.87**	.4500	N/A	N/A	n/a	.4665	4.664	n/a	**N/A**	**3.7%**
3,661	**3.66**	**7.83**	**4.57**	.2250	N/A	N/A	n/a	.2287	2.295	n/a	**N/A**	**1.6%**
6,864	**6.86**	**13.11**	**7.55**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
10,296	**10.30**	**18.76**	**10.74**	.0800	N/A	N/A	n/a	.0780	0.781	n/a	**N/A**	**-2.6%**

Operator: Tim Mierop

QC Review:

	Initial		Final
M =	**#DIV/0!**	M =	**1.04053**
B =	**#DIV/0!**	B =	**-0.00321**
Corr. =	**#DIV/0!**	Corr. =	**0.99992**

Average %

N/A	**0.9%**

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

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Network: Kwajalein Range Svcs **Site:** Meck **Date:** 11/18/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN: 43019-268

	Initial	Final	
B1	1.0	1.0	
B3	4.6	5.0	
Span CF	0.067	0.067	
Balance F	4.274	4.577	
Conv. Effc	100.4	100.4	
Vac	-21.0	-21.0	in/Hg

Calibrator: Thermo 143
Cert. Date: 11/14/2017 **SN:** 6638-86
Glass M= **0.6076** B= **-1.0992**
Steel M= **1.0747** B= **-1.2486**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52584 **Rate:** 1548.32
Perm. Oven Temp: 35 **Expiration:**

Comments: Repsonse in spec but low, recaling
Time Off: 8:10 **Time On:** 9:15
DAS: CR1000 **S/N:**
Strip Chart: **S/N:**
Precision & Level One: X
Multipoint Calibration: X
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.81**	**1.16**	.0000	-.0004	0.000	n/a	-.0004	0.000	n/a	**N/A**	**N/A**
1,830	**1.83**	**4.82**	**2.87**	.4500	.4310	4.313	n/a	.4638	4.639	n/a	**-4.2%**	**3.1%**
3,661	**3.66**	**7.83**	**4.57**	.2250	.2162	2.167	n/a	.2361	2.367	n/a	**-3.9%**	**4.9%**
6,864	**6.86**	**13.11**	**7.55**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
10,296	**10.30**	**18.76**	**10.74**	.0800	.0695	0.690	n/a	.0806	0.805	n/a	**-13.1%**	**0.8%**

Operator: Tim Mierop

QC Review: 12/21/17

	Initial		Final
M =	**0.96526**	M =	**1.03434**
B =	**-0.00312**	B =	**-0.00021**
Corr. =	**0.99985**	Corr. =	**0.99993**

Average %

-7.1% ✓	**2.9%** ✓

1234 Data Entry | .500 Conc. Entry | 0.500 DAS Entry | **BOLD #'s** Calculation | Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Meck	**Date:**	12/6/2017	**Initial / Final:**		QTR 1234

Instrument:	Thermo Scientific Model 42		**Calibrator:**	Thermo 143			**Comments:**		
SN:	43019-268		**Cert. Date:**	11/14/2017	**SN:**	6638-86	**Time Off:**	8:33	**Time On:** 9:11
	Initial	**Final**	Glass M=	**0.6076**	B=	**-1.0992**			
B1		1.0	Steel M=	**1.0747**	B=	**-1.2486**	**DAS:**	CR1000	**S/N:**
B3		4.6					**Strip Chart:**		**S/N:**
Span CF		0.067	**DVM:**		**SN:**		**Precision & Level One:**	X	
Balance F		4.274	**Cert. Date:**		**ML#:**		**Multipoint Calibration:**	X	
Conv. Effc		100.4	**PermTube SN:**	59-52584	**Rate:**	1548.32	**Audit:**	X	
Vac		-21.3 in/Hg	**Perm. Oven Temp:**	35	**Expiration:**		**Other:**		

Flows and Settings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2	DAS	Volt	Chart%	DAS	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.81**	**1.16**	.0000	N/A	N/A	n/a	-.0004	0.000	n/a	**N/A**	**N/A**
1,830	**1.83**	**4.82**	**2.87**	.4500	N/A	N/A	n/a	.4752	4.750	n/a	**N/A**	**5.6%** ✓
3,661	**3.66**	**7.83**	**4.57**	.2250	N/A	N/A	n/a	.2361	2.360	n/a	**N/A**	**4.9%** ✓
6,864	**6.86**	**13.11**	**7.55**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
10,296	**10.30**	**18.76**	**10.74**	.0800	N/A	N/A	n/a	.0760	0.763	n/a	**N/A**	**-5.0%** ✓

Operator: Robert Sicard

QC Review: 12/21/17

M =	**#DIV/0!**	M =	**1.06406**
B =	**#DIV/0!**	B =	**-0.00412**
Corr. =	**#DIV/0!**	Corr. =	**0.99985**

Average %	
N/A	**1.8%** ✓

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Meck	**Date:**	12/14/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 42	
SN:	43019-268	
	Initial	**Final**
B1		1.0
B3		4.6
Span CF		0.067
Balance F		4.274
Conv. Effc		100.4
Vac		-21.0 in/Hg

Calibrator:	Thermo 143		
Cert. Date:	11/14/2017	**SN:**	6638-86
Glass M=	**0.6076**	B=	**-1.0992**
Steel M=	**1.0747**	B=	**-1.2486**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52584	**Rate:**	1548.32
Perm. Oven Temp:	35	**Expiration:**	

Comments:	Final take down Calibration		
Time Off:	**8:33**	**Time On:**	**9:15**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:		X	
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**1.81**	**1.16**	.0000	N/A	N/A	n/a	.0030	0.027	n/a	**N/A**	**N/A**
1,830	**1.83**	**4.82**	**2.87**	.4500	N/A	N/A	n/a	.4757	4.757	n/a	**N/A**	**5.7%**
3,661	**3.66**	**7.83**	**4.57**	.2250	N/A	N/A	n/a	.2069	2.069	n/a	**N/A**	**-8.0%**
6,864	**6.86**	**13.11**	**7.55**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
10,296	**10.30**	**18.76**	**10.74**	.0800	N/A	N/A	n/a	.0754	0.754	n/a	**N/A**	**-5.8%**

Operator:	Robert Sicard
QC Review:	William Van Eck 12/21/17

.

M =	**#DIV/0!**	M =	**1.05121**
B =	**#DIV/0!**	B =	**-0.00817**
Corr. =	**#DIV/0!**	Corr. =	**0.99729**

Average %	
N/A	**-2.7%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

One-Point Flow Rate Verification Check Data Sheet
For Met One BAM Particulate Monitors

Date & Time: 8/31/17	**Operator :** R. Sicard
Location : Meck	**Network :** KRS - Marshall islands
BAM S/N : T21178	

Reference Standard:

Flows – Model: **S/N:**

Temperature – Model: 4243 **S/N:**

Barometric Pressure – Model: AiR-HB-1L **S/N:** 5K3194 6/15/18

Verification Specifications	**Display (BAM)**	**Audit (deltaCal)**	**Difference**
Amb. Temperature (^{0}C)	AT= 30	Ta = 30	AT-Ta = 0 ✓
Amb. Pressure (mm Hg)	BP_D = 756.7	BP_A = 756.5	BP_D-BP_A = 0.2 ✓
Flow Rate (1) (LPM)	Flow Rate = 16.7	Qa = 16.7	$\frac{Flow-Qa}{Qa} * 100\% =$ 0.0 (W) 9/21/
Flow Rate (2) (LPM)	**N/A**		$\frac{Qa-16.7}{16.7} * 100\% =$ 0.0 (W) 9/21/17
Leak Check (LPM)	Flow Rate = 0.8	**1.0**	**Pass:** [✓ **Yes** ☒] **No** ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : **Temperature within +/- 2 ^{0}C**
Barometric Pressure within +/- 10 mm Hg
Flow Rate (1) – Display is within +/- 4% of Reference Standard
Flow Rate (2) – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)
Leak Check – Display must be less than 1.0 LPM.

Comments: Looks Good

Field Check Data Sheet **WHITE – AECOM** **YELLOW – Site** Rev: Jan 2011

Rev (W) 9/21/17

One-Point Flow Rate Verification Check Data Sheet
For Met One BAM Particulate Monitors

Date & Time: 0750 10-14-2017	**Operator :** Kwajalein Atoll - KRS
Location : Meck	**Network :** AECOM
BAM S/N : T21178	

<u>Reference Standard</u>:

Flows – Model: Δ Cal	**S/N:** 850
Temperature – Model:	**S/N:** 850
Barometric Pressure – Model:	**S/N:** 850

Verification Specifications	**Display (BAM)**	**Audit (deltaCal)**	**Difference**
Amb. Temperature (^{0}C)	AT= 29.3	Ta = 29.2	AT-Ta = 0.1
Amb. Pressure (mm Hg)	BP_D = 754	BP_A = 754.5	BP_D-BP_A = -0.5
Flow Rate (1) (LPM)	Flow Rate = 16.7	Qa = 16.69	$\frac{Flow-Qa}{Qa}*100\%$ = 0.063
Flow Rate (2) (LPM)	**N/A**		$\frac{Qa-16.7}{16.7}*100\%$ =
Leak Check (LPM)	Flow Rate = 0.3	**1.0**	**Pass: Yes** ☒ **No** ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : <u>Temperature</u> within +/- 2 ^{0}C

<u>Barometric Pressure</u> within +/- 10 mm Hg

<u>Flow Rate (1)</u> – Display is within +/- 4% of Reference Standard

<u>Flow Rate (2)</u> – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)

<u>Leak Check</u> – Display must be less than 1.0 LPM.

Comments:

One-Point Flow Rate Verification Check Data Sheet
For Met One BAM Particulate Monitors

Date & Time: 12/14/17 09:40
Operator : R. Sicard
Location : Meck Island
Network : Kwajalein -Meck Island
BAM S/N : T21178

Reference Standard:
Flows – Model: DeltaCal **S/N:** 903 6/28/17
Temperature – Model: ~~Del~~ Telatemp **S/N:** 358654 10/18/17
Barometric Pressure – Model: TelaTc **S/N:** C4310002 3/27/18

Verification Specifications	Display (BAM)	Audit (deltaCal)	Difference
Amb. Temperature (^0C)	AT= 30.1	Ta = 30.2	AT-Ta = -0.1
Amb. Pressure (mm Hg)	BP_D = 756.4	BP_A = 756.2	BP_D-BP_A = 0.2
Flow Rate (1) (LPM)	Flow Rate = 16.7	Qa = 16.53	$\frac{Flow-Qa}{Qa}*100\%$ = +1.2%
Flow Rate (2) (LPM)	N/A		$\frac{Qa-16.7}{16.7}*100\%$ = 1.2%
Leak Check (LPM)	Flow Rate = < 0.2	1.0 < 0.2	Pass: Yes ☑ No ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : **Temperature within +/- 2 ^0C**
Barometric Pressure within +/- 10 mm Hg
Flow Rate (1) – Display is within +/- 4% of Reference Standard
Flow Rate (2) – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)
Leak Check – Display must be less than 1.0 LPM.

Comments: Good Audit

Roi-Namur

Roi-Namur Calibration Checks

Parameter	Calibration Check	Date Completed
SO_2	Startup Calibration	9/12/17
	Precision/Level 1	9/21/17
	Precision/Level 1	10/3/17
	Precision/Level 1	10/17/17
	Precision/Level 1	10/20/17
	Precision/Level 1	11/2/17
	Multi-point Verification	11/17/17
	Multi-point Verification	11/21/17
	Precision/Level 1	12/4/17
	Shutdown Multi-point Verification	12/15/17
NO_2	Startup Calibration	9/12/17
	Multi-point Calibration	9/16/17
	Precision/Level 1	9/21/17
	Multi-point Calibration	10/3/17
	Precision/Level 1	10/17/17
	Multi-point Calibration	10/20/17
	Multi-point Verification	11/2/17
	Multi-point Calibration	11/17/17
	Multi-point Calibration	11/21/17
	Multi-point Verification	11/30/17
	Precision/Level 1	12/4/17
	Shutdown Multi-point Verification	12/15/17
$PM_{2.5}$	One-point Flow Rate Verification	9/12/17
	One-point Flow Rate Verification	10/24/17
	One-point Flow Rate Verification	12/4/17
	One-point Flow Rate Verification	12/15/17
	Zero Check	12/15/17

Definitions:

NO_2 – nitrogen dioxide (measured in parts per billion)
$PM_{2.5}$ – particulate matter ≤2.5 microns (measured in micrograms per cubic meter)
SO_2 – sulfur dioxide (measured in parts per billion)

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SO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 9/12/2017 **Initial / Final:** Startup **QTR 1234**

Instrument: Thermo Scientific Model 43A
SN: 28552-232

	Initial	Final	
Backgrnd	N/A	275	
Span Coef	N/A	140	
Flow	N/A	0.6	LPM
Vacuum	N/A	19.5	mm/Hg
Lamp Volts	N/A	877	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 9/11/2017 **SN:** 14020-144
Glass M= **0.5983** B= **-1.4567**
Steel M= **1.0612** B= **-1.5012**
DVM: Fluke **SN:** 4270385
Cert. Date: 7/21/2017 **ML#:** 8060A
PermTube SN: 33-52573 **Rate:** 2316.59
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 11:20 **Time On:** 15:07
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One:
Multipoint Calibration: X
Audit: X
Other:

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow CCM	LPM	**Glass Ball** Read Top of Ball	**Steel Ball**	**Input** SO2(ppm)	**INITIAL** DAS(ppm)	Volt	Chart%	**FINAL** DAS(ppm)	Volt	Chart%	**Initial** % Error	**Final** % Error
0.00	**0.00**	**2.43**	**1.41**	.0000	N/A	N/A	n/a	.0004	0.005	n/a	**N/A**	**N/A**
1,967	**1.97**	**5.72**	**3.27**	.4500	N/A	N/A	n/a	.4600	4.603	n/a	**N/A**	**2.2%**
3,933	**3.93**	**9.01**	**5.12**	.2250	N/A	N/A	n/a	.2297	2.298	n/a	**N/A**	**2.1%**
7,374	**7.37**	**14.76**	**8.36**	.1200	N/A	N/A	n/a	.1214	1.200	n/a	**N/A**	**1.2%**
11,062	**11.06**	**20.93**	**11.84**	.0800	N/A	N/A	n/a	.0786	0.783	n/a	**N/A**	**-1.8%**

M =	**#DIV/0!**	M =	**1.02459**
B =	**#DIV/0!**	B =	**-0.00128**
Corr. =	**#DIV/0!**	Corr. =	**0.99997**

Average %

N/A	**0.9%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/6/17

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

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Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 9/21/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 28552-232

	Initial	Final	
Backgrnd	N/A	275	
Span Coef	N/A	140	
Flow	N/A	0.6	LPM
Vacuum	N/A	-19.5	mm/Hg
Lamp Volts	N/A	882	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 10/3/2017 **SN:** 14020-144
Glass M= **0.5928** B= **-1.4032**
Steel M= **1.0360** B= **-1.4301**

DVM: Fluke **SN:** 4270385
Cert. Date: 7/21/2017 **ML#:** 8060A
PermTube SN: 33-52573 **Rate:** 2316.59
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 13:36 **Time On:** 13:55
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0003	0.000	n/a	**N/A**	**N/A**
1,967	**1.97**	**5.68**	**3.28**	.4500	N/A	N/A	n/a	.4523	4.630	n/a	**N/A**	**0.5%**
3,933	**3.93**	**9.00**	**5.18**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,374	**7.37**	**14.81**	**8.50**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,062	**11.06**	**21.03**	**12.06**	.0800	N/A	N/A	n/a	.0803	0.081	n/a	**N/A**	**0.4%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/18/17

M =	**#DIV/0!**	M =	**1.00566**
B =	**#DIV/0!**	B =	**-0.00023**
Corr. =	**#DIV/0!**	Corr. =	**1.00000**

Average %

N/A	**0.4%**

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	10/3/2017	**Initial / Final:**		**QTR 1234**	

Instrument: Thermo Scientific Model 43A
SN: 28552-232

	Initial	Final	
Backgrnd	N/A	275	
Span Coef	N/A	140	
Flow	N/A	0.6	LPM
Vacuum	N/A	-19.5	mm/Hg
Lamp Volts	N/A	882	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 10/3/2017 **SN:** 14020-144

Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**

DVM: Fluke **SN:** 4270385
Cert. Date: 7/21/2017 **ML#:** 8060A
PermTube SN: 33-52573 **Rate:** 2316.59
Perm. Oven Temp: 35 **Expiration:**

Comments:

Time Off:	**13:36**	**Time On:**	**13:55**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
Audit:		X	
Other:			

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppb)	DAS	Volt	Chart%	DAS (ppb)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	.0004	0.005	n/a	**NA**	**NA**
1,967	**1.97**	**5.68**	**3.28**	.4500	N/A	N/A	n/a	.4753	4.748	n/a	**NA**	**5.6%**
3,933	**3.93**	**9.00**	**5.18**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**NA**	**NA**
7,374	**7.37**	**14.81**	**8.50**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**NA**	**NA**
11,062	**11.06**	**21.03**	**12.06**	.0800	N/A	N/A	n/a	.0795	0.793	n/a	**NA**	**-0.6%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 11/21/17

M =	**#DIV/0!**	M =	**1.05980**
B =	**#DIV/0!**	B =	**-0.00216**
Corr. =	**#DIV/0!**	Corr. =	**0.99994**

Average %	
NA	**2.5%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	<u>Underlined</u>	Linked Cells

SO2 PERMEATION CALIBRATION

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Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	10/17/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	28552-232		
	Initial	Final	
Backgrnd	N/A	275	
Span Coef	N/A	140	
Flow	N/A	0.6	LPM
Vacuum	N/A	-19.5	mm/Hg
Lamp Volts	N/A	882	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:	Fluke	**SN:**	4270385
Cert. Date:	7/21/2017	**ML#:**	8060A
PermTube SN:	33-52573	**Rate:**	2316.59
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**13:36**	**Time On:**	**13:55**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2(ppm)	DAS	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0003	0.000	n/a	**N/A**	**N/A**
1,967	**1.97**	**5.68**	**3.28**	.4500	N/A	N/A	n/a	.4631	4.630	n/a	**N/A**	**2.9%**
3,933	**3.93**	**9.00**	**5.18**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,374	**7.37**	**14.81**	**8.50**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,062	**11.06**	**21.03**	**12.06**	.0800	N/A	N/A	n/a	.0809	0.081	n/a	**N/A**	**1.1%**

Operator: Aaron Wilson

QC Review: Arthur Carpenito 11/21/17

M =	**#DIV/0!**	M =	**1.03077**
B =	**#DIV/0!**	B =	**-0.00087**
Corr. =	**#DIV/0!**	Corr. =	**1.00000**

Average %	
N/A	**2.0%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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SO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	10/20/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	28552-232		
	Initial	**Final**	
Backgrnd	N/A	275	
Span Coef	N/A	140	
Flow	N/A	0.6	LPM
Vacuum	N/A	-19.5	mm/Hg
Lamp Volts	N/A	882	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:	Fluke	**SN:**	4270385
Cert. Date:	7/21/2017	**ML#:**	8060A
PermTube SN:	33-52573	**Rate:**	2316.59
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**13:36**	**Time On:**	**13:55**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0003	0.000	n/a	**N/A**	**N/A**
1,967	**1.97**	**5.68**	**3.28**	.4500	N/A	N/A	n/a	.4631	4.630	n/a	**N/A**	**2.9%**
3,933	**3.93**	**9.00**	**5.18**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,374	**7.37**	**14.81**	**8.50**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,062	**11.06**	**21.03**	**12.06**	.0800	N/A	N/A	n/a	.0809	0.081	n/a	**N/A**	**1.1%**

Operator: Aaron Wilson

QC Review: Arthur Carpenito 11/21/17

M =	**#DIV/0!**	M =	**1.03077**
B =	**#DIV/0!**	B =	**-0.00087**
Corr. =	**#DIV/0!**	Corr. =	**1.00000**

Average %	
N/A	**2.0%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

Gas Dilution Calibration

Network: Kwajalein Atoll **Site:** Roi-Namur **Instrument:** 43A **S/N:** 28552-232 **Date:** 11-2-2017

Calibrator: 143 **S/N:** 14020-144 **Cal Date:** 10-3-2017 **Cylinder S/N:** ______ **Conc.(ppm)** ______ **Date:** ______

Initial: Zero Pot 2.75 Span Pot 1.4

~~Final:~~ ~~Zero Pot~~ ______ ~~Span Pot~~ ______

Precision and Level One Check ☑

Multipoint Calibration ☐

Other ☐

DAS: CR1000

Strip Chart: ______

Time Off: 0925 **On:** 0939

Flow Setting		Flow (cc/min)		Input	Initial Analyzer DAS Response			Final Analyzer DAS Response		Strip Chart Percent Full Scale		Final Δ%
Span	Dilution	Span	Dilution	(ppm)	(Vdc)	(ppm)	Δ %	(Vdc)	(ppm)	Initial	Final	(≤ 10%)
Ball Height	12.0 Steel Ball			.080	.768	.0768						-4.0
Ball height	5.7 glass Ball			.450	4.575	.4577						1.7

Average Δ% ______

Standards Comparison

Network Calibrator: ______ S/N: ______ Cal Date: ______

Cylinder: ______ S/N: ______ Cal Date: ______

	Reference Calibrator			Network Calibrator			
Input	Span	Dilution	Response	Span	Dilution	Response	Δ%

Signature: Tim Mierop (AD)

QC Review: Arthur Carpenito 12/22/17

Accepted ☑ Rejected ☐

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SO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 11/17/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 28552-232

	Initial	Final	
Backgrnd	N/A	275	
Span Coef	N/A	140	
Flow	N/A	0.6	LPM
Vacuum	N/A	-19.5	mm/Hg
Lamp Volts	N/A	882	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 10/3/2017 **SN:** 14020-144
Glass M= **0.5928** B= **-1.4032**
Steel M= **1.0360** B= **-1.4301**

DVM: Fluke **SN:** 4270385
Cert. Date: 7/21/2017 **ML#:** 8060A
PermTube SN: 33-52573 **Rate:** 2316.59
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 9:45 **Time On:** 10:32
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0006	0.000	n/a	**N/A**	**N/A**
1,967	**1.97**	**5.68**	**3.28**	.4500	N/A	N/A	n/a	.4498	4.496	n/a	**N/A**	**0.0%**
3,933	**3.93**	**9.00**	**5.18**	.2250	N/A	N/A	n/a	.2265	2.267	n/a	**N/A**	**0.7%**
7,374	**7.37**	**14.81**	**8.50**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,062	**11.06**	**21.03**	**12.06**	.0800	N/A	N/A	n/a	.0772	0.775	n/a	**N/A**	**-3.5%**

Operator: Tim Mierop

QC Review: Will Veld 12/21/17

M =	**#DIV/0!**	M =	**1.00359**
B =	**#DIV/0!**	B =	**-0.00120**
Corr. =	**#DIV/0!**	Corr. =	**0.99997**

Average %

N/A	**-1.0%** ✓

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 11/21/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 43A
SN: 28552-232

	Initial	Final	
Backgrnd	N/A	275	
Span Coef	N/A	140	
Flow	N/A	0.6	LPM
Vacuum	N/A	-19.5	mm/Hg
Lamp Volts	N/A	882	(800-1200)
PMT Volts	N/A	N/A	

Calibrator: Thermo 143
Cert. Date: 10/3/2017 **SN:** 14020-144
Glass M= **0.5928** B= **-1.4032**
Steel M= **1.0360** B= **-1.4301**

DVM: Fluke **SN:** 4270385
Cert. Date: 7/21/2017 **ML#:** 8060A
PermTube SN: 33-52573 **Rate:** 2316.59
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 11:45 **Time On:** 12:05
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One: X
Multipoint Calibration:
Audit: X
Other:

Flows and Settings				Initial Readings				Final Readings				Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL				Initial	Final
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%		% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0010	-0.019	n/a		**N/A**	**N/A**
1,967	**1.97**	**5.68**	**3.28**	.4500	N/A	N/A	n/a	.4537	4.539	n/a		**N/A**	**0.8%** ✓
3,933	**3.93**	**9.00**	**5.18**	.2250	N/A	N/A	n/a	.2282	2.287	n/a		**N/A**	**1.4%** ✓
7,374	**7.37**	**14.81**	**8.50**	.1200	N/A	N/A	n/a	N/A	N/A	n/a		**N/A**	**N/A**
11,062	**11.06**	**21.03**	**12.06**	.0800	N/A	N/A	n/a	.0776	0.776	n/a		**N/A**	**-3.0%** ✓

Operator: Tim Mierop

QC Review: Willi Vahl

Initial		Final	
M =	**#DIV/0!**	M =	**1.01310**
B =	**#DIV/0!**	B =	**-0.00160**
Corr. =	**#DIV/0!**	Corr. =	**0.99997**

Average %

N/A	**-0.3%** ✓

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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SO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	12/4/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	28552-232		
	Initial	**Final**	
Backgrnd	N/A	275	
Span Coef	N/A	140	
Flow	N/A	0.6	LPM
Vacuum	N/A	-19.6	mm/Hg
Lamp Volts	N/A	886	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:	Fluke	**SN:**	4270385
Cert. Date:	7/21/2017	**ML#:**	8060A
PermTube SN:	33-52573	**Rate:**	2316.59
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**11:16**	**Time On:**	**12:04**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0010	-0.019	n/a	**N/A**	**N/A**
1,967	**1.97**	**5.68**	**3.28**	.4500	N/A	N/A	n/a	.4664	4.661	n/a	**N/A**	**3.6%**
3,933	**3.93**	**9.00**	**5.18**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,374	**7.37**	**14.81**	**8.50**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,062	**11.06**	**21.03**	**12.06**	.0800	N/A	N/A	n/a	.0792	0.790	n/a	**N/A**	**-1.0%**

Operator: Robert Sicard

QC Review: William Van Eck 12/21/17

M =	**#DIV/0!**	M =	**1.04109**
B =	**#DIV/0!**	B =	**-0.00239**
Corr. =	**#DIV/0!**	Corr. =	**0.99998**

Average %	
N/A	**1.3%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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SO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	12/15/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 43A		
SN:	28552-232		
	Initial	Final	
Backgrnd	N/A	275	
Span Coef	N/A	140	
Flow	N/A	0.6	LPM
Vacuum	N/A	-19.5	mm/Hg
Lamp Volts	N/A	882	(800-1200)
PMT Volts	N/A	N/A	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:	Fluke	**SN:**	4270385
Cert. Date:	7/21/2017	**ML#:**	8060A
PermTube SN:	33-52573	**Rate:**	2316.59
Perm. Oven Temp:	35	**Expiration:**	

Comments:	Final take down Calibration		
Time Off:	**11:45**	**Time On:**	**12:05**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:		x	
	Audit:		
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		SO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	.0014	0.014	n/a	**N/A**	**N/A**
1,967	**1.97**	**5.68**	**3.28**	.4500	N/A	N/A	n/a	.4601	4.606	n/a	**N/A**	**2.2%**
3,933	**3.93**	**9.00**	**5.18**	.2250	N/A	N/A	n/a	.2324	2.323	n/a	**N/A**	**3.3%**
7,374	**7.37**	**14.81**	**8.50**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,062	**11.06**	**21.03**	**12.06**	.0800	N/A	N/A	n/a	.0748	0.748	n/a	**N/A**	**-6.5%**

Operator: Robert Sicard

QC Review: William Van Eck 12/21/17

M =	**#DIV/0!**	M =	**1.02742**
B =	**#DIV/0!**	B =	**-0.00175**
Corr. =	**#DIV/0!**	Corr. =	**0.99979**

Average %

N/A	**-0.3%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

NO2 PERMEATION CALIBRATION

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Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 9/12/2017 **Initial / Final:** Startup **QTR 1234**

Instrument: Thermo Scientific Model 42
SN: 38757-258

	Initial	Final	
Backgrnd	N/A	26.3	
Span Coef	N/A		
Vacuum	N/A	21	in/Hg
Cooler Tmp	N/A	-3.9	C
Conv. Temp	N/A	336	C
RC Temp	N/A	49.9	C

Calibrator: Thermo 143
Cert. Date: 9/11/2017 **SN:** 14020-144
Glass M= **0.5983** B= **-1.4567**
Steel M= **1.0612** B= **-1.5012**

DVM: Fluke **SN:** 4270385
Cert. Date: 7/21/2017 **ML#:** 8060A
PermTube SN: 59-52580 **Rate:** 1673.19
Perm. Oven Temp: 35 **Expiration:**

Comments:

Time Off:	**12:18**	**Time On:**	**15:07**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:	X		
Audit:	X		
Other:			

Flows and Settings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.43**	**1.41**	.0000	N/A	N/A	n/a	-.0021	-0.026	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.74**	**3.28**	.4500	N/A	N/A	n/a	.4456	4.522	n/a	**N/A**	**-1.0%**
3,956	**3.96**	**9.05**	**5.14**	.2250	N/A	N/A	n/a	.2249	2.224	n/a	**N/A**	**0.0%**
7,418	**7.42**	**14.83**	**8.40**	.1200	N/A	N/A	n/a	.1194	1.195	n/a	**N/A**	**-0.5%**
11,127	**11.13**	**21.03**	**11.90**	.0800	N/A	N/A	n/a	.0755	0.753	n/a	**N/A**	**-5.6%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/6/17

M =	**#DIV/0!**	M =	**0.99680**
B =	**#DIV/0!**	B =	**-0.00178**
Corr. =	**#DIV/0!**	Corr. =	**0.99993**

Average %

N/A	**-1.8%**

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation <u>Underlined</u> Linked Cells

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NO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 9/16/2017 **Initial / Final:** Repair **QTR 1234**

Instrument: Thermo Scientific Model 42
SN: 38757-258

	Initial	Final	
Backgrnd 3	3.0	2.9	
BF:	0.711	0.711	
Vacuum	-22.00	-20.00	in/Hg
SF	0.531	0.631	
Backgrnd 1	1.4	1.9	
Converter E	96.7	96.7	

Calibrator: Thermo 143
Cert. Date: 9/11/2017 **SN:** 14020-144
Glass M= 0.5928 B= -1.4032
Steel M= 1.0360 B= -1.4301
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52580 **Rate:** 1673.19
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 7:20 **Time On:** 9:48
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One:
Multipoint Calibration: X
Audit: x
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	0.00	2.37	1.38	.0000	-.0116	-0.118	n/a	-.0010	0.002	n/a	N/A	N/A
1,978	1.98	5.70	3.29	.4500	.3833	3.833	n/a	.4539	4.684	n/a	-14.8%	0.9%
3,956	3.96	9.04	5.20	.2250	.1871	1.871	n/a	.2249	2.328	n/a	-16.8%	0.0%
7,418	7.42	14.88	8.54	.1200	.0805	0.081	n/a	.1165	1.233	n/a	-32.9%	-2.9%
11,127	11.13	21.14	12.12	.0800	.0434	0.434	n/a	.0755	0.767	n/a	-45.8%	-5.6%

	Initial		Final	
	M =	0.89604	M =	1.01542
	B =	-0.02027	B =	-0.00374
	Corr. =	0.99888	Corr. =	0.99994

Average %

-27.6%	-1.9%

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/18/17

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

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Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 9/21/2017 **Initial / Final:** Repair **QTR 1234**

Instrument: Thermo Scientific Model 42
SN: 38757-258

	Initial	Final	
Backgrnd 3	6.0	3.0	
BF:	0.906	0.711	
Vacuum	-17.75	-22.00	in/Hg
SF	0.531	0.531	
Backgrnd 1	1.5	1.4	
Converter E	96.9	96.7	

Calibrator: Thermo 143
Cert. Date: 10/3/2017 **SN:** 14020-144
Glass M= **0.5928** B= **-1.4032**
Steel M= **1.0360** B= **-1.4301**

DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52580 **Rate:** 1673.19
Perm. Oven Temp: 35 **Expiration:**

Comments:
Time Off: 8:17 **Time On:** 11:15
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One:
Multipoint Calibration: X
Audit: X
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS(ppm)	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0001	-0.005	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.70**	**3.29**	.4500	N/A	N/A	n/a	.3840	4.273	n/a	**N/A**	**-14.7%**
3,956	**3.96**	**9.04**	**5.20**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,418	**7.42**	**14.88**	**8.54**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,127	**11.13**	**21.14**	**12.12**	.0800	N/A	N/A	n/a	.0430	0.728	n/a	**N/A**	**-46.3%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 10/10/17

	Initial		Final
M =	**#DIV/0!**	M =	**0.87468**
B =	**#DIV/0!**	B =	**-0.01223**
Corr. =	**#DIV/0!**	Corr. =	**0.99790**

Average %

Initial	Final
N/A	**-30.5%**

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	10/3/2017	**Initial / Final:**	Repair	**QTR 1234**	

Instrument:	Thermo Scientific Model 42		
SN:	38757-258		
	Initial	**Final**	
Backgrnd 3	6.0	3.0	
BF:	0.906	0.711	
Vacuum	-17.75	-22.00	in/Hg
SF	0.531	0.531	
Backgrnd 1	1.5	1.4	
Converter E	96.9	96.7	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52580	**Rate:**	1673.19
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**8:17**	**Time On:**	**11:15**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:	X		
Audit:	X		
Other:			

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppb)	DAS	Volt	Chart%	DAS (ppb)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	-.0042	-0.043	n/a	-.0002	-0.005	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.70**	**3.29**	.4500	.3510	3.513	n/a	.4561	4.556	n/a	**-22.0%**	**1.4%**
3,956	**3.96**	**9.04**	**5.20**	.2250	.1743	0.174	n/a	.2213	2.208	n/a	**-22.5%**	**-1.6%**
7,418	**7.42**	**14.88**	**8.54**	.1200	N/A	N/A	n/a	.1103	0.110	n/a	**NA**	**-8.1%**
11,127	**11.13**	**21.14**	**12.12**	.0800	.0529	0.525	n/a	.0735	0.735	n/a	**-33.9%**	**-8.1%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 11/21/17

M =	**0.79523**	M =	**1.02217**
B =	**-0.00660**	B =	**-0.00668**
Corr. =	**0.99982**	Corr. =	**0.99965**

Average %	
-26.1%	**-4.1%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	10/17/2017	**Initial / Final:**	Repair	**QTR 1234**

Instrument:	Thermo Scientific Model 42		
SN:	38757-258		
	Initial	**Final**	
Backgrnd 3	6.0	3.0	
BF:	0.906	0.711	
Vacuum	-17.75	-22.00	in/Hg
SF	0.531	0.531	
Backgrnd 1	1.5	1.4	
Converter E	96.9	96.7	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52580	**Rate:**	1673.19
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**8:17**	**Time On:**	**11:15**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:	X		
Audit:	X		
Other:			

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS	Volt	Chart%	DAS(ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0002	-0.005	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.70**	**3.29**	.4500	N/A	N/A	n/a	.4273	4.273	n/a	**N/A**	**-5.0%**
3,956	**3.96**	**9.04**	**5.20**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,418	**7.42**	**14.88**	**8.54**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,127	**11.13**	**21.14**	**12.12**	.0800	N/A	N/A	n/a	.0729	0.728	n/a	**N/A**	**-8.9%**

Operator: Aaron Wilson

QC Review: Arthur Carpenito 11/21/17

.

M =	**#DIV/0!**	M =	**0.95243**
B =	**#DIV/0!**	B =	**-0.00160**
Corr. =	**#DIV/0!**	Corr. =	**0.99998**

Average %	
N/A	**-7.0%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	10/20/2017	**Initial / Final:**	Repair	**QTR 1234**	

Instrument:	Thermo Scientific Model 42		
SN:	38757-258		
	Initial	**Final**	
Backgrnd 3	3.0	2.9	
BF:	0.711	0.711	
Vacuum	-22.00	-20.00	in/Hg
SF	0.531	0.631	
Backgrnd 1	1.4	1.9	
Converter E	96.7	96.7	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52580	**Rate:**	1673.19
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**8:04**	**Time On:**	**11:15**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:	X		
Audit:	x		
Other:			

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2(ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	-.0023	-0.002	n/a	.0023	0.002	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.70**	**3.29**	.4500	.4100	4.110	n/a	.4684	4.684	n/a	**-8.9%**	**4.1%**
3,956	**3.96**	**9.04**	**5.20**	.2250	.2057	2.057	n/a	.2328	2.328	n/a	**-8.6%**	**3.5%**
7,418	**7.42**	**14.88**	**8.54**	.1200	.1118	1.117	n/a	.1233	1.233	n/a	**-6.8%**	**2.8%**
11,127	**11.13**	**21.14**	**12.12**	.0800	.0717	0.072	n/a	.0767	0.767	n/a	**-10.4%**	**-4.1%**

Operator: Aaron Wilson

QC Review: Arthur Carpenito 11/21/17

M =	**0.91454**	M =	**1.04288**
B =	**-0.00067**	B =	**-0.00181**
Corr. =	**0.99994**	Corr. =	**0.99984**

Average %	
-8.7%	**1.5%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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NO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 11/2/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN: 38757-258

	Initial	Final	
Backgrnd 3	N/A	3.0	
BF:	N/A	0.571	
Vacuum	N/A	-20.00	in/Hg
SF	N/A	0.820	
Backgrnd 1	N/A	2.0	
Converter E	N/A	96.7	

Calibrator: 230 Dynacalibrator
Cert. Date: 11/2/2017 **SN:** M-902
Glass M= **0.9200** B= **-2.4609**
Steel M= **1.0000** B= **0.0000**

DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52586 **Rate:** 1529.74
Perm. Oven Temp: 35 **Expiration:**

Comments: Data taken from 1Minute Raw
Time Off: 9:45 **Time On:** 11:58
DAS: CR1000 S/N:
Strip Chart: S/N:
Precision & Level One:
Multipoint Calibration: X
Audit:
Other:

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2	DAS	Volt	Chart%	DAS	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.67**	**0.00**	.0000	N/A	N/A	n/a	-.0010	N/A	n/a	**N/A**	**N/A**
1,808	**1.81**	**4.64**	**1.81**	.4500	N/A	N/A	n/a	.4224	N/A	n/a	**N/A**	**-6.1%**
3,617	**3.62**	**6.61**	**3.62**	.2250	N/A	N/A	n/a	.2240	N/A	n/a	**N/A**	**-0.4%**
6,782	**6.78**	**10.05**	**6.78**	.1200	N/A	N/A	n/a	.1248	N/A	n/a	**N/A**	**4.0%**
10,173	**10.17**	**13.73**	**10.17**	.0800	N/A	N/A	n/a	.0778	N/A	n/a	**N/A**	**-2.8%**

M =	**#DIV/0!**	M =	**0.93775**
B =	**#DIV/0!**	B =	**0.00549**
Corr. =	**#DIV/0!**	Corr. =	**0.99916**

Average %

N/A	**-1.3%**

Operator: Tim Mierop

QC Review: Arthur Carpenito 12/26/17

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 11/17/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN: 38757-258

	Initial	Final	
Backgrnd 3	2.0	1.9	
BF:	0.571	0.413	
Vacuum	-18.25	-22.75	in/Hg
SF	0.820	0.749	
Backgrnd 1	3.0	1.5	
Converter E	96.7	96.4	

Calibrator: Thermo 143
Cert. Date: 10/3/2017 **SN:** 14020-144
Glass M= **0.5928** B= **-1.4032**
Steel M= **1.0360** B= **-1.4301**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52580 **Rate:** 1673.19
Perm. Oven Temp: 35 **Expiration:**

Comments: not achievable on initial, lack of dilutio

Time Off:	**8:16**	**Time On:**	**10:15**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:		X	
	Audit:	X	
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		Glass Ball	Steel Ball	Input	INITIAL			FINAL			Initial	Final
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	.0008	0.008	n/a	.0000	0.001	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.70**	**3.29**	.4500	.4347	4.334	n/a	.4475	4.465	n/a	**-3.4%**	**-0.6%**
3,956	**3.96**	**9.04**	**5.20**	.2250	.2134	2.133	n/a	.2225	2.220	n/a	**-5.2%**	**-1.1%**
7,418	**7.42**	**14.88**	**8.54**	.1200	.1113	1.114	n/a	.1152	1.154	n/a	**-7.3%**	**-4.0%**
10,472	**10.47**	**20.03**	**11.49**	.0850	.0730	0.731	n/a	.0745	0.740	n/a	**-14.1%**	**-12.4%**

Operator: Tim Mierop

QC Review: 12/21/17

	Initial		Final
M =	**0.97228**	M =	**1.00348**
B =	**-0.00448**	B =	**-0.00467**
Corr. =	**0.99974**	Corr. =	**0.99974**

Average %

-7.5% ✓	**-4.5%** ✓

1234 Data Entry | .500 | Conc. Entry | 0.500 | DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

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Network: Kwajalein Range Svcs **Site:** Roi Namur **Date:** 11/21/2017 **Initial / Final:** QTR 1234

Instrument: Thermo Scientific Model 42
SN: 38757-258

	Initial	Final	
Backgrnd 3	1.9	3.9	
BF:	0.413	0.508	
Vacuum	-22.75	-22.75	in/Hg
SF	0.749	0.749	
Backgrnd 1	1.5	1.9	
Converter E	96.4	96.4	

Calibrator: Thermo 143
Cert. Date: 10/3/2017 **SN:** 14020-144
Glass M= **0.5928** B= **-1.4032**
Steel M= **1.0360** B= **-1.4301**
DVM: **SN:**
Cert. Date: **ML#:**
PermTube SN: 59-52580 **Rate:** 1673.19
Perm. Oven Temp: 35 **Expiration:**

Comments:

Time Off:	**7:45**	**Time On:**	**10:15**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:		X	
	Audit:	X	
	Other:		

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow CCM	Total Flow LPM	Glass Ball (Read Top of Ball)	Steel Ball (Read Top of Ball)	Input NO2(ppm)	INITIAL DAS	INITIAL Volt	Chart%	FINAL DAS (ppm)	FINAL Volt	Chart%	Initial % Error	Final % Error
0.00	**0.00**	**2.37**	**1.38**	.0000	-.0010	0.001	n/a	-.0010	0.001	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.70**	**3.29**	.4500	.4280	4.284	n/a	.4940	4.942	n/a	**-4.9%** ✓	**9.8%** ✓
3,956	**3.96**	**9.04**	**5.20**	.2250	.2061	2.067	n/a	.2418	2.418	n/a	**-8.4%** ✓	**7.5%** ✓
7,418	**7.42**	**14.88**	**8.54**	.1200	.0968	0.963	n/a	.1137	1.138	n/a	**-19.3%** ✓	**-5.3%** ✓
11,127	**11.13**	**21.14**	**12.12**	.0800	.0604	0.603	n/a	.0689	0.691	n/a	**-24.5%** ✓	**-13.9%**

Operator: Tim Mierop

QC Review: 12/21/17

	Initial		Final
M =	**0.96952**	M =	**1.12017**
B =	**-0.01161**	B =	**-0.01255**
Corr. =	**0.99904**	Corr. =	**0.99908**

Average %

-14.3%	**-0.5%** ✓

1234 Data Entry .500 Conc. Entry 0.500 DAS Entry **BOLD #'s** Calculation Underlined Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	11/30/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 42		
SN:	38757-258		
	Initial	**Final**	
Backgrnd 3	3.8	3.8	
BF:	0.642	0.642	
Vacuum	-21.80	-21.80	in/Hg
SF	0.826	0.826	
Backgrnd 1	1.6	1.6	
Converter E	97.3	97.3	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52580	**Rate:**	1673.19
Perm. Oven Temp:	35	**Expiration:**	

Comments:	Start up Cal after pump Failure		
Time Off:	**7:45**	**Time On:**	**10:15**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:	X		
Audit:			
Other:	Pump Failure		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0010	0.001	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.70**	**3.29**	.4500	N/A	N/A	n/a	.4437	4.437	n/a	**N/A**	**-1.4%**
3,956	**3.96**	**9.04**	**5.20**	.2250	N/A	N/A	n/a	.2067	2.067	n/a	**N/A**	**-8.1%**
7,418	**7.42**	**14.88**	**8.54**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,127	**11.13**	**21.14**	**12.12**	.0800	N/A	N/A	n/a	.0739	0.691	n/a	**N/A**	**-7.6%**

Operator: Robert Sicard

QC Review: William Van Eck 12/21/17

M =	**#DIV/0!**	M =	**0.98751**
B =	**#DIV/0!**	B =	**-0.00556**
Corr. =	**#DIV/0!**	Corr. =	**0.99937**

Average %	
N/A	**-5.7%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

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NO2 PERMEATION CALIBRATION

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	12/4/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 42		
SN:	38757-258		
	Initial	**Final**	
Backgrnd 3	3.8	3.8	
BF:	0.684	0.684	
Vacuum	-21.80	-21.80	in/Hg
SF	0.749	0.749	
Backgrnd 1	1.9	1.9	
Converter E	98.2	98.2	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52580	**Rate:**	1673.19
Perm. Oven Temp:	35	**Expiration:**	

Comments:			
Time Off:	**11:40**	**Time On:**	**12:06**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:		X	
Multipoint Calibration:			
Audit:		X	
Other:			

Flows andSettings				Initial Readings				Final Readings			Delta %	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0010	0.001	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.70**	**3.29**	.4500	N/A	N/A	n/a	.4790	4.791	n/a	**N/A**	**6.4%**
3,956	**3.96**	**9.04**	**5.20**	.2250	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
7,418	**7.42**	**14.88**	**8.54**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,127	**11.13**	**21.14**	**12.12**	.0800	N/A	N/A	n/a	.0871	0.870	n/a	**N/A**	**8.9%**

M =	**#DIV/0!**	M =	**1.06435**
B =	**#DIV/0!**	B =	**0.00033**
Corr. =	**#DIV/0!**	Corr. =	**0.99998**

Operator: Robert Sicard

QC Review: William Van Eck 12/21/17

Average %	
N/A	**7.7%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

NO2 PERMEATION CALIBRATION

AECOM
325 Ayer Road Harvard, MA. 01451
T 978.772.2345 F 978.772.4956
www.aecom.com

Network:	Kwajalein Range Svcs	**Site:**	Roi Namur	**Date:**	12/15/2017	**Initial / Final:**		**QTR 1234**	

Instrument:	Thermo Scientific Model 42		
SN:	38757-258		
	Initial	**Final**	
Backgrnd 3	1.9	3.9	
BF:	0.413	0.508	
Vacuum	-22.75	-22.75	in/Hg
SF	0.749	0.749	
Backgrnd 1	1.5	1.9	
Converter E	96.4	96.4	

Calibrator:	Thermo 143		
Cert. Date:	10/3/2017	**SN:**	14020-144
Glass M=	**0.5928**	B=	**-1.4032**
Steel M=	**1.0360**	B=	**-1.4301**
DVM:		**SN:**	
Cert. Date:		**ML#:**	
PermTube SN:	59-52580	**Rate:**	1673.19
Perm. Oven Temp:	35	**Expiration:**	

Comments:	Final take down Calibration		
Time Off:	**7:45**	**Time On:**	**10:15**
DAS:	CR1000	S/N:	
Strip Chart:		S/N:	
Precision & Level One:			
Multipoint Calibration:		X	
	Audit:	X	
	Other:		

Flows andSettings				**Initial Readings**				**Final Readings**			**Delta %**	
Total Flow		**Glass Ball**	**Steel Ball**	**Input**	**INITIAL**			**FINAL**			**Initial**	**Final**
CCM	LPM	Read Top of Ball		NO2 (ppm)	DAS	Volt	Chart%	DAS (ppm)	Volt	Chart%	% Error	% Error
0.00	**0.00**	**2.37**	**1.38**	.0000	N/A	N/A	n/a	-.0092	-0.092	n/a	**N/A**	**N/A**
1,978	**1.98**	**5.70**	**3.29**	.4500	N/A	N/A	n/a	.4551	4.554	n/a	**N/A**	**1.1%**
3,956	**3.96**	**9.04**	**5.20**	.2250	N/A	N/A	n/a	.2113	2.110	n/a	**N/A**	**-6.1%**
7,418	**7.42**	**14.88**	**8.54**	.1200	N/A	N/A	n/a	N/A	N/A	n/a	**N/A**	**N/A**
11,127	**11.13**	**21.14**	**12.12**	.0800	N/A	N/A	n/a	.0771	0.771	n/a	**N/A**	**-3.6%**

Operator: Robert Sicard

QC Review: William Van Eck 12/21/17

.

M =	**#DIV/0!**	M =	**1.02468**
B =	**#DIV/0!**	B =	**-0.00983**
Corr. =	**#DIV/0!**	Corr. =	**0.99948**

Average %

N/A	**-2.9%**

1234	Data Entry	.500	Conc. Entry	0.500	DAS Entry	**BOLD #'s**	Calculation	Underlined	Linked Cells

One-Point Flow Rate Verification Check Data Sheet
For Met One BAM Particulate Monitors

Date & Time: 9/12/17 14:30
Operator : R. Sicard
Location : Roi Lamur
Network : Marshall Islands (KRS)
BAM S/N : G4599

Reference Standard:

Flows – Model: DeltaCal **S/N:** 903 6/28/17
Temperature – Model: TelaTemp **S/N:** 358659 10/18/17
Barometric Pressure – Model: PTB 330 **S/N:** C4310002 3/27/18

Verification Specifications	Display (BAM)	Audit (deltaCal)	Difference
Amb. Temperature (°C)	AT= 30.1	Ta = 30.0	AT-Ta = 0.1 ✓
Amb. Pressure (mm Hg)	BP_D = 755	BP_A = 755	BP_D-BP_A = 0.0 ✓
Flow Rate (1) (LPM)	Flow Rate = 16.87	Qa = 16.5	$\frac{Flow-Qa}{Qa}*100\%$ = 1.2%
Flow Rate (2) (LPM)	N/A		$\frac{Qa-16.7}{16.7}*100\%$ = 1.2%
Leak Check (LPM)	Flow Rate =	1.0	Pass: Yes ☒ No ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : **Temperature within +/- 2 °C**
Barometric Pressure within +/- 10 mm Hg
Flow Rate (1) – Display is within +/- 4% of Reference Standard
Flow Rate (2) – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)
Leak Check – Display must be less than 1.0 LPM.

Comments: Good test, Everything appeared normal.

Rev. RW 9/21/17

One-Point Flow Rate Verification Check Data Sheet
For Met One BAM Particulate Monitors

Date & Time: 10-24-2017 0717

Operator : AECOM

Location : Roi

Network : Kwagalein Atoll - KRS

BAM S/N : G4594

Reference Standard:

Flows – Model: Δ Cal **S/N:** 903

Temperature – Model: **S/N:**

Barometric Pressure – Model: **S/N:**

Verification Specifications	**Display (BAM)**	**Audit (deltaCal)**	**Difference**
Amb. Temperature (^{0}C)	AT= 27.9	Ta = 28.6	AT-Ta = -0.7
Amb. Pressure (mm Hg)	BP_D = 761	BP_A = 759.5	BP_D-BP_A = -1.5
Flow Rate (1) (LPM)	Flow Rate = 16.7	Qa = 17.34	$\frac{Flow-Qa}{Qa}*100\%$ = -3.82
Flow Rate (2) (LPM)	**N/A**		$\frac{Qa-16.7}{16.7}*100\%$ =
Leak Check (LPM)	Flow Rate = 0.3	**1.0**	**Pass: Yes** ☒ **No** ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : **Temperature within +/- 2 ^{0}C**
Barometric Pressure within +/- 10 mm Hg
Flow Rate (1) – Display is within +/- 4% of Reference Standard
Flow Rate (2) – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)
Leak Check – Display must be less than 1.0 LPM.

Comments:

One-Point Flow Rate Verification Check Data Sheet
For Met One BAM Particulate Monitors

Date & Time: 12/4/2017

Operator : R. Sicard

Location : Roi

Network : Marshall Islands (KRS)

BAM S/N : G 4594

Reference Standard:

Flows – Model: Delta Cal **S/N:** 903 6/28/17

Temperature – Model: Telatemp **S/N:** 358654 10/18/17

Barometric Pressure – Model: PTB 330 **S/N:** C4310002 3/27/18

Verification Specifications	Display (BAM)	Audit (deltaCal)	Difference
Amb. Temperature (^{0}C)	AT= 29.8	Ta = 29.8	AT-Ta = 0.0
Amb. Pressure (mm Hg)	BP_D = 757	BP_A = 758	BP_D-BP_A = 0.1
Flow Rate (1) (LPM)	Flow Rate = 16.7	Qa = 16.6	$\frac{Flow-Qa}{Qa}$ *100% = +0.6 %
Flow Rate (2) (LPM)	N/A		$\frac{Qa-16.7}{16.7}$ *100% = 0.6 %
Leak Check (LPM)	Flow Rate = < 1.0	1.0	Pass: Yes ☑ No ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : **Temperature within +/- 2 ^{0}C**
Barometric Pressure within +/- 10 mm Hg
Flow Rate (1) – Display is within +/- 4% of Reference Standard
Flow Rate (2) – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)
Leak Check – Display must be less than 1.0 LPM.

Comments: Running Good. System still pretty Clean.

One-Point Flow Rate Verification Check Data Sheet

For Met One BAM Particulate Monitors

Date & Time: 12/15/17 09:50

Operator : R. Sicard

Location : Roi-Lamur

Network : Kwajalein (Roi-Lamur)

BAM S/N : 64594

Reference Standard:

Flows – Model: DeltaCal **S/N:** 903

Temperature – Model: Telatemp **S/N:** 358654

Barometric Pressure – Model: C4310002 **S/N:** C4310002 Vaisala PTB330

Verification Specifications	Display (BAM)	Audit (deltaCal)	Difference
Amb. Temperature (^{0}C)	AT= 80.9/27.2	Ta = 80.7/27.1	AT-Ta = 0.01
Amb. Pressure (mm Hg)	BP_D = 756.0	BP_A = 756.5	BP_D-BP_A = 0.5
Flow Rate (1) (LPM)	Flow Rate = 16.7	Qa = 16.65	$\frac{Flow-Qa}{Qa} * 100\%$ = <1.2%
Flow Rate (2) (LPM)	N/A		$\frac{Qa-16.7}{16.7} * 100\%$ = <1.1%
Leak Check (LPM)	Flow Rate = <0.1	1.0 <0.2	Pass: Yes ☒ No ☐

*****If any criteria fail verification specifications, call AECOM for instruction.*****

Verification Specs : **Temperature within +/- 2 ^{0}C**

Barometric Pressure within +/- 10 mm Hg

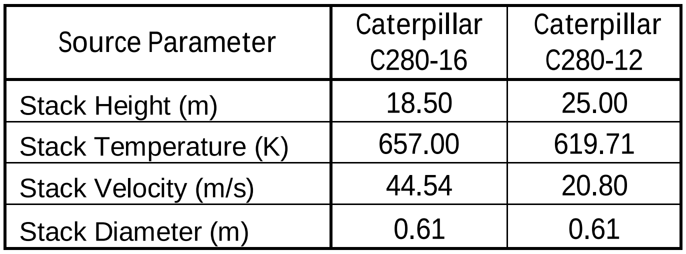
Flow Rate (1) – Display is within +/- 4% of Reference Standard

Flow Rate (2) – Audit is within +/- 5% of 16.7 LPM (15.84 to 17.50 LPM)

Leak Check – Display must be less than 1.0 LPM.

Comments: Looks good

Appendix F – Power Plant Annex Engine Specification Comparison



Source Parameter	Caterpillar C280-16	Caterpillar C280-12
Stack Height (m)	18.50	25.00
Stack Temperature (K)	657.00	619.71
Stack Velocity (m/s)	44.54	20.80
Stack Diameter (m)	0.61	0.61

APPENDIX B

RESERVED

APPENDIX C

NCA FOR AIR EMISSIONS FROM MAJOR, SYNTHETIC MINOR, AND INDUSTRIAL BOILER STATIONARY SOURCES,

NCA-11-001.0, 28 FEBRUARY 2013

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NOTICE OF CONTINUING ACTIVITY

ACTIVITY:
AIR EMISSIONS FROM MAJOR, SYNTHETIC MINOR, AND INDUSTRIAL BOILER STATIONARY SOURCES

CONTROL NUMBER NCA-11-001.0

FEBRUARY 2013

U.S. ARMY KWAJALEIN ATOLL IN THE
REPUBLIC OF THE MARSHALL ISLANDS

PREPARED BY TELEDYNE BROWN ENGINEERING, INC.
HUNTSVILLE, ALABAMA

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NOTICE OF CONTINUING ACTIVITY
(NCA)
AIR EMISSIONS FROM MAJOR STATIONARY SOURCES

DATE SUBMITTED: February 2013

REFERENCES

- J. W. Morrow. *Air Quality Impact Report (AQIR)*, U.S. Army Kwajalein Atoll (USAKA), Kwajalein, August 12, 2012
- J. W. Morrow. *AQIR*, USAKA, Roi-Namur, August 6, 2012
- U.S. Army Kwajalein Atoll/Kwajalein Missile Range. *Document of Environmental Protection: Air Emissions from Major Stationary Sources at USAKA/KMR* (Control Number DEP-05-001.1). September 21, 2006; modified December 16, 2010
- U.S. Army Space and Missile Defense Command. *Environmental Standards and Procedures for United States Army Kwajalein Atoll (USAKA) Activities in the Republic of the Marshall Islands*. Twelfth Edition. August 2011. Section 2-17.3, Section 3.1
- U. S. Environmental Protection Agency. 40 Code of Federal Regulations (CFR) Parts 50, 53, 58, 60, and 63
- USAKA Air Toxics Report and Emissions Inventory Calendar Year 2003 (CY03) Kwajalein Range Services, Inc., May 15, 2004.

TYPE OF ACTIVITY

The activities described herein are for the continuing emission of air pollutants from existing and modified major or synthetic minor stationary sources at USAKA. The NCA and subsequent Document of Environmental Protection (DEP) establish operational limitations and associated monitoring and records-keeping requirements for sources that will not operate at full capacity and would otherwise be major sources, and for sources with operational limitations necessary to maintain air quality standards.

LOCATION OF ACTIVITY

The USAKA leased islands of Kwajalein, Roi-Namur, and Meck.

COMPLIANCE STATUS

USAKA is in substantive compliance with DEP-05-001.1, and with the USAKA Environmental Standards (UES), Twelfth Edition, dated August 2011. The analyses of sources have identified several instances where new Ambient Air Quality Standards (AAQS) are potentially exceeded. U.S. National AAQS (NAAQS) were modified in 2006, 2010 and 2012 resulting in the occurrence of exceedances. The exceedances and remedies are discussed in NCA Section 6.0.

TABLE OF CONTENTS

TABLES

CHAPTERS

ABBREVIATIONS AND ACRONYMS

AAQS	Ambient Air Quality Standards
AQIR	Air Quality Impact Report
CFR	Code of Federal Regulations
CI	Compression Ignition
CO	Carbon Monoxide
CY	Calendar Year
DEP	Document of Environmental Protection
Gensets	Diesel- And Gasoline-Fueled Generator Sets
HAPS	Hazardous Air Pollutant Standards
KMR	Kwajalein Missile Range
kW	Kilowatt
MDA	Missile Defense Agency
MEP	Mobile Electric Power
MMBtu/Hr	One Million British Thermal Units Per Hour
MOGAS	Mobility or Motor Gas
MPH	Miles Per Hour
MSW	Municipal Solid Waste
MW	Megawatt
NAAQs	National Ambient Air Quality Standards
NCA	Notice of Continuing Activity
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NO_2	Nitrogen Dioxide
$PM_{2.5}$	Particulate Matter (2.5 microns or less)
PM_{10}	Particulate Matter (10 microns or less)
ppb	Parts Per Billion
ppm	Parts Per Million
RICE	Reciprocating Internal Combustion Engine
RSL	Regional Screening Level
RTS	Ronald Reagan Ballistic Missile Defense Test Site
PTE	Potential to Emit
SO_2	Sulfur Dioxide
Synthetic Minor	An emissions source that is rendered a minor source when its PTE is based on limits contained in a DEP
TPD	Tons Per Day
TPY	Tons Per Year
UES	USAKA Environmental Standards
U.S.	United States
USAKA	U.S. Army Kwajalein Atoll
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound
VPPF	Vehicle Paint and Preparation Facility
$\mu g/m^3$	Micrograms per cubic meter

1.0 TECHNICAL DESCRIPTION OF ACTIVITY

The purpose of this Notice of Continuing Activity (NCA), NCA-11-001.0 and the companion Document of Environmental Protection (DEP), DEP-11-001.1, is to incorporate and update the activities covered by DEP-05.001.1, *Air Emissions from Major Stationary Sources at USAKA/Ronal Reagan Ballistic Missile Defense Test Site (RTS)*, the *Skid-Mounted Back-up Generators Minor Modification* to DEP-05.001.1, and the *FTI-01 Minor Modification* to DEP-05.001.1. This NCA addresses the modification to allow limited operation of four skid-mounted generators, and reflect a replacement generator for the Kwajalein Power Plant; and a modification to allow limited operation of numerous generators associated with the Flight Test Integrated-01 Missile Defense Agency (MDA) program. This document also reflects USAKA Environmental Standards (UES) 12th Edition revisions effective August 27, 2011 and new NAAQS that have come into effect since DEP-05.001.1 was completed in 2006.

If a stationary source has Potential to Emit (PTE) pollutants in excess of the stated thresholds at UES Table 3-1.5.2, the source is a “major” source. The definition of PTE was revised in DEP-05.001.1 to require the documentation and verification of the application of operational controls, or pollution control devices, for sources that would be “major” sources without the application of the controls (referred to as a “synthetic minor” source).

1.1 Air Quality Requirements Updates

1.1.1 Revised or New AAQS

Since DEP-5-001.1 was completed in 2006, changes have occurred in U.S. air quality requirements that directly affect the UES and USAKA. These changes include:

- Revised U.S. National Ambient Air Quality Standards (NAAQS)
    - New 24-hour $PM_{2.5}$ standard of 35 micrograms per cubic meter ($\mu g/m^{3)}$ (3-year average of the 98th percentile values), effective December 2006
    - New annual $PM_{2.5}$ standard of 12 micrograms per cubic meter ($\mu g/m^3$) (3-year average), effective December 2012
    - Revoke annual PM_{10} standard, effective December 2006
    - New 1-hour NO_2 standard of 100 parts per billion (ppb) (3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations), effective April 2010
    - New 1-hour SO_2 standard of 75 ppb (3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations), effective August 2010
    - Revoke annual SO_2 standard, effective August 2010

The revised NAAQS are considered health-based standards and are effective under the UES upon their effective date in the U.S., unless they are modified as part of the UES periodic review process (UES§2-22.2). The UES AAQS is equal to 80% of the corresponding NAAQS.

1.1.2 Revised National Emission Standards for Hazardous Air Pollutants (NESHAPs) Standards

Two relatively new NESHAPs rules have been promulgated since DEP-05.001.1 became effective that are applicable to some emission units at USAKA:

- 40 Code of Federal Regulations (CFR) Part 63, Subpart JJJJJJ – Industrial, Commercial and Institutional Boilers and Process Heaters at Area Sources, March 2011
- 40 CFR Part 63, Subpart ZZZZ – Reciprocating Internal Combustion Engines (RICE) [constructed before June 2006], March 2010

The UES do not automatically adopt new NESHAPs. However, NCAs must include an assessment of NESHAPs compliance (UES§3-1.5.2(b)(4)(iii) and 3-1.5.3).

1.1.2.1 40 Code of Federal Regulations (CFR) Part 63, Subpart ZZZZ – Reciprocating Internal Combustion Engines (RICE)

The portions of the rule that are relevant for USAKA are the requirements for stationary, compression ignition (CI) engines constructed before June 12, 2006, that are located at an area source of hazardous air pollutants (HAPs). Engines constructed after June 12, 2006 are subject to the New Source Performance Standard at 40CFR Part 60, Subpart IIII. In addition to several reporting and notification requirements, and for CI RICE greater than 300 brake horsepower (bhp), the rule requires:

- limiting carbon monoxide (CO) in exhaust to 49 parts per million (ppm) at 15 percent oxygen ($O_{2)}$, or;
- reducing carbon monoxide (CO) emissions by 70 percent or more;
- conducting initial performance testing within 180 days of compliance date;
- if not already present , installing a closed or open crankcase ventilation system; and
- initial compliance by 03 May 2013.

Requirements for smaller CI RICEs include routine maintenance requirements such as oil and filter changes at prescribed intervals.

An amendment to the RICE rule is currently in the rulemaking process. If the revision is promulgated, CI RICEs greater than 300 bhp at area sources constructed before June 12, 2006 and that meet Tier 2 or 3 emission standards (as applicable based on rating) will be compliant with the RICE NESHAPs.

The basic purpose of the RICE NESHAPs is to reduce HAPs emissions from stationary RICEs. USEPA stated that CO can be used as a surrogate indicator for RICE HAPs emissions and, therefore, requiring reductions in CO emissions would also reduce HAPs emissions. Two of the HAPs of concern are formaldehyde and acrolein.

The affected RICEs at USAKA are not compliant with the requirements of 40 CFR Part 63, Subpart ZZZZ, thereby requiring a determination of whether a significant health risk results. To assess the HAPs impact of non-compliance, estimates of formaldehyde and acrolein ambient concentrations resulting from power plant emissions were made and compared with the ambient air Regional Screening Levels (RSLs) for residential and industrial scenarios. Maximum predicted concentrations were estimated using CO as a surrogate and assuming the formaldehyde or acrolein concentration would be at the same ratio to the CO concentration as the ratio of the CO to HAP emission rates. Formaldehyde and acrolein emission rates were estimated using USEPA AP-42 emission factors. The 2005 Air Quality Impact Reports (AQIRs) were used to obtain maximum 8-hour CO predictions (annual CO concentration was not modeled). Table 1.3.1 summarizes the results of this analysis and shows that the residential RSLs for formaldehyde and acrolein are not exceeded on Kwajalein, Roi-Namur or Meck. These estimates suggest that an unreasonable public health risk does not result from not meeting the requirements of the RICE NESHAPs. It also should be noted that the estimates are based on the maximum modeled 8-hour CO concentrations. Annual CO concentrations would be considerably less than the maximum modeled 8-hour concentrations. While annual CO

Table 1.1.2.1 Estimated Maximum 8-Hour Formaldehyde and Acrolein Concentrations vs. Residential Screening Levels

Notes: kW = kilowatt gal = gallon gal/hr = gallons per hour lb/hr = pounds per hour MMbtu/hr = Million British Thermal Units per hour

Estimated Maximum 8-Hour Formaldehyde Concentrations vs. Regional Screening Level

Island	Max Fuel Consumption (gal/hr)	Formaldehyde Emission Factor (lb/MMbtu/hr)	Formaldehyde Emission Rate (lb/hr)	CO Emission Rate (lb/hr)[1]	Formaldehyde/ CO Emission Rate Ratio	Max 8-hr CO Concentration ($\mu g/m^3$)	Estimated Formaldehyde Concentration ($\mu g/m^3$)	Formaldehyde Residential RSL ($\mu g/m^3$)[2]	Formaldehyde Industrial RSL ($\mu g/m^3$)[3]
Kwajalein	1724	0.0000789	0.01864	215.76	0.000086	316	0.0273	0.19	0.94
Roi-Namur	976	0.0000789	0.01055	113.66	0.000093	25	0.0023	0.19	0.94
Meck	197	0.0000789	0.00213	22.94	0.000093	347	0.0322	0.19	0.94

Estimated Maximum 8-hr Acrolein Concentration vs. Regional Screening Level

Island	Max Fuel Consumption (gal/hr)	Acrolein Emission Factor (lb/MMbtu/hr)	Acrolein Emission Rate (lb/hr)	CO Emission Rate (lb/hr)	Acrolein/CO Emission Rate Ratio	Max 8-hr CO Concentration ($\mu g/m^3$)	Estimated Acrolein Concentration ($\mu g/m^3$)	Acrolein Residential RSL ($\mu g/m^3$)[4]	Acrolein Industrial RSL ($\mu g/m^3$)[5]
Kwajalein	1724	0.00000788	0.00186	215.76	0.0000086	316	0.0027	0.021	0.088
Roi-Namur	976	0.00000788	0.00211	113.66	0.0000186	25	0.0004	0.021	0.088
Meck	197	0.00000788	0.00021	22.94	0.0000093	347	0.0032	0.021	0.088

Footnotes:
1. CO emission rates from the 2005 AQIRs that were used to model 8-hr maximum CO concentrations.
2. 1E-6 increased cancer risk; assumes 30 years of continuous (24 hrs/day) exposure.
3. 1E-6 increased cancer risk; assumes 25 years of exposure at 350 days per year and 8 hours per day.
4. Hazard quotient of 1.0; assumes 30 years of continuous (24 hrs/day) exposure.
5. Hazard quotient of 1.0; assumes 25 years of exposure at 350 days per year and 8 hours per day.

concentrations would be a better surrogate to gauge long-term risk than 8-hour CO concentrations, the estimated levels provided in Table 1.3.1 present a more conservative health risk comparison.

In view of the above, compliance with the existing RICE NEHAPS is not required in the DEP at this time. However, the DEP-11.001.0 does contain a requirement to reassess compliance with the RICE NESHAPs as part of the DEP modification process described above. Modifications or engine replacements that may be planned to attain the 1-hour NO_2 AAQS, as well as any revisions to the rule, could affect the applicability of the rule to USAKA and compliance with the rule.

1.1.2.2 40 CFR Part 63, Subpart JJJJJJ – Industrial, Commercial, and Institutional Boilers and Process Heaters - Area Sources

USAKA has five boilers that are subject to this NESHAPs: three on Kwajalein and two on Roi-Namur. All the boilers are rated at less than 10.0 MMBtu/hr input. Under Subpart JJJJJJ, and due to their small rating, the boilers have maintenance, recordkeeping and reporting requirements but no emission standards or monitoring requirements. The current rule requires compliance by July 19, 2012; however, a revision to this rule to change the compliance date to March 21, 2013, is currently in the rulemaking process. The principal requirements applicable to USAKA boilers under this rule include:

- Bi-annual tune-ups;
- Maintenance of records for the tune-up dates and procedures;
- Maintenance of records for the type of fuel combusted.

DEP-11-001.0 requires compliance with the substantive elements of this NESHAPs.

1.1.2.3 Revisions to Emission Units

In addition to new AAQS and NESHAPs, the generator set (genset) status has changed on several islands:

- On Ennylabegan, the main power plant was taken out of service. Only two 30 kW gensets remain on the island to power ancillary equipment. The PTE for the gensets is below the thresholds in UES Table 3-1.5.2. Consequently, Ennylabegan is not included in the updated DEP.
- On Omelek, SpaceX has ceased operations and removed the gensets. Consequently, Omelek is not included in the updated DEP.
- Emission sources on Gagan and Legan soon will be replaced with smaller generators (80 kW Tier 3 Kohler units) that will render them minor sources. The Illeginni power plant was downsized in 2010, and is now a minor source. Illeginni also will receive the same generators types that will be installed on Gagan and Legan. Moreover, Gagan, Legan, and Illeginni have no residential population and are only occasionally visited for short durations by USAKA personnel for maintenance and repairs. These islands are not visited by non-USAKA personnel and are closed for visitation under

the Military Use and Operating Rights Agreement (MUORA) between the US and GRMI. Accordingly, air at the island(s) and immediate, surrounding reef areas is not considered as ambient air within the meaning of the UES. Consequently, the DEP does not include emission sources on Gagan, Legan or Illeginni. As a matter of good practice and worker safety USAKA plans to make improvements in the stack configuration on these islands by heightening them to no less than 10 feet and orienting the discharges to vertical.

There are also several emergency generators at USAKA. Three of them could be major sources if operated 8,760 hours per year. U.S. Environmental Protection Agency (USEPA) guidance dated September 6, 1995 (Memorandum for John Seitz, Director Office of Air Planning and Standards entitled "Calculating Potential to Emit (PTE) for Emergency Generators"), states that calculating PTE for emergency generators is appropriately based on 500 hours of operation per year. None of the USAKA emergency generators are major sources based on 500 hours of operation per year. Accordingly, they are not included in this NCA.

A Minor Modification (June 2012) to DEP-05-001.1 defined the operating practices and established operational limits for emission units under the Missile Defense Agency (MDA) Flight Test Integrated -01 (FTI-01, FTO-01) to classify them as "synthetic minors." A number of generators ranging in size from 1.3 megawatts (MW) to 3 kilowatts (kW) will support various functions during the testing period. Additionally, portable air conditioning and power units will operate at the airfield on Kwajalein to support aircraft associated with the tests. The Minor Modification is included in the DEP as Appendix B.

This NCA addresses the revised requirements identified above, presents recent ambient air quality modeling results, and generally updates information in DEP-05.001.1. For the most part, the 2005 AQIRs incorporated in DEP-05.001.1 are still applicable for the AAQS impacts they addressed. The Air Quality Impact Reports (AQIRs) prepared to support DEP-05-001.1 have been updated to address the new 1-hour sulfur dioxide ($SO_{2)}$ and nitrogen dioxide (NO_x) standards, and the annual and 24-hour $PM_{2.5}$ standards. The AQIRs do not specifically address the new annual $PM_{2.5}$ standard (NAAQS – 12.0 $\mu g/m^3$, UES – 9.6 $\mu g/m^3$) that was promulgated in December 2012. However, insofar as the results indicate exceedances of the old annual $PM_{2.5}$ standard (NAAQS – 15.0 $\mu g/m^3$, UES – 12.0 $\mu g/m^3$), the plan to attain all AAQS discussed in §2.1 below will utilize the most recent standard. The AQIRs are included here as Chapters 1-3. The updated AQIRs show widespread exceedances of the 1-hour SO_2 and NO_x standards and localized exceedances of the annual and 24-hour $PM_{2.5}$ standards on some islands.

1.2 Major Stationary Sources

The major stationary sources addressed in this NCA are:

- Abrasive blasting - various locations
- Operation of power plants - Kwajalein, Roi-Namur, Meck.
- Operation of existing solid waste incinerators - Kwajalein, Roi-Namur, and Meck
- Bulk gasoline storage (Kwajalein Fuel Farm Tanks 7 and 8)
- Operation of a vehicle painting and preparation facility on Kwajalein

1.3 Individual Sources and Associated Technical Information

Technical details on sources are provided in the AQIRs (see Appendices). Fuel oil burning source locations are also shown in the AQIRs. Technical information on most existing sources was previously provided in DEP 05-001.1, as modified.

Table 1.3 Major and Synthetic Minor Stationary Sources of Air Pollution

Source ID	Type	Rating	Make/Model	Classification	Remarks
Kwajalein					
KWPP1A	Gensets	2 units @ 4,000 kW each	Caterpillar 3616	Major	
KWPP1A	Genset	1 unit @ 1,820 kW	Caterpillar C280-6	Major	Replacement, 2010
KWPP1B	Gensets	4 units @ 4,400 kW each	Caterpillar 3616	Major	
KWIN02	MSW Incinerator	1 unit @ 32 tons/day	EnerWaste Batch Oxidation	Major	
KWST01	MOGAS Storage Tank #9	355,740 gal	External floating roof; AST	Major	Approx. 109K gal/yr throughput
KWVPP	Vehicle Paint & Prep Facility	NA	NA	Synthetic minor	
KWB01	Boiler - Laundry	3.35 MMBtu/hr	Clayton	Minor subject to NESHAPs	40 CFR Part 63, Subpart JJJJJJ
KWB02	Boiler – Café Pacific	0.27 MMBtu/hr	A.O. Smith	Minor subject to NESHAPs	40 CFR Part 63, Subpart JJJJJJ
KWB03	Boiler – Café Pacific	0.27 MMBtu/hr	A.O. Smith	Minor subject to NESHAPs	40 CFR Part 63, Subpart JJJJJJ
Roi-Namur					
RNIN	MSW Incinerator	1 unit @ 850 lbs/hr		Major	
RNPP	Gensets	9 units @ 1500 kW each	Caterpillar 3606	Major	
RNB01	Heater – Café Roi	1.02 MMBtu/hr	Cleveland Steam	Minor subject to NESHAPs	40 CFR Part 63, Subpart JJJJJJ
RNB02	Boiler – Café Roi	1.02 MMBtu/hr	A.O. Smith	Minor subject to NESHAPs	40 CFR Part 63, Subpart JJJJJJ

Table 1.3 Major and Synthetic Minor Stationary Sources of Air Pollution

Source ID	Type	Rating	Make/Model	Classification	Remarks
Meck					
MKIN	MSW Incinerator	1 unit @ 850 lbs/hr		Major	
MKPP	Gensets	5 units@ 565 kW each	Caterpillar 3508	Major	
USAKA-Wide					
SB	Abrasive Blasting	NA	NA	Synthetic Minor	Various locations
BGENS	Backup Generators	4 units @ 750 kW each	Cummins KTA-2300G	Synthetic Minor	
FTI-01/FTO-01 Temporary Gensets					
FTRN1	Gensets	14 units @ 420 kW each	Caterpillar 3456	Synthetic Minor	
FTRN2	Gensets	4 units @ 60 kW each	Not Specified	Synthetic Minor	
FTRN3	Gensets	3 units @ 60 kW each	Onan or Olympia	Synthetic Minor	
FTRN7	Gensets	4 units @ 150 kW each	Not Specified	Synthetic Minor	
FTME3	Gensets	4 units @ 715 kW each	Caterpillar C-32	Synthetic Minor	
FTME12	Gensets	2 units @ 150 kW each	Not Specified	Synthetic Minor	
FTME16	Gensets	2 units @ 150 kW each	Not Specified	Synthetic Minor	
FTME17	Gensets	2 units @ 150 kW each	Not Specified	Synthetic Minor	

Notes: kW = kilowatt, gal = gallon, gal/yr = gallons per year, lbs/hr = pounds per hour,
MMbtu/hr = Million British Thermal Units per hour

2.0 SOURCE DESCRIPTIONS, MODELING RESULTS, LIMITATIONS, AND EMISSION ESTIMATES FROM MAJOR AND SYNTHETIC MINOR SOURCES

Emission calculations are based on USEPA’s Compilation of Air Pollutant Emission Factors, AP-42 (Fifth Edition) and manufacturer emission factors (when available).

At UES §3-1.5.2 emission thresholds are given. The application of operational limitations, agreed to in a DEP that decrease PTE to below the thresholds can make the source a “synthetic minor” source. The UES §3-1.5.2 thresholds are:

Table 2.0 Pollutant Thresholds for Major Stationary Sources

Pollutant	Threshold (PTE) - Tons/Year
Carbon monoxide	100
Nitrogen oxides	40
Sulfur dioxide	40
Ozone (as VOC)	40
Lead	0.6
Particulate matter	25 total particulate matter 15 PM_{10} 10 $PM_{2.5}$
MSW Combustor Organics (CDD/CDF) (measured as total tetra-through octa-chlorinated dibenzo-p-dioxins and dibenzofurans)	3.5×10^{-6}
MSW Combustor Metals (measured as particulate matter)	15
MSW Combustor acid gases (measured as sulfur dioxide and hydrogen chloride)	40
MSW Landfill Emissions (measured as non-methane organic compounds)	50
Fluorides	3
Sulfuric acid mist	7
Hydrogen sulfide	10
Total reduced sulfur (including H_2S)	10
Reduced sulfur compounds (including H_2S)	10
Hazardous Air Pollutants (HAPs) (UES Appendix 3-1A)	10 of any single HAP 25 of any combination of HAPs
[40 CFR 52.21 (b)(23)(i), Amended at 73 FR 28349, May 16, 2008]	

2.1 USAKA-Wide

The current modeling results consistently show widespread exceedances of the new 1-hour SO_2 and NO_2 AAQS. The results for the 24-hour and annual $PM_{2.5}$ AAQS show either attainment with existing operations or localized exceedances in the immediate vicinity of the power plants.

The 2005 and 2012 modeling results indicate the operating limitations in DEP-05.001.1 for existing sources should be retained. They should be retained until they are superseded or rendered not applicable by any new limitations and conditions resulting from implementation of a plan to achieve attainment. Accordingly, the revised DEP retains the operating limitations in the existing DEP for those sources that remain in operation.

The 2012 modeling results show widespread exceedances on all islands of the new 1-hour NO_2 and SO_2 AAQS and localized exceedances of the 24-hour and annual $PM_{2.5}$ AAQS on some islands. Achieving attainment of the new AAQS will be a complicated and potentially costly proposition. Potential solutions include using lower sulfur fuel, installing higher exhaust stacks, replacing gensets with higher efficiency and lower emission units, employing renewable energy alternatives, conducting emission control retrofits, or some combination of measures. The atoll-wide scope of the problem requires an atoll-wide approach to developing and selecting remedies. USAKA is actively considering renewable energy alternatives to meet the goal of becoming a "Net Zero Energy Installation." A Net Zero Energy Installation produces as much energy on site as it uses over the course of a year. Integrating USAKA renewable energy planning into the process of defining and selecting remedies for AAQS attainment makes sense.

DEP-11-001.0 proposes a process and timetable to achieve AAQS attainment that approximates the provisions of the Clean Air Act (CAA) for non-attainment areas. Section 172 of the CAA (42 USC §7502) states in part:

> ***"(a) Classifications and attainment date…***
> ***(2) Attainment dates for nonattainment areas***
> ***(A)*** *The attainment date for an area designated nonattainment with respect to a national primary ambient air quality standard shall be the date by which attainment can be achieved as expeditiously as practicable, but no later than 5 years from the date such area was designated nonattainment under section 7407 (d) of this title, except that the Administrator may extend the attainment date to the extent the Administrator determines appropriate, for a period no greater than 10 years from the date of designation as nonattainment, considering the severity of nonattainment and the availability and feasibility of pollution control measures.*
>
> ***(b) Schedule for plan submissions***
> *At the time the Administrator promulgates the designation of an area as nonattainment with respect to a national ambient air quality standard under section 7407 (d) of this title, the Administrator shall establish a schedule according to which the State containing such area shall submit a plan or plan revision (including the plan items) meeting the applicable requirements of subsection (c) of this section and section 7410 (a)(2) of this title. Such schedule shall at a minimum, include a date or dates, extending no later than 3 years from the date of the nonattainment designation, for the submission of a plan or plan revision (including the plan items) meeting the applicable requirements of subsection (c) of this section and section 7410 (a)(2) of this title."*

DEP-11-001.0 approximates the above by:

1. Stating the date of non-attainment designation is the effective date of DEP-11-001.0.
2. Requiring USAKA to submit a proposed modification to the DEP with a plan and schedule to Appropriate Agencies in accordance with UES§2-17.3.6 for review within three years of the effective date of the DEP. The proposed plan shall describe the actions and schedule of actions that will be undertaken to attain all AAQS or otherwise protect public health. Among other things the DEP modification will:

- demonstrate that AAQS attainment and/or other public health protection measures will be achieved within five years of the effective date of the DEP, or if a longer period is required, the plan shall justify the longer period. In no event shall attainment be achieved later than ten years from the effective date of DEP-11-001.0.
- describe specific actions that will be taken along with an associated schedule, including any actions to limit the sulfur content of fuel delivered to USAKA for combustion in stationary sources.
- include reporting and notifications to the Appropriate Agencies of sufficient frequency and content to enable monitoring implementation of the plan
- describe any operating limitations or contingency measures that will be in place and the period of time during which they will remain in place.
- identify which limitations or other requirements in DEP-11-001.0 are superseded or otherwise rendered no longer applicable. The plan and schedule modification to the DEP will be effective in accordance with the actions and time frames set forth in UES§2-17.3.6 as if the modification were a DEP.

2.1.1 Abrasive Blasting

Abrasive blasting occurs at several locations throughout USAKA. A single blast nozzle can have a maximum throughput of over two tons per hour. The applicable AP 42 emission factor is 13 pounds PM_{10} per 1,000 pounds of abrasive. The maximum emissions for a single blast nozzle (i.e., PTE) can be well over the 15 TPY of PM_{10} specified in UES §3-1.5.2. If the USAKA-wide use of abrasives is limited to less than 1,154 TPY, the resulting PM_{10} emissions are less than 15 TPY. By limiting the total use of abrasive blasting media to less than 1,150 TPY at USAKA, no single, or combination of, abrasive blasting location(s) could become a “major source” of PM_{10} in accordance with UES §3-1.5.2. The annual use of abrasive media at all abrasive blasting locations at USAKA is limited to less than 1,150 tons in a rolling 12-month period. Consequently, abrasive blasting operations become a “synthetic minor” source.

2.1.2 Fuel Sulfur Content

Fuel oil at USAKA is centrally managed and distributed from the main fuel farm on Kwajalein. Consequently, if compliance with any sulfur content limitations associated with fuel oil burning sources at USAKA is achieved at the main fuel farm, compliance with the source-specific limitations is also achieved.

The air quality analyses (Chapter 1) indicate that substantial reductions in fuel sulfur content may be needed to meet AAQS. The DEP modification described in Section 2.1 above will describe any necessary actions needed to limit sulfur content. The current limit of 1.0 percent sulfur by weight is retained until such time as it is revised.

2.1.3 Skid-Mounted Generators

United States Army Kwajalein Atoll (USAKA) acquired four skid-mounted, 750 kW backup generators to temporarily supplement power production from existing power plants. The generators will be used during periods when existing permanent power plant generators are under repair and supplemental power is needed to meet demand during missions. Depending on power demand and the status of the existing power plants, more than one backup generator may be co-located to meet anticipated demand. The backup generators will be located in close proximity to, or adjacent to, existing permanent power plants.

Use of the generators was covered in a Minor Modification to DEP-5-001.1, which is attached to the DEP as Appendix A.

2.1.4 FTI-01/FTO-01

The Missile Defense Agency (MDA) is planning a series of demonstrations at U.S. Army Kwajalein Atoll (USAKA) to evaluate the Ballistic Missile Defense System's operational effectiveness against short range ballistic missile, medium range ballistic missile, and anti-air warfare targets in an operationally realistic flight test. Each test will occur over a period not to exceed 60 days. The tests will include activities on Kwajalein, Roi-Namur, Omelek and Meck Islands. This Minor Modification addresses Flight Test Integrated - 01 (FTI-01 and FTO-01), FTI-01 was completed in 2012 and FTO-01 is scheduled for late summer of 2013. A number of generators ranging in size from 1.3 MW to 3 kW will be required to support various functions during the testing period. Additionally, portable air conditioning and power units will be operated at the airfield on Kwajalein to support aircraft associated with the tests.

Use of the generators was covered in a Minor Modification to DEP-5-001.1, which is attached to the DEP as Appendix B. Since the minor modification was completed, the Tier rating of some gensets has been identified and the projected use pattern for FTO-01 has changed somewhat. These changes resulted in revised operational limits for some gensets. Table 2.1.4 contains the revised PTE calculations using the emission factors for the associated Tier rating (Note: emission factors default to AP42 factors if no tier rating is stated) and new operational limits. The gensets that require operational limits to render them synthetic minor sources are those identified in the minor modification and listed in Table 1.3 above: FTRN1, FTRN2, FTRN3, FTRN7, FTME3, FTME12, FTME16, and FTME17. The operational limits in the minor modification for those units that exceeded the limits in UES Table 3-1.5.2 when operated for 8,760 hours (365 days at 24 hours per day) were based on a 60 day mission period and 12 hours a day of operation. These operational limits can be increased significantly while still rendering the affected gensets as synthetic minor sources under the UES. Additionallly, one genset on Omelek has changed from an 11 kW unit to 15 kW. The unit will remain as a minor source.

2.2 Kwajalein

2.2.1 Power Plants 1A and 1B

Power Plants 1A (PP1A) and 1B (PP1B) are co-located in Building 994. Power Plant 1A consists of two Caterpillar 4,000 kW diesel-fired generators and one Caterpillar 1,820 kW, diesel-fired generator. Power Plant 1B consists of four Caterpillar 4,400 kW, diesel-fired generators. The power plant complex is a major stationary source in accordance with UES §3-1.5.2 for NO_x, CO, SO_2, VOC and PM_{10}. PTE is based on an annual fuel use of 10.0 million gallons with a sulfur content of 1.0 percent for PP1A and PP1B combined.

Table 2.1.4 FTO-01 Calculated Emission

Emission Unit	Tier	Type	Size hp	No. of units	Fuel gal/hr/unit	OpHrs/ Unit	Emission Factor					Emissions - TPY				
							NOx lb/hp-hr	SO$_2$ lb/gal	CO lb/hp-hr	PM$_{10}$ lb/hp-hr	VOC lb/hp-hr	NO$_x$	SO$_2$	CO	PM$_{2.5}$ PM$_{10}$	VOC
FT-GA1	2	Genset	130	2	5.2	8760	0.0108	0.143	0.0082	0.0022	0.00247	12.30	6.51	9.34	2.51	2.81
FT-GA2		Genset	42	1	1.5	8760	0.031	0.143	0.00668	0.0022	0.00247	5.70	0.94	1.23	0.40	0.45
FT-IL1	2	Genset	35.5	2	1.1	8760	0.0123	0.143	0.009	0.0022	0.00247	3.83	1.38	2.80	0.68	0.77
FT-IL2	2	Genset	130	2	5.2	8760	0.0108	0.143	0.0082	0.0022	0.00247	12.30	6.51	9.34	2.51	2.81
FT-IL3		Genset	16.3	3	0.7	8760	0.031	0.143	0.00668	0.0022	0.00247	6.64	1.32	1.43	0.47	0.53
FT-ME1		Genset	5	1	0.5	8760	0.031	0.143	0.00668	0.0022	0.00247	0.68	0.31	0.15	0.05	0.05
FT-ME2		Genset	92	2	2.8	8760	0.031	0.143	0.00668	0.0022	0.00247	24.98	3.51	5.38	1.77	1.99
FT-ME3	2	Genset	1000	4	60	**1700**	0.011	0.143	0.0055	0.0003	0.00075	37.40	29.17	18.70	1.02	2.55
FT-ME4		Genset	24	1	1.1	8760	0.031	0.143	0.00668	0.0022	0.00247	3.26	0.69	0.70	0.23	0.26
FT-ME5		Genset	134	2	5.4	8760	0.031	0.143	0.00668	0.0022	0.00247	36.39	6.76	7.84	2.58	2.90
FT-ME6		Genset	40	1	1.3	8760	0.031	0.143	0.00668	0.0022	0.00247	5.43	0.81	1.17	0.39	0.43
FT-ME7		Genset	40	1	1.3	8760	0.031	0.143	0.00668	0.0022	0.00247	5.43	0.81	1.17	0.39	0.43
FT-ME8		Genset	42	1	1.5	8760	0.031	0.143	0.00668	0.0022	0.00247	5.70	0.94	1.23	0.40	0.45
FT-ME9		Genset	5	1	0.5	8760	0.031	0.143	0.00668	0.0022	0.00247	0.68	0.31	0.15	0.05	0.05
FT-ME10		Genset	25	1	1.2	8760	0.031	0.143	0.00668	0.0022	0.00247	3.39	0.75	0.73	0.24	0.27
FT-ME11		Genset	92	2	2.8	8760	0.031	0.143	0.00668	0.0022	0.00247	24.98	3.51	5.38	1.77	1.99
FT-ME12		Genset	210	4	30	**2880**	0.031	0.143	0.00668	0.0022	0.00247	37.50	24.71	8.08	2.66	2.99
FT-ME13		Genset	92	1	2.8	8760	0.031	0.143	0.00668	0.0022	0.00247	12.49	1.75	2.69	0.89	1.00
FT-ME14		Genset	92	1	2.8	8760	0.031	0.143	0.00668	0.0022	0.00247	12.49	1.75	2.69	0.89	1.00
FT-ME15		Genset	16.3	1	0.7	8760	0.031	0.143	0.00668	0.0022	0.00247	2.21	0.44	0.48	0.16	0.18
FT-ME16		Genset	210	2	30	**2880**	0.031	0.143	0.00668	0.0022	0.00247	18.75	12.36	4.04	1.33	1.49
FT-ME17		Genset	210	2	30	**2880**	0.031	0.143	0.00668	0.0022	0.00247	18.75	12.36	4.04	1.33	1.49
FT-ME18		Genset	12.2	1	0.5	8760	0.031	0.143	0.00668	0.0022	0.00247	1.66	0.31	0.36	0.12	0.13
FT-ME19	3	Genset	279	1	21	8760	0.0066	0.143	0.0057	0.0022	0.00247	8.07	13.15	6.97	2.69	3.02
FT-OM1		Genset	21	2	1.8	8760	0.031	0.143	0.00668	0.0022	0.00247	5.70	2.25	1.23	0.40	0.45
FT-OM2		Genset	19.7	1	1.3	8760	0.031	0.143	0.00668	0.0022	0.00247	2.67	0.81	0.58	0.19	0.21
FT-OM3		Genset	19.7	1	1.3	8760	0.031	0.143	0.00668	0.0022	0.00247	2.67	0.81	0.58	0.19	0.21
FT-OM4		Genset	19.7	2	0.5	8760	0.031	0.143	0.00668	0.0022	0.00247	3.31	0.63	0.71	0.24	0.26
FT-RN1	2	Genset	525	14	30	**975**	0.011	0.143	0.0057	0.0003	0.00075	39.41	29.28	20.42	1.07	2.69
FT-RN2		Genset	134	4	5.4	**2880**	0.031	0.143	0.00668	0.0022	0.00247	23.93	4.45	5.16	1.70	1.91
FT-RN3		Genset	134	3	5.4	**2880**	0.031	0.143	0.00668	0.0022	0.00247	17.95	3.34	3.87	1.27	1.43
FT-RN4[1]		Genset	6.5	1	0.5	8760	0.011	0.000591	0.00696	0.000721	0.0207	0.31	0.00	0.20	0.02	0.59
FT-RN5		Genset	35.5	2	1.1	8760	0.031	0.143	0.00668	0.0022	0.00247	9.64	1.38	2.08	0.68	0.77
FT-RN6		Genset	130	2	5.2	8760	0.031	0.143	0.00668	0.0022	0.00247	35.30	6.51	7.61	2.51	2.81
FT-RN7		Genset	210	4	30	**2880**	0.031	0.143	0.00668	0.0022	0.00247	37.50	24.71	8.08	2.66	2.99
FT-RN8		Genset	70	1	10	8760	0.031	0.143	0.00668	0.0022	0.00247	9.50	6.26	2.05	0.67	0.76
FT-KW1		Genset	210	1	13.2	8760	0.031	0.143	0.00668	0.0022	0.00247	28.51	8.27	6.14	2.02	2.27
FT-KW2		Genset	35.5	2	1.1	8760	0.031	0.143	0.00668	0.0022	0.00247	9.64	1.38	2.08	0.68	0.77
FT-KW3		Genset	130	2	5.2	8760	0.031	0.143	0.00668	0.0022	0.00247	35.30	6.51	7.61	2.51	2.81
FT-KW4		Genset	50	2	2.5	8760	0.031	0.143	0.00668	0.0022	0.00247	13.58	3.13	2.93	0.96	1.08
FT-KW5		A/C Cart	18	1	1.2	8760	0.031	0.143	0.00668	0.0022	0.00247	2.44	0.75	0.53	0.17	0.19
FT-KW6		GPU	117	1	5	8760	0.031	0.143	0.00668	0.0022	0.00247	15.89	3.13	3.42	1.13	1.27
FT-KW7		Genset	16	2	0.7	8760	0.031	0.143	0.00668	0.0022	0.00247	4.34	0.88	0.94	0.31	0.35

2.2.2 Municipal Solid Waste (MSW) Incinerator

One multiple chamber, starved air incinerator, a 32 tons per day (TPD) batch oxidation unit manufactured by EnerWaste, combusts non-hazardous solid waste. The incinerator utilizes a combination of fuel oil and used oil for auxiliary fuel. For emission and air quality analysis purposes, used oil is assumed to comprise 50 percent of the combusted fuel and have a sulfur content of 0.67 percent by weight. The used oil meets the criteria set forth in UES §3-6.5.7(b)(4)(iii). When operated at the rated capacity of 32 TPD, the incinerator constitutes a major stationary source for PM_{10} and MSW combustor organics using a 50:50 blend of 1.0 percent sulfur fuel oil and used oil.

2.2.3 Fuel Farm - 500,000-Gallon MOGAS Tank

USAKA Air Toxics Report and Emissions Inventory Calendar Year 2003 (CY03)(May 15, 2004) indicated this tank can emit over 100 TPY of VOCs based on a throughput of 272,225 gallons per year and using USEPA TANKS 4.0 model (version 4.09b). Since throughput is an operational variable, a maximum PTE cannot be stated based on design capacity. PTE emissions for this tank are based on an annual throughput of 275,000 gallons. As a general matter, MOGAS use at USAKA is projected to decrease over time as USAKA gravitates to a "single fuel" installation. When this tank, or any other tank that would be subject to the New Source Performance Standards (NSPS), is replaced or rehabilitated consideration will be given to the standards given in 40 CFR Part 60, Subpart Kb (NSPS - Volatile Organic Liquid Storage Vessels).

2.2.4 Vehicle Paint and Preparation Facility

The Vehicle Paint and Preparation Facility (VPPF) is located between Buildings 1789 and 808. The major components of the facility with associated emissions are the paint/rhino booth, abrasive blast booth and metallization booth. Each booth is equipped with ventilation and a high efficiency filter system to capture particulate matter. Current usage of paint and solvents was scaled up to represent 8,760 hours of operation per year to obtain maximum potential to emit estimates. No emission controls for VOCs or HAPs were assumed. Based on these estimates the facility is a major source for HAPs and VOCs in accordance with UES §3-1.5.2. However, if operating hours for the paint/rhino and metallization booths are limited to less than 4,190 hours each per 12-month rolling period (approximately 11 hours per day each on average) the source is below the thresholds set forth in UES §3-1.5.2.

2.2.5 AAQS Compliance

The replacement of one unit at the Kwajalein power plant with a smaller one with less emissions slightly improves the projected impacts from the 2005 AQIR. However, it does not dramatically change the operating limits in DEP-005.001.1 to achieve attainment with AAQS, Based on the air quality analysis provided in the 2012 AQIR (Chapter 1) one or more of the following modifications to operation of Power Plants 1A and 1B, as well as offsets from renewable energy sources and energy conservation measures, should be considered in developing the plan called for in Section 2.1 above to attain compliance with the UES ambient air quality 1-hour NO_2 and SO_2 and 24-hour and annual $PM_{2.5}$ standards.

- Increase in stack heights.
- Reduction of NO_2 through selective catalytic reduction (SCR) with urea injection capable of 60 to 90 percent NO_x removal efficiency.
- Limit the sulfur content of combusted fuel to no more than 0.08 to 0.73 percent by weight, depending on the operating scenario USAKA-wide.
- Reduction of SO_2 through installation of a scrubber system with alkali injection.
- Replacement of the engines with newer low-NO_x emitting engines also would contribute to compliance.

Until such time as new limitations and constraints are developed, the existing limits remain in place:

- Limit the total 12-month rolling fuel consumption of Power Plants 1A and 1B combined to less than 10.0 million gallons.

Table 2.2.5
Kwajalein PTE[5] Estimated Emissions (Tons/Year)

Pollutant	Power Plants 1A & 1B[1]	MSW Incinerator	MOGAS 500K Storage Tank	Vehicle Paint & Prep Facility[2]	Total With Existing MSW Incinerator	Total With Replacement MSW Incinerator
NO_x	**2192.0**	15.0	-	-	2213.0	2207.0
SO_2	**249.0**	28.0	-	-	287.0	277.0
CO	**583.0**	1.7	-	-	585.3	584.7
PM_{10}	**39.2**	**15.4**	-	2.2	63.4	56.8
VOC	**56.0**	0.1	106.8[3]	<40.0	202.9	202.9
Pb	-	<0.1		-	0.2	0.2
HCL	-	7.8	-		12.0	7.8
Combustor Organics (CDD/CDF)	-	**1.07E-05**	-	-	1.64 E-05	1.07 E-05
Total HAPs	1.2	<7.9		15.5[4]	28.8	24.6

(**Bold** print notes exceedance of UES Table 3-1.5.2 Thresholds)
1. Based on $10x10^6$ gallons/year fuel with 1.0 percent sulfur
2. Based on 11 hours/day average use for paint/rhino and metallization booths
3. Based on 275,000 gallons/year throughput
4. No single HAP exceeds 10 TPY
5. Revised PTE estimates will be reflected in DEP modification required in three years to achieve attainment of all current AAQS

2.3 Roi-Namur

2.3.1 Power Plant

The power plant consists of nine 1,650 kW Caterpillar 3606, diesel-fired generators. The power plant is a major stationary source in accordance with UES §3-1.5.2. PTE is based on an annual fuel use of 6.5 million gallons.

2.3.2 MSW Incinerator

The Roi-Namur incinerator is a multi-chamber, starved-air unit with a maximum capacity of 850 pounds per hour. Unconstrained PTE for the unit is below the thresholds set forth in UES §3-1.5.2, except for combustor organics. Consequently, the unit is a major source.

2.3.3 AAQS Compliance

Based on the air quality analysis provided in the 2012 AQIR (Chapter 2) one or more of the following modifications to operation of the Power Plant, as well as offsets from renewable energy sources, replacement engines and energy conservation measures, should be considered in developing the plan called for in Section 2.1 above to attain compliance with the UES ambient air quality 1-hour NO_2 and SO_2 and 24-hour and annual $PM_{2.5}$ standards.

2.3.3(a) Increase in stack heights.
2.3.3(b) Reduce NO_x emissions by 23 to 73 percent depending on operating scenario; and
2.3.3(c) Limit the sulfur content of combusted fuel to not more than 0.22 to 0.59 percent by weight depending on operating scenario.

Until such time as new limitations and constraints are developed, the existing limits remain in place:

2.3.3(d) Limit the total rolling twelve-month fuel consumption to less than 6.5 million gallons.

Table 2.3.3
Roi-Namur PTE Estimated Emissions (Tons/Year)

Pollutant	Estimated Emissions		
	Power Plant[1]	Incinerator	Total
NO_x	**1,634.0**	7.1	1,641.1
SO_2	**445.0**	14.4	459.4
CO	64.0	0.9	64.9
PM_{10}	18.3	6.4	24.7
VOC	**71.9**	<0.1	<72.0
Pb	-	<0.1	<0.1
Combustor Organics (CDD/CDF)	-	**5.47E-06**	5.47E-06
Total HAPs	<0.9	<4.1	<5.0

(**Bold** print notes exceedance of UES Table 3-1.5.2 Thresholds)

[1] Based on $6.5x10^6$ gal/yr fuel with 1.0 percent sulfur.

2.4 Meck

2.4.1 Power Plant

The Meck power plant consists of five 550 kW, Caterpillar 3508 diesel-fired generators. The power plant is a major stationary source under UES §3-1.5.2. PTE emissions are based on a limit of 1.0 million gallons of fuel per year with a sulfur content of 1.0 percent by weight.

2.4.2 MSW Incinerator

The Meck incinerator is a multi-chamber, starved-air unit with a maximum capacity of 850 pounds per hour. Unconstrained PTE for the unit is below the thresholds set forth in UES §3-1.5.2, except for combustor organics. Consequently, the unit is a major source; however, no source-specific conditions and limitations are necessary to achieve compliance with ambient air quality standards.

2.4.3 AAQS Compliance

Based on the air quality analysis provided in the 2012 AQIR (Chapter 3) one or more of the following modifications to operation of the Power Plant, as well as offsets from renewable energy sources, replacement engines and energy conservation measures, should be considered in developing the plan called for in Section 2.1 above to attain compliance with the UES ambient air quality 1-hour NO_2 and SO_2 and 24-hour and annual $PM_{2.5}$ standards.

2.4.3(a) Increase in stack height coupled with emission controls.
2.4.3(b) Limit the sulfur content of combusted fuel to not more than 0.20 to 0.82 percent sulfur by weight, depending on the operating scenario.
2.4.3(c) Reduce NO_x emissions by 52 to 78 percent depending on operating scenario.

Until such time as new limitations and constraints are developed, the existing limits remain in place:

2.4.3(d) Personnel on Meck shall be advised to limit access to the area immediately north of Facility 5036 (a warehouse) when more than two (2) generators are running concurrently; and

2.4.3(e) Limit the total rolling 12-month fuel consumption to less than 1.0 million gallons.

Table 2.4.3
Meck PTE Estimated Emissions (Tons/Year)

Pollutant	Estimated Emissions		
	Power Plant[1]	Incinerator	Total
NO_x	**219.0**	7.1	226.1
SO_2	**69.0**	14.4	83.4
CO	58.0	0.9	63.9
PM_{10}	3.9	6.4	10.3
VOC	5.6	<0.1	<5.7
Pb	-	<0.1	<0.1
Combustor Organics (CDD/CDF)	-	**5.47E-06**	5.47E-06
Total HAPs	<0.2	<4.1	<4.3

(**Bold** print notes exceedance of UES Table 3-1.5.2 Thresholds)
1. Based on 1.0 million gallons of fuel with 1.0 percent sulfur

3.0 ADDITIONAL ENVIRONMENTAL CONSIDERATIONS

3.1 Description of Activity Environmental Setting

Kwajalein Atoll is a crescent-shaped atoll containing approximately 100 islands with a total land area of about 5.6 square miles. The coral reef and islands enclose the world's largest lagoon (1,100 square miles). Kwajalein is the largest island in the atoll with an area of 748 acres. The land areas of the other islands addressed in this NCA are: Roi-Namur (398 acres); and Meck (55 acres). All the islands are typical low-lying atoll islands with average elevations of between four and six feet above sea level.

Kwajalein Atoll has a tropical marine climate characterized by warm and humid weather throughout the year. The mean monthly temperature is 81.8 degrees (^{o}) F with little seasonal variation. Average rainfall is around 100 inches per year. Approximately 75 percent of the annual rainfall occurs during the wet season of May through November. December through June is considered the dry season.

Northeasterly trade winds ranging from nine to 16 miles per hour (mph) are dominant during most of the year. The summer months can bring relatively calm conditions. Typhoons occasionally occur at Kwajalein Atoll; however, the atoll is considered to be outside the main areas of typhoon occurrence in the Western Pacific Ocean.

3.2 Analysis of Waste Discharge for Point-Source Waste Discharges to Water

The continuing activities are not projected to contribute to surface water degradation. The Kwajalein power plant(s) (PP1A, PP1B) has an existing cooling water discharge that is addressed in DEP-97-001.1 and DEP-06-002.1, *Point-Source Discharges at USAKA*. The cooling water discharge associated with the Roi-Namur power plant was eliminated with construction of the new power plant. The other power plants and emergency generators addressed in this NCA have closed-loop cooling systems.

The discharge associated with the Kwajalein Fuel Farm (re: KIWW07, Table 2.2.2) is addressed in DEP-97-001.1 and DEP-06-002.1, *Point-Source Discharges at USAKA*.

The VPPF on Kwajalein has a positive impact on water quality. The facility captures emissions from abrasive blasting and painting operations, thereby eliminating their presence in stormwater runoff. Abrasive blasting operations at other USAKA locations are managed to minimize fugitive discharges from entering surface waters.

Operation of the replacement solid waste incinerator on Kwajalein does not have a regulated point source discharge and does not adversely impact water quality.

3.3 Endangered Species, Migratory Birds, Wildlife Resources, and Habitats

The continuing activity of air emissions from major stationary sources will not have a foreseeable effect on endangered species, migratory birds, wildlife resources and habitats. Limitations on emission sources are described for stationary sources in NCA Section 2.0 through 2.8. Emissions from USAKA stationary sources have not been identified as having a detrimental effect on wildlife resources, including migratory birds.

3.4 Information on Marine Life, Currents, and Other Characteristics of an Ocean Disposal Site

The continuing activity of air emissions from major stationary sources does not require any form of ocean disposal.

3.5 Information on Marine Life and Environment In Areas Where Dredging and/or Filling Will Take Place

The continuing activity of air emissions from major stationary sources does not require any form of dredging and/or filling.

3.6 Material and Waste Management

Routine power plant and emergency generator maintenance and operations do require the storage and use of fuel, lubricants, coolants and solvents. Operation of the VPPF involves the storage and use of paints, thinners, and the disposal of spent filters, thinners, abrasive media and paint residuals. All materials and wastes will be managed in accordance with the applicable provisions in UES §3-6.

4.0 NOTIFICATION

4.1 Emergency Notifications

USAKA will notify the Appropriate Agencies and the public of any release or anticipated release of air pollutants that could result in an exposure of the public representing a significant public health threat. (UES §2-7.3)

4.2 Air Quality Notifications

USAKA will notify the Appropriate Agencies of the following:

4.2.1 Any changes to the emission units listing as contained in DEP-11-001.0.

4.2.2 An operational change, malfunction, or other circumstance that either has, or potentially will, result in an exceedance of a limitation stated in this NCA, or non-compliance with a requirement stated in the DEP, including those specified in Sections 2.0 through 2.6. (UES §2-7.2.1(a))

4.2.3 Authorizations, or proposed authorizations, for open burning under UES §§3-1.7.1(a) or (b). (UES §2-7.2.1(c)(1))

4.2.4 When any fuel oil delivered to the Kwajalein Fuel Farm has a sulfur content exceeding 1.0 percent by weight. (Section 2.1.3)

4.2.5 When FTO-01 testing activities begin and end.

5.0 RECORD-KEEPING

5.1 USAKA-Wide

All records specified in this NCA will be retained in accordance with UES §2-13. The records will be available for examination by the Appropriate Agencies upon request.

5.2 Fuel Sulfur Content

USAKA will maintain records of sulfur content in fuel received at USAKA.

5.3 Abrasive Blast Media

USAKA will monitor the monthly usage of abrasive blast media and maintain a record showing the rolling 12-month total usage of abrasive blast media at USAKA.

5.4 Power Plants

USAKA will monitor and record the monthly fuel consumption and maintain a record showing the rolling-12 month total fuel consumption at the following Power Plants: Kwajalein, Roi-Namur, and Meck.

5.5 Kwajalein Vehicle Paint and Preparation Facility

USAKA will monitor and record the monthly operating hours of the paint/rhino and metallization booths, and maintain a record showing the 12-month rolling total hours of operation for each booth.

5.6 Deployed Backup Generators

USAKA will maintain records showing the locations of all deployed backup generators and the duration of their deployment. USAKA will monitor and record the monthly operating hours of deployed backup generators at each location. USAKA will maintain records showing the total 12-month rolling operating hours of all backup generators operating at a single location.

5.7 Kwajalein and Roi-Namur Boilers

USAKA will maintain records of the dates and methods used to tune-up the boilers at Kwajalein and Roi-Namur, and will record the type of fuel combusted.

5.8 FTI-01/FTO-01 Gensets

USAKA will maintain records of weekly readings of the hour meters on each genset, or, if an hour meter is not installed on the engine, records of the start and stop times each time the genset was placed into operation. USAKA will maintain records or documentation verifying the required advisories were issued.

6.0 RESOLUTION OF NONCOMPLIANT AREAS

USAKA is in substantive compliance with DEP-05-001.1. The 2005 analyses of the sources have identified several instances where ambient air quality standards were potentially exceeded. These exceedances were addressed by the limitations and conditions in DEP-05-001.1 that are proposed to be retained until such time as they may be superseded. Addressing the predicted exceedances of the new 1-hour NO_x and SO_2 standards and 24-hour $PM_{2.5}$ standard is discussed in Section 2.1.

CHAPTER 1

AIR QUALITY IMPACT REPORT

KWAJALEIN

AUGUST 12, 2012

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AIR QUALITY IMPACT REPORT
(AQIR)

KWAJALEIN ISLAND
U.S. ARMY KWAJALEIN ATOLL
REPUBLIC OF THE MARSHALL ISLANDS

12 AUGUST 2012

PREPARED FOR:

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CONTENTS

1.0 INTRODUCTION

In December 1995, the U.S. Army Kwajalein Atoll (USAKA), after consultation with the Republic of the Marshall Islands (RMI), promulgated Environmental Standards and Procedures which are now in their twelfth edition [1]. Specific processes for addressing activities with potential environmental impact are detailed. In the case of air pollution, sources which have the potential to emit regulated pollutants above specified thresholds require preparation of various documents including Notices of Proposed Activity (NPA) for existing sources and Notices of Continuing Activity (NCA) for existing sources, both of which are necessary predecessors to Documents of Environmental Protection (DEP), the primary mechanism for environmental review and ultimate approval or denial of an activity. Ambient air quality standards are also included for new and existing sources.

A required component of NPA's and NCA's for air pollution sources is an ambient air quality impact analysis, the minimum contents of which are detailed in the USAKA Environmental Standards (UES). These UES air quality requirements are linked to U. S. Environmental Protection Agency (EPA) requirements that have been amended or expanded in recent years. It is therefore the purpose of this report to update the 2005 air quality analysis [2] for Kwajalein, a flat 748-acre coral and fill piece of land, with its 29.6 MW power plant and 20 T/day incinerator.

2.0 EXISTING SOURCES

2.1 Power Plant. The existing power plant (Facility No. 994) is located on the central part of the island (Figure 1) and consists of two plants designatged 1A and 1B. Plant 1 includes three (3) 4,000 kWe Caterpillar Model 3616 diesel engine generator sets, and Plant 1B contains four (4) 4,400 kWe Caterpillar Model 3616 generator sets. Additional descriptive data used in this analysis are summarized in Tables 1 and 2.

2.2 Incinerator. A multiple chamber, starved air incinerator designed to combust nonhazardous waste including municipal solid waste, construction waste, and operations solid waste is located on the west end of the island (Figure 1). The incinerator consists of three (3) primary chambers and one (1) secondary combustion chamber and fires diesel and waste oils as auxiliary fuels. Table 3 summarizes analysis parameters.

3.0 NEW AMBIENT AIR QUALITY STANDARDS

3.1 PM2.5. In October 2006, EPA promulgated new standards for particulate matter (PM) [3]. The new 24-hour standard for PM less than or equal to 2.5 micrometers (μm) in diameter ($PM_{2.5}$) was set at 35 μg/m^3 based on a 3-year average of the 98th percentile values. The annual $PM_{2.5}$ standard of 15 μg/m^3 was retained, but the annual PM_{10} standard was revoked. The effective date of these standards was 18 Dec 06.

FIGURE 1

KWAJALEIN ISLAND

TABLE 1

KWAJALEIN POWER PLANT 1A

Parameter	Value	Units
Model	CAT 3616	n/a
No. of units	3	n/a
Unit rating	4,000	ekW
Stack height (existing)	24.9	m
Stack diameter	0.69	m
Exit gas velocity	39.01	m/sec
Exit gas temperature	760	deg K
Exit gas volume	14.41	m^3/sec
Fuel type	Diesel	n/a
Fuel use (max rate per unit)	251	gal/hr
Fuel sulfur (DEP limit)	1.0	%(w)
Fuel sulfur (CY 2010 max)	0.58	%(w)
PM2.5 emission rate	1.77	lb/hr
Lead (Pb) emission rate	n/a	lb/hr
NO2 emission rate	110	lb/hr
SO2 emission rate	34.7	lb/hr

TABLE 2

KWAJALEIN POWER PLANT 1B

Parameter	Value	Units
Model	CAT 3616	n/a
No. of units	4	n/a
Unit rating	4,400	ekW
Stack height (existing)	24.9	m
Stack diameter	0.79	m
Exit gas velocity	31.13	m/sec
Exit gas temperature	722	deg K
Exit gas volume	15.16	m^3/sec
Fuel type	Diesel	n/a
Fuel use (max rate per unit)	275	gal/hr
Fuel sulfur (DEP limit)	1.0	%(w)
Fuel sulfur (CY 2010 max)	0.58	%(w)
PM2.5 emission rate	1.94	lb/hr
Lead (Pb) emission rate	n/a	lb/hr
NO2 emission rate	121	lb/hr
SO2 emission rate	38.1	lb/hr

TABLE 3

KWAJALEIN INCINERATOR

Parameter	Value	Units
No. of operating units	1	n/a
Unit rating	20	T/da
Stack height	10.7	m
Stack diameter	1.02	m
Exit gas velocity[1]	14.76	m/sec
Exit gas temperature[1]	1,200	deg K
Exit gas volume[1]	12.0	m^3/sec
Fuel type	Diesel/Waste Oil	n/a
Fuel use (design) - primary[2]	16.1	gal/hr
- secondary[3]	25.5	gal/hr
PM2.5 emission rate	1.3	lb/hr
Lead (Pb) emission rate	4.94E-03	lb/hr
NO2 emission rate	3.38	lb/hr
SO2 emission rate	6.45	lb/hr

3.2 Lead (Pb). In November 2008, EPA promulgated a new ambient air quality standard for lead (Pb) [4]. The new standard is a rolling 3-month average of 0.15 $\mu g/m^3$ evaluated over a 3-year period. The effective date of the standard was 12 Jan 09.

3.3 NO2. In February 2010, EPA promulgated a new 1-hour ambient air quality standard for nitrogen dioxide (NO_2) to supplement the existing annual standard [5]. The standard is 100 parts per billion (ppb) based on the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations. The effective date of the standard was 12 Apr 10.

3.4 SO2. In June 2010, EPA promulgated a new 1-hour ambient air quality standard for sulfur dioxide (SO_2) and revoked the existing 24-hour and annual SO_2 standards [6]. The new standard is 75 ppb based on a 3-year average of the 99th percentile of the yearly distribution of 1-hour daily maximum concentrations. The effective date of this standard was 23 Aug 10.

In accordance with UES §3.1-3, the ambient concentration of any criteria pollutant shall not exceed 80% of the respective national ambient air quality standard; therefore, the UES air pollutant standards based on the new NAAQS are as shown in Table 4.

TABLE 4

UES AIR POLLUTANT STANDARDS

Averaging Time/Pollutant	UES
1-hour NO_2	80 ppb
1-hour SO_2	60 ppb
24-hour $PM_{2.5}$	28 µg/m^3
Annual $PM_{2.5}$	12 µg/m^3
3-month Pb	0.12 µg/m^3

4.0 AMBIENT IMPACT ANALYSIS

4.1 Model Input. Impacts of the new 1-hour NO_2 and SO_2 ambient standards were assessed based on modeling of the aforementioned power plant. Modeling was conducted in accordance with the latest U.S. EPA modeling guidelines [5] and specific guidance for the new 1-hour standards [6, 7, 8]. Given the simple, i.e., flat, terrain of the island, the latest edition of the AERMOD model (ver. 12060) [9] was selected for use along with five (5) years (2005 and 2007 - 2010) of surface and upper air data from Kwajalein. Data from 2006 was not used because the number of missing data hours exceeded EPA guidelines [10]. The AERMET program (ver. 11059) [11] was used to process the raw data into data files suitable for use with AERMOD. A receptor grid with 10-meter spacing was generated by the AERMOD model to cover the potential impact area around the power plant.

Stack parameters and emission rates input to the model were derived from data presented in Tables 1 and 2. Emission rates were based on EPA emission factors [12]. The initial model runs were intended to determine whether the facilities in their existing condition could comply with the new ambient standards. If initial compliance was not possible, then additional runs were made in order to identify design changes, e.g., increased stack height, which would allow compliance.

4.2 Modeling Results. Results of initial modeling with existing stack heights are depicted in Tables 5 - 8 and indicate non-compliance with the 1-hour NO_2 and SO_2 standards. Figures 2, 3, 4 and 5 depict the extent of the NO_2, SO_2, and $PM_{2.5}$ non-compliance areas. Modeling results for lead (Pb) were not listed in the table because the highest modeled 1-month Pb concentration was 0.0064 $\mu g/m^3$ and thus any 3-month average would be several orders of magnitude below the new ambient standard.

TABLE 5

AERMOD NO_2 MODELING RESULTS AND CONTROL ALTERNATIVES FOR COMPLIANCE

***PP-1A Scenario:**	**1-Hour NO_2 (UES = 80 ppb)**		
	1 Gens	**2 Gens**	**3 Gens**
Concentration (ppb) with existing 81.6' stacks	103	215	335
Stack height ** required to comply OR	**106'**	**>120'**	**>120'**
Minimum pollutant removal efficiency	23%	63%	77%

***PP-1B Scenario:**	**1- Hour NO_2 (UES = 80 ppb)**				
	1 Gens	**2 Gens**	**3 Gens**	**4 Gens**	****5 Gens**
Concentration (ppb) with existing 81.6' stacks	134	261	376	491	581
Stack height required to comply OR	**112'**	**>120'**	**>120'**	**>120'**	**>120'**
Minimum pollutant removal efficiency	41%	70%	79%	84%	87%

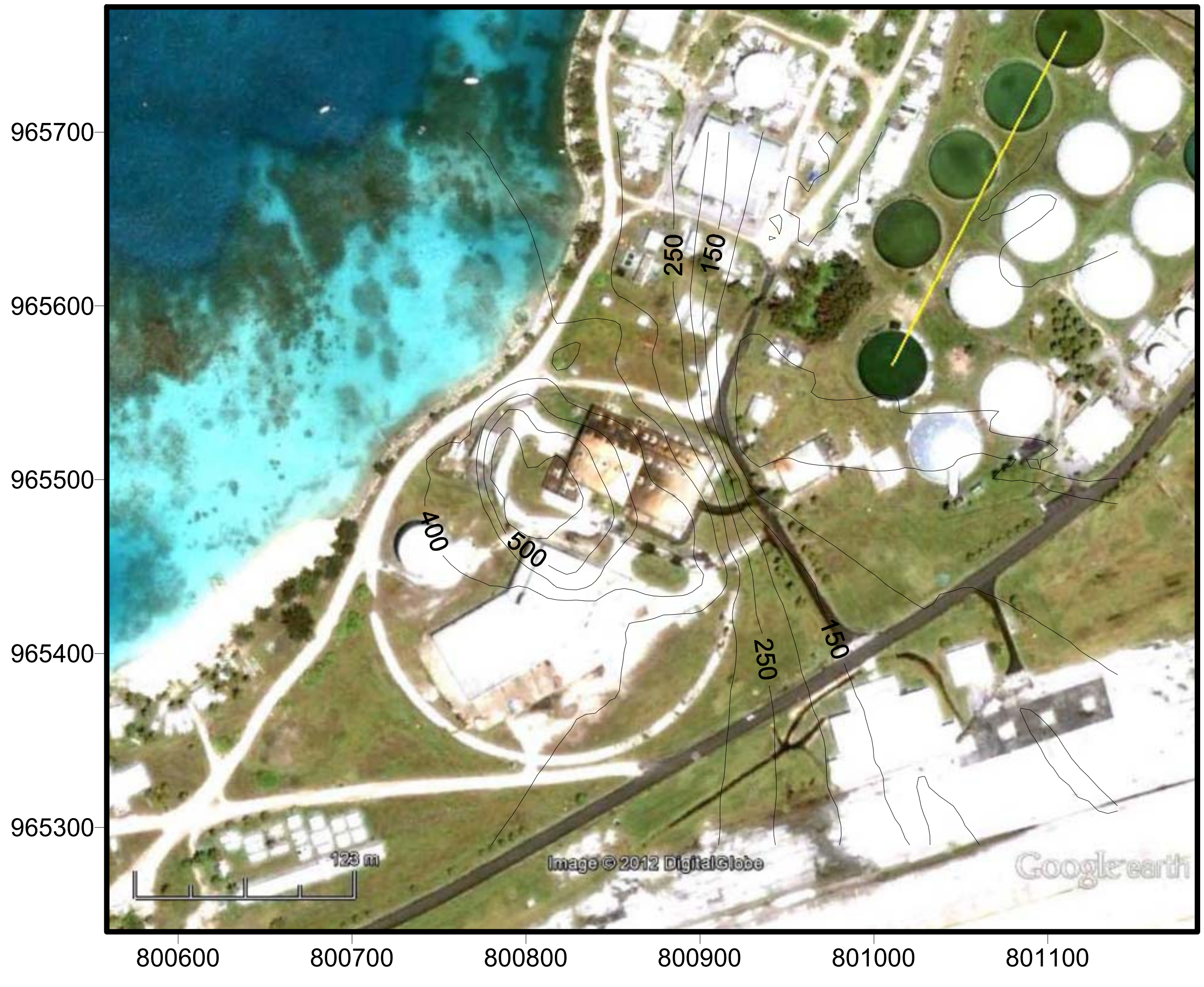
* "Scenario" is the number of generators operating simultaneously with the incinerator

** "Worst case" = PP-1A (1 engine) + PP-1B (4 engines)

*** Stack heights ≥100' may not be feasible for the engines in this plant due to back pressure and structural factors.

FIGURE 2

98TH PERCENTILE 1-HOUR NO2 ISOPLETHS (PPB)
(Existing Stack Heights)



NAAQS: 100 ppb
UES: 80 ppb

UTM Zone 58P / WGS-84

TABLE 6

AERMOD SO_2 MODELING RESULTS AND CONTROL ALTERNATIVES FOR COMPLIANCE

***PP-1A Scenario:**	**1-Hour SO_2 (UES = 60 ppb)**		
	1 Gens	**2 Gens**	**3 Gens**
Concentration (ppb) with existing 81.6' stacks	111	242	391
Stack height ** required to comply OR	**105'**	**117'**	**>120'**
Minimum pollutant removal efficiency OR	47%	76%	85%
Maximum fuel sulfur content	0.53%	0.24%	0.15%

***PP-1B Scenario:**	**1- Hour SO_2 (UES = 60 ppb)**				
	1 Gens	**2 Gens**	**3 Gens**	**4 Gens**	****5 Gens**
Concentration (ppb) with existing 81.6' stacks	179	346	483	619	701
Stack height required to comply OR	**110'**	**117'**	**>120'**	**>120'**	**>120'**
Minimum pollutant removal efficiency OR	67%	83%	88%	91%	92%
Maximum fuel sulfur content	0.33%	0.17%	0.12%	0.09%	0.08%

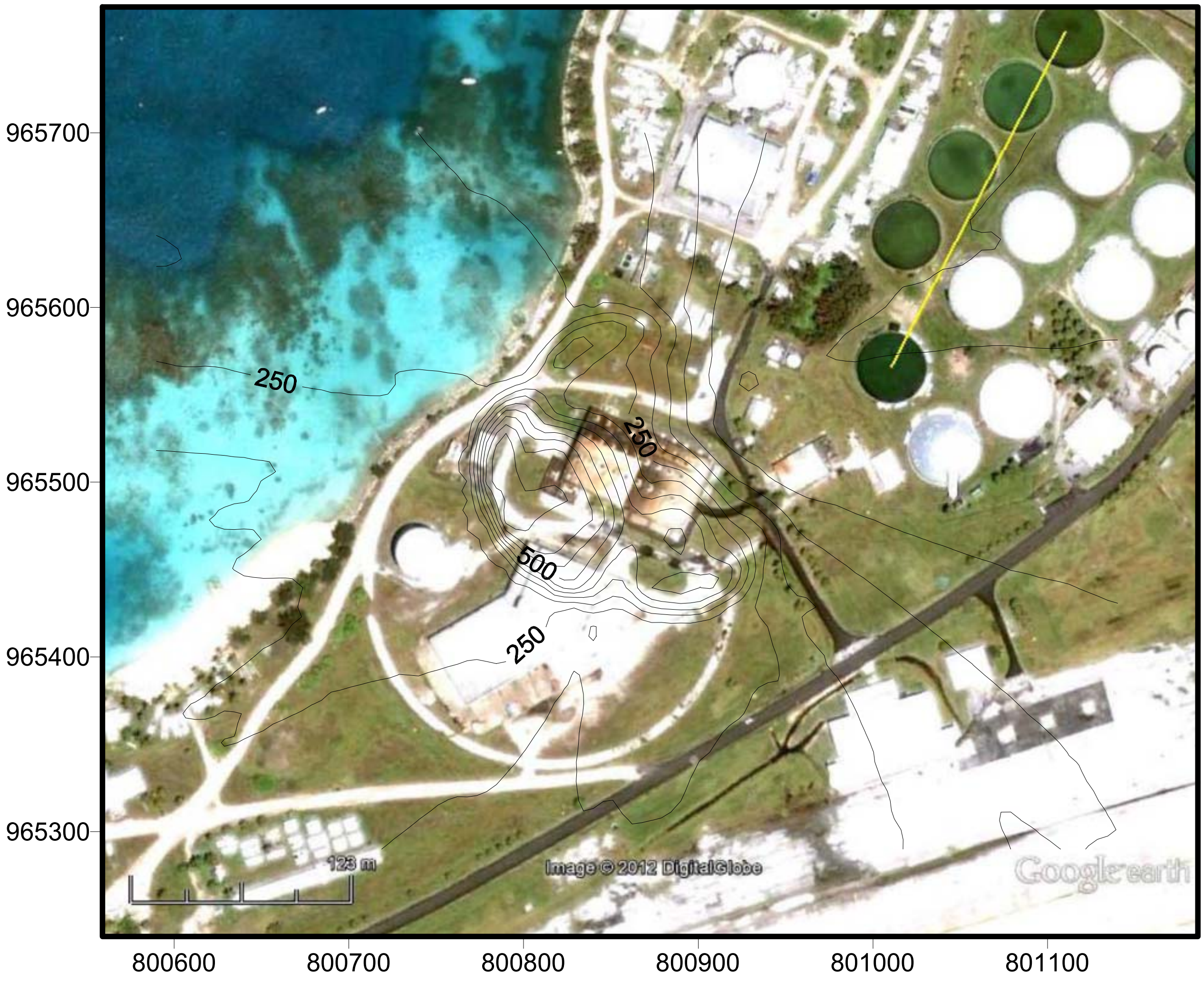
* "Scenario" is the number of generators operating simultaneously with the incinerator

** "Worst case" = PP-1A (1 engine) + PP-1B (4 engines)

*** Stack heights ≥120' may not be feasible for the engines in this plant due to back pressure and structural factors.

FIGURE 3

99TH PERCENTILE 1-HOUR SO2 ISOPLETHS (PPB)
(Existing Stack Heights)



NAAQS: 75 ppb
UES: 60 ppb

UTM Zone 58P / WGS-84

TABLE 7

AERMOD 24-HOUR $PM_{2.5}$ MODELING RESULTS AND CONTROL ALTERNATIVES FOR COMPLIANCE

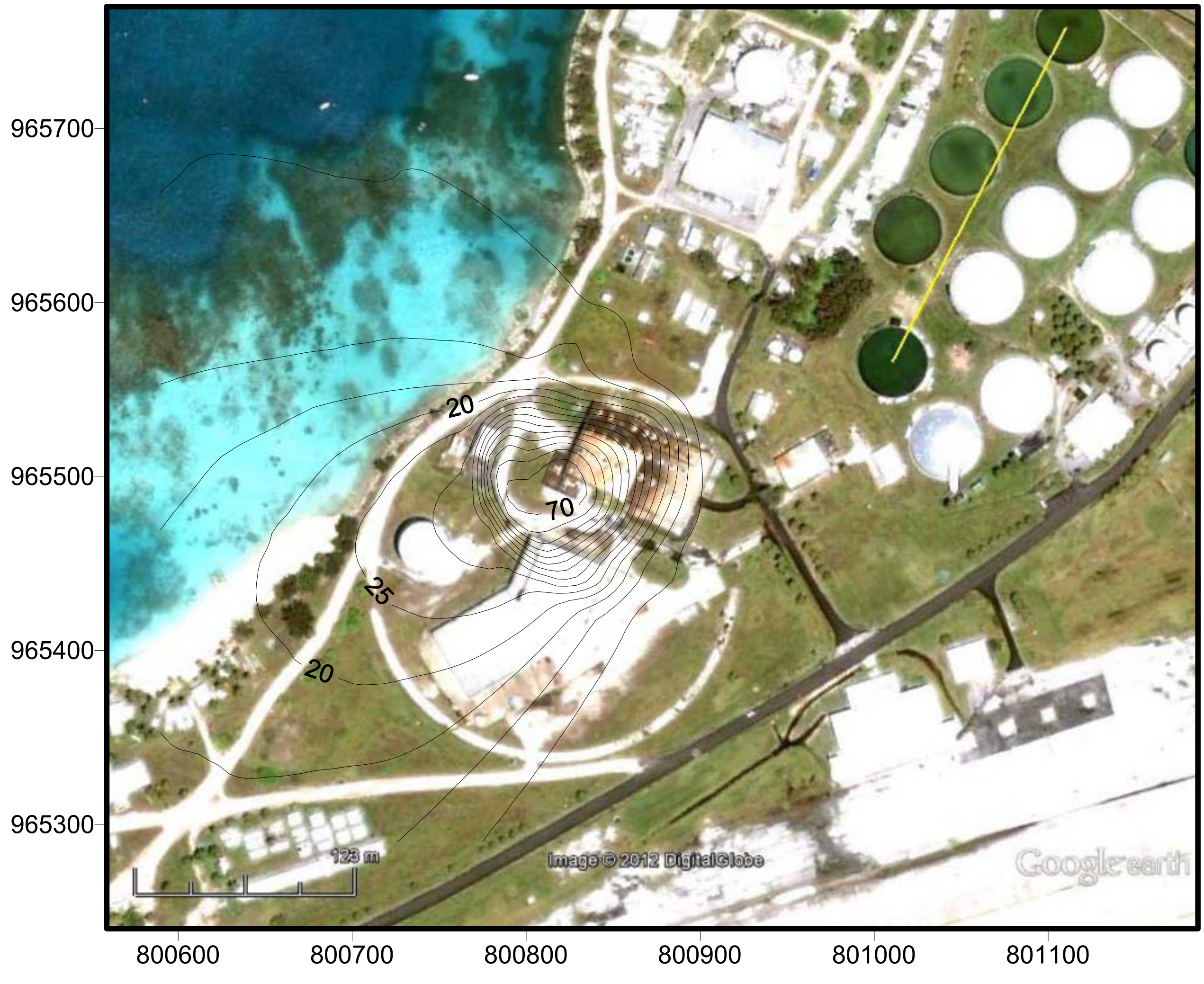
	24-Hour $PM_{2.5}$ (UES = 28 ppb)		
***PP-1A Scenario:**	**1 Gens**	**2 Gens**	**3 Gens**
Concentration (ppb) with existing 81.6' stacks	9.5	21.0	34.4
Stack height ** required to comply OR	n/a	n/a	**95'**
Minimum pollutant removal efficiency	n/a	n/a	20%

	24- Hour $PM_{2.5}$ (UES = 28 ppb)				
***PP-1B Scenario:**	**1 Gens**	**2 Gens**	**3 Gens**	**4 Gens**	****5 Gens**
Concentration (ppb) with existing 81.6' stacks	17.6	35.1	51.4	65.3	74.9
Stack height required to comply OR	**n/a**	**95'**	**100'**	**105'**	**108'**
Minimum pollutant removal efficiency	n/a	22%	47%	58%	64%

* "Scenario" is the number of generators operating simultaneously with the incinerator
** "Worst case" = PP-1A (1 engine) + PP-1B (4 engines)
*** Stack heights ≥100' may not be feasible for the engines in this plant due to back pressure and structural factors.

FIGURE 4

98TH PERCENTILE 24-HOUR PM2.5 ISOPLETHS (UG/M3)
(Existing Stack Heights)



UTM Zone 58P / WGS-84

NAAQS: 35 ug/m3
UES: 28 ug/m3

TABLE 8

AERMOD ANNUAL $PM_{2.5}$ MODELING RESULTS AND CONTROL ALTERNATIVES FOR COMPLIANCE

***PP-1A Scenario:**	**Annual $PM_{2.5}$ (UES = 12 ppb)**		
	1 Gens	**2 Gens**	**3 Gens**
Concentration (ppb) with existing 81.6' stacks	4.8	10.9	18.4
Stack height ** required to comply OR	n/a	n/a	**103'**
Minimum pollutant removal efficiency	n/a	n/a	38%

***PP-1B Scenario:**	**Annual $PM_{2.5}$ (UES = 12 ppb)**				
	1 Gens	**2 Gens**	**3 Gens**	**4 Gens**	****5 Gens**
Concentration (ppb) with existing 81.6' stacks	12.1	23.8	34.7	43.8	50.9
Stack height required to comply OR	**85'**	**100'**	**105'**	**108'**	**110'**
Minimum pollutant removal efficiency	1%	54%	69%	76%	79%

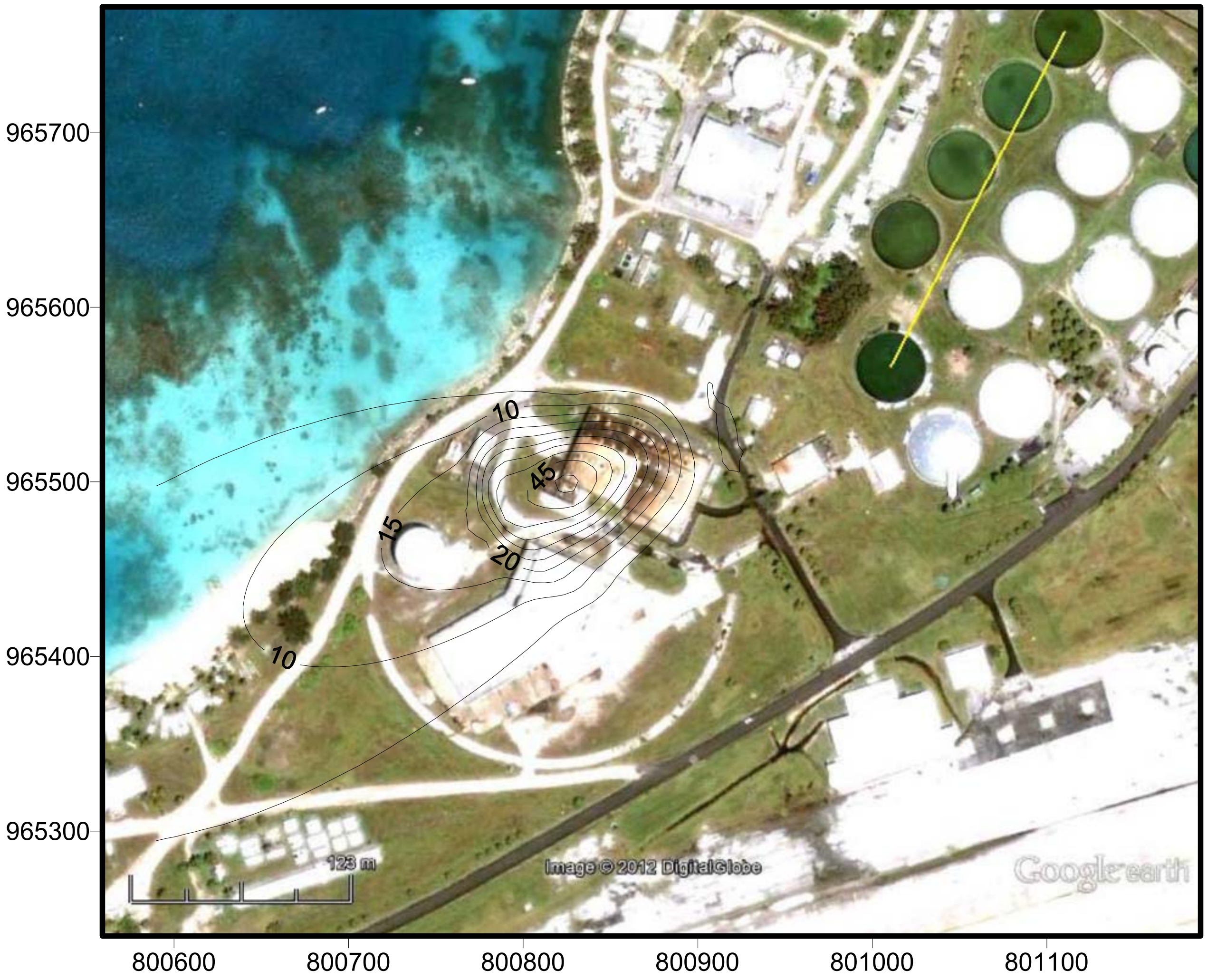
* "Scenario" is the number of generators operating simultaneously with the incinerator

** "Worst case" = PP-1A (1 engine) + PP-1B (4 engines)

*** Stack heights ≥100' may not be feasible for the engines in this plant due to back pressure and structural factors.

FIGURE 5

ANNUAL PM2.5 ISOPLETHS (UG/M3)
(Existing Stack Heights)



NAAQS: 15 ug/m3
UES: 12 ug/m3

UTM Zone 58P / WGS-84

4.3 Compliance Alternatives. Table 2 also includes control alternatives that will achievecompliance. Simply raising the stack heights to achieve compliance with both NO_2 and SO_2 standards does not appear feasible in this case due to the excessively tall stacks required on these engines. A more moderate increase in stack heights coupled with a control method having a minimum removal efficiency somewhat less than that shown in Tables 5 - 8 could achieve compliance with the new ambient standards. In the case of NO_2, the method could be selective catalytic reduction (SCR) with urea injection that is capable of 60 - 90% NOx removal efficiency. Replacement of the engines with newer low-NOx emitting engines would also contribute to compliance. For SO_2, the control method could be limiting fuel sulfur content or installation of some type of scrubber system with alkali injection.

5.0 NEW NESHAP STANDARDS

5.1 RICE Rules. In March 2010, EPA promulgated national emission standards for hazardous air pollutants (NESHAP) for existing stationary compression ignition reciprocating internal combustion engines (RICE) located at non-major sources (i.e., "area sources") of hazardous air pollutants (HAP) [13]. "Existing" was defined as engines installed prior to 12 Jun 06. The major requirements in these rules that could affect the Kwajalein power plant units because they are rated >300 bhp include the following:

- limit carbon monoxide (CO) in exhaust to 49 ppm at 15% O_2, or;
- reduce CO emissions by 70% or more;
- conduct initial performance test within 180 days of compliance date;
- if not already present , install a closed or open crankcase ventilation system;

- initial compliance date is 3 May 13.

There are also a number of notifications, recordkeeping, and reporting requirements in the rules.

5.2 Area Source Boiler Rules. In March 2011, EPA promulgated new rules affecting industrial, commercial and institutional boilers at new and existing area sources of hazardous air pollutants (HAP) [14]. "Area sources" are defined as sources that are not major HAP sources. The one oil-fired boilers on Kwajalein would be subject to these rules. However, due to its relatively small size, i.e., 3.35 MMBTU/hr, it is not subject to emission standards, but rather to work practice and management practice standards including biennial tune-ups. It would also be subject to notification, reporting and recordkeeping requirements. The compliance date for the initial boiler tune-up was 21 Mar 12, but this was extended to 1 Oct 12 by EPA [15].

6.0 CONCLUSIONS

The foregoing analysis indicates that certain actions will be necessary at the Kwajalein power plant in order to assure compliance with the new NO_2 , SO_2 and $PM_{2.5}$ ambient air quality standards. These may include increasing the height of exhaust stacks, reduction in fuel sulfur content, installation of control equipment, or engine replacement to reduce emission rates.

The promulgation of new NESHAP rules by EPA may also necessitate additional requirements related to reduction of CO emissions from the existing diesel engines. If, however, the engines were replaced to meet the new ambient standards, then the NESHAP rules would not apply. The new boiler rules would require biennial tune-ups for the existing oil-fired boilers. Both sets of rules include notification, reporting and recordkeeping requirements.

REFERENCES

1. U. S. Army Kwajalein Atoll. *Environmental Standards and Procedures for United States Army Kwajalein Atoll (USAKA) Activities in the Republic of the Marshall Islands*, Twelfth Edition, Aug 11.

2. Morrow, J. W. *Air Quality Impact Report (AQIR), Kwajalein Island, U. S. Army Kwajalein Atoll, Republic of the Marshall Islands*, 19 Apr 05.

3. U. S. Environmental Protection Agency. *40 CFR Parts 50 and 58, Primary National Ambient Air Quality Standards for Nitrogen Dioxide; Final Rule*, Federal Register, Volume 75, No. 26, 9 Feb 10.

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5. U. S. Environmental Protection Agency. *Guideline on Air Quality Models,* 40 CFR 51, Appendix W, Jul 11.

6. U. S. Environmental Protection Agency. *Guidance Concerning the Implementation of the 1-hour NO_2 NAAQS for the Prevention of Significant Deterioration Program*, OAQPS Memorandum, 29 Jun 10.

7. U. S. Environmental Protection Agency. *Application of Appendix W Modeling Guidance for the 1-hour SO_2 National Ambient Air Quality Standard*, Air Quality Modeling Group Memorandum, 23 Aug 10.

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10. U. S. Environmental Protection Agency. *Meteorological Monitoring Guidance for Regulatory Modeling Applications*, EPA-454/R-99-005, Feb 00.

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13. U. S. Environmental Protection Agency. *40 CFR Part 63, National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule*, Federal Register, Volume 75, No. 41, 3 Mar 10.

14. U. S. Environmental Protection Agency. *40 CFR Part 63, National Emission Standards for Hazardous Air Pollutants for Area Sources: Industrial, Commercial, and Institutional Boilers; Final Rule*, Federal Register, Volume 76, No. 54, 21 Mar 11.

15. U. S. Environmental Protection Agency. Letter from Assistant Administrator, Cynthia Giles, *Re: No Action Assurance Regarding Certain Work Practice or Management Practice Standard Deadlines in the March 2011 Area Source Boiler Rule*, 13 Mar 12.

CHAPTER 2

AIR QUALITY IMPACT REPORT

ROI-NAMUR

AUGUST 6, 2012

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AIR QUALITY IMPACT REPORT
(AQIR)

ROI NAMUR ISLAND
U.S. ARMY KWAJALEIN ATOLL
REPUBLIC OF THE MARSHALL ISLANDS

6 AUGUST 2012

PREPARED FOR:

Teledyne Brown Engineering

PREPARED BY:

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CONTENTS

1.0 INTRODUCTION

In December 1995, the U.S. Army Kwajalein Atoll (USAKA), after consultation with the Republic of the Marshall Islands (RMI), promulgated Environmental Standards and Procedures which are now in their twelfth edition [1]. Specific processes for addressing activities with potential environmental impact are detailed. In the case of air pollution, sources which have the potential to emit regulated pollutants above specified thresholds require preparation of various documents including Notices of Proposed Activity (NPA) for existing sources and Notices of Continuing Activity (NCA) for existing sources, both of which are necessary predecessors to Documents of Environmental Protection (DEP), the primary mechanism for environmental review and ultimate approval or denial of an activity. Ambient air quality standards are also included for new and existing sources.

A required component of NPA's and NCA's for air pollution sources is an ambient air quality impact analysis, the minimum contents of which are detailed in the USAKA Environmental Standards (UES). These UES air quality requirements are linked to U. S. Environmental Protection Agency (EPA) requirements that have been amended or expanded in recent years. It is therefore the purpose of this report to update the 2005 air quality analysis [2] for Roi Namur, a flat 398-acre coral and fill piece of land, with its 14.85 MW power plant and 850 lb/hr incinerator.

2.0 EXISTING SOURCES

2.1 Power Plant. The existing power plant (Facility No. 5030) is located on the west central part of the island (Figure 1) and consists of nine 1,650 kWe Caterpillar Model 3606 diesel engine generator sets. Additional descriptive data used in this analysis are summarized in Table 1.

2.2 Incinerator. A multiple chamber, starved air incinerator designed to combust nonhazardous waste including municipal solid waste, construction waste, and operations solid waste is located on the southwest end of the island (Figure 1). The incinerator consists of a ram feeder and primary and secondary combustion chambers each equipped with two oil-fired burners. Table 2 summarizes analysis parameters.

3.0 NEW AMBIENT AIR QUALITY STANDARDS

3.1 PM2.5. In October 2006, EPA promulgated new standards for particulate matter (PM) [3]. The new 24-hour standard for PM less than or equal to 2.5 micrometers (μm) in diameter ($PM_{2.5}$) was set at 35 μg/m^3 based on a 3-year average of the 98th percentile values. The annual $PM_{2.5}$ standard of 15 μg/m^3 was retained, but the annual PM_{10} standard was revoked. The effective date of these standards was 18 Dec 06.

3.2 Lead (Pb). In November 2008, EPA promulgated a new ambient air quality standard for lead (Pb) [4]. The new standard is a rolling 3-month average of 0.15 μg/m^3 evaluated over a 3-year period. The effective date of the standard was 12 Jan 09.

FIGURE 1

ROI NAMUR ISLAND

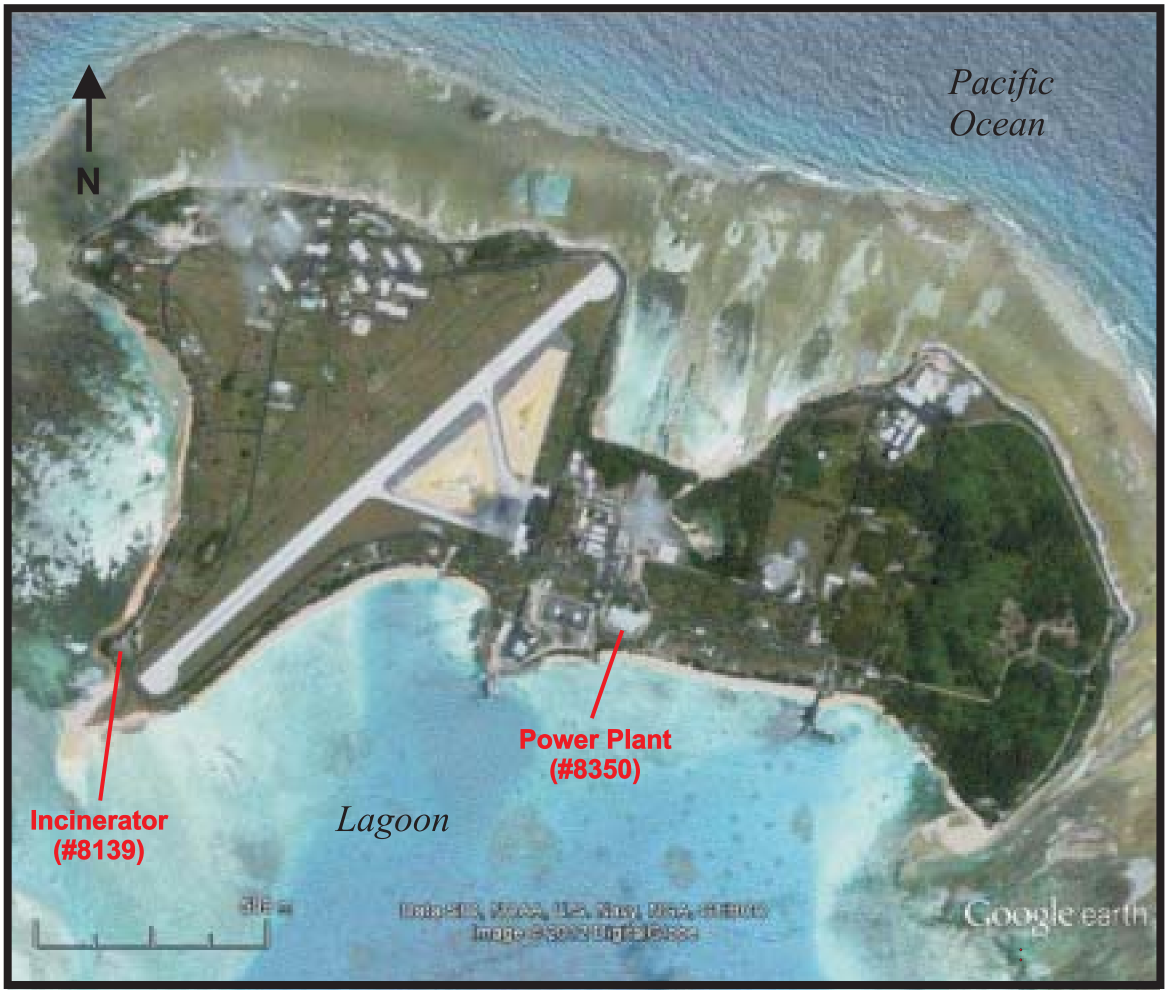


TABLE 1

ROI NAMUR POWER PLANT

Parameter	Value	Units
Model	CAT 3606	n/a
No. of units	9	n/a
Unit rating	1,650	ekW
Stack height	24.2	m
Stack diameter	0.51	m
Exit gas velocity[1]	58.64	m/sec
Exit gas temperature	709	deg K
Exit gas volume	11.9	m^3/sec
Fuel type	Diesel	n/a
Fuel use (max rate per unit)	217.00	gal/hr
Fuel sulfur (DEP limit)	1.0	%(w)
Fuel sulfur (CY 2010 max)	0.58	%(w)
PM2.5 emission rate	0.55	lb/hr
Pb emission rate	n/a	lb/hr
NOx emission rate	54.5	lb/hr
SO2 emission rate	15.0	lb/hr

TABLE 2

ROI NAMUR INCINERATOR

Parameter	Value	Units
No. of operating units	1	n/a
Unit rating	850	lb/hr
Stack height	8.3	m
Stack diameter	0.91	m
Exit gas velocity	6.5	m/sec
Exit gas temperature	1,033	deg K
Exit gas volume	4.3	m^3/sec
Fuel type	Diesel	n/a
Fuel use (max rate)	13.5	gal/hr
Fuel sulfur (DEP limit)	1.0	%(w)
Fuel sulfur (CY 2010 max)	0.58	%(w)
PM2.5 emission rate	0.40	lb/hr
Pb emission rate	1.70.E-05	lb/hr
NOx emission rate	1.61	lb/hr
SO2 emission rate	3.29	lb/hr

3.3 NO2. In February 2010, EPA promulgated a new 1-hour ambient air quality standard for nitrogen dioxide (NO_2) to supplement the existing annual standard [5]. The standard is 100 parts per billion (ppb) based on the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations. The effective date of the standard was 12 Apr 10.

3.4 SO2. In June 2010, EPA promulgated a new 1-hour ambient air quality standard for sulfur dioxide (SO_2) and revoked the existing 24-hour and annual SO_2 standards [6]. The new standard is 75 ppb based on a 3-year average of the 99th percentile of the yearly distribution of 1-hour daily maximum concentrations. The effective date of this standard was 23 Aug 10.

In accordance with UES §3.1-3, the ambient concentration of any criteria pollutant shall not exceed 80% of the respective national ambient air quality standard; therefore, the UES air pollutant standards based on the new NAAQS are as shown in Table 3.

TABLE 3

UES AIR POLLUTANT STANDARDS

Averaging Time/Pollutant	UES
1-hour NO_2	80 ppb
1-hour SO_2	60 ppb
24-hour $PM_{2.5}$	28 $\mu g/m^3$
Annual $PM_{2.5}$	12 $\mu g/m^3$
3-month Pb	0.12 $\mu g/m^3$

4.0 AMBIENT IMPACT ANALYSIS

4.1 Model Input. Impacts of the new 1-hour NO_2 and SO_2 ambient standards were assessed based on modeling of the aforementioned power plant. Modeling was conducted in accordance with the latest U.S. EPA modeling guidelines [5] and specific guidance for the new 1-hour standards [6, 7, 8]. Given the simple, i.e., flat, terrain of the island, the latest edition of the AERMOD model (ver. 12060) [9] was selected for use along with five (5) years (2005 and 2007 - 2010) of surface and upper air data from Kwajalein. Data from 2006 was not used because the number of missing data hours exceeded EPA guidelines [10]. The AERMET program (ver. 11059) [11] was used to process the raw data into data files suitable for use with AERMOD. A receptor grid with 10-meter spacing was generated by the AERMOD model to cover the potential impact area around the power plant.

Stack parameters and emission rates input to the model were derived from data presented in Tables 1 and 2. Emission rates were based on EPA emission factors [12]. The initial model runs were intended to determine whether the facilities in their existing condition could comply with the new ambient standards. If initial compliance was not possible, then additional runs were made in order to identify design changes, e.g., increased stack height, which would allow compliance.

4.2 Modeling Results. Results of initial modeling with existing stack heights are depicted in Table 4 and indicate non-compliance with the 1-hour NO_2 and SO_2 standards. Figures 2 and 3 depict the extent of the non-compliance. Modeling results for lead (Pb) were not listed in the table because the highest modeled 1-month Pb concentration was 0.0009 $\mu g/m^3$ and thus any 3-month average would be several orders of magnitude below the new ambient standard.

TABLE 4

AERMOD MODELING RESULTS AND CONTROL ALTERNATIVES FOR COMPLIANCE

***Scenario:**	**1-Hour NO_2 (UES = 80 ppb)**					
	1 Gens	**2 Gens**	**3 Gens**	**4 Gens**	**5 Gens**	**6 Gens**
Concentration (ppb) with existing 79.5' stacks	79	102.6	224	208.5	271	284
Stack height ** required to comply OR	n/a	**>100'**	**>100'**	**>100'**	**>100'**	**>100'**
Minimum pollutant removal efficiency	n/a	23%	65%	62%	71%	73%

***Scenario:**	**1- Hour SO_2 (UES = 60 ppb)**					
	1 Gens	**2 Gens**	**3 Gens**	**4 Gens**	**5 Gens**	**6 Gens**
Concentration (ppb) with existing 79.5' stacks	50	99.6	131	212	238	263
Stack height required to comply OR	n/a	**91'**	**95'**	**98'**	**>100'**	**>100'**
Minimum pollutant removal efficiency OR	n/a	41%	55%	72%	76%	78%
Maximum fuel sulfur content	n/a	0.59%	0.45%	0.28%	0.24%	0.22%

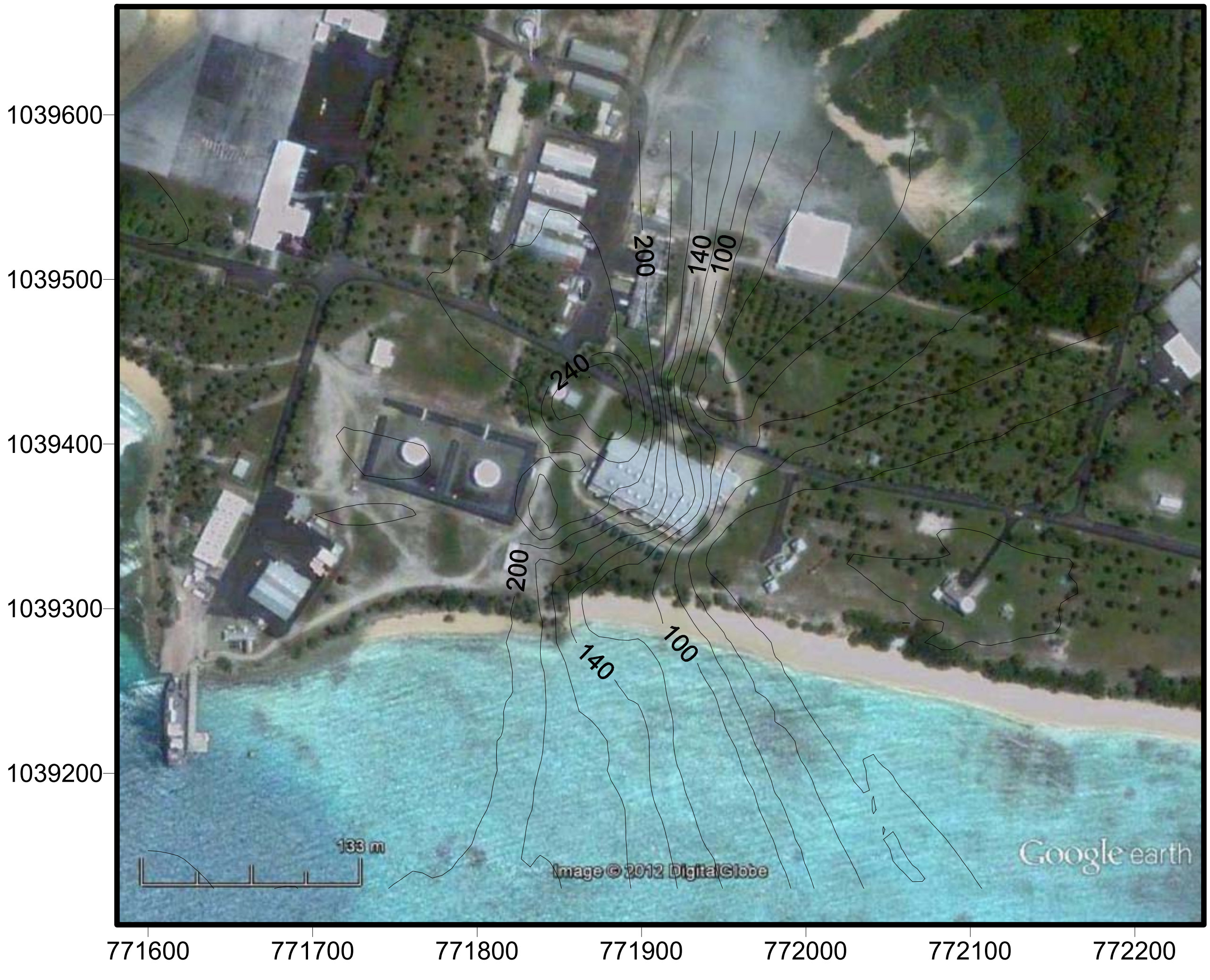
Scenario (6 Engines):	**$PM_{2.5}$**	
	24-hr (UES: 28 μg/m^3)	**Annual (UES: 12 μg/m^3)**
Concentration (μg/m^3) with existing 79.5' stacks	10.6	4.95
Stack height ** required to comply OR	n/a	n/a
Minimum pollutant removal efficiency	n/a	n/a

* "Scenario" is the number of generators operating simultaneously with the incinerator

** Stack heights ≥100' may not be feasible for the engines in this plant due to back pressure and structural factors.

FIGURE 2

98TH PERCENTILE 1-HOUR NO2 ISOPLETHS (PPB)
(Existing Stack Heights)

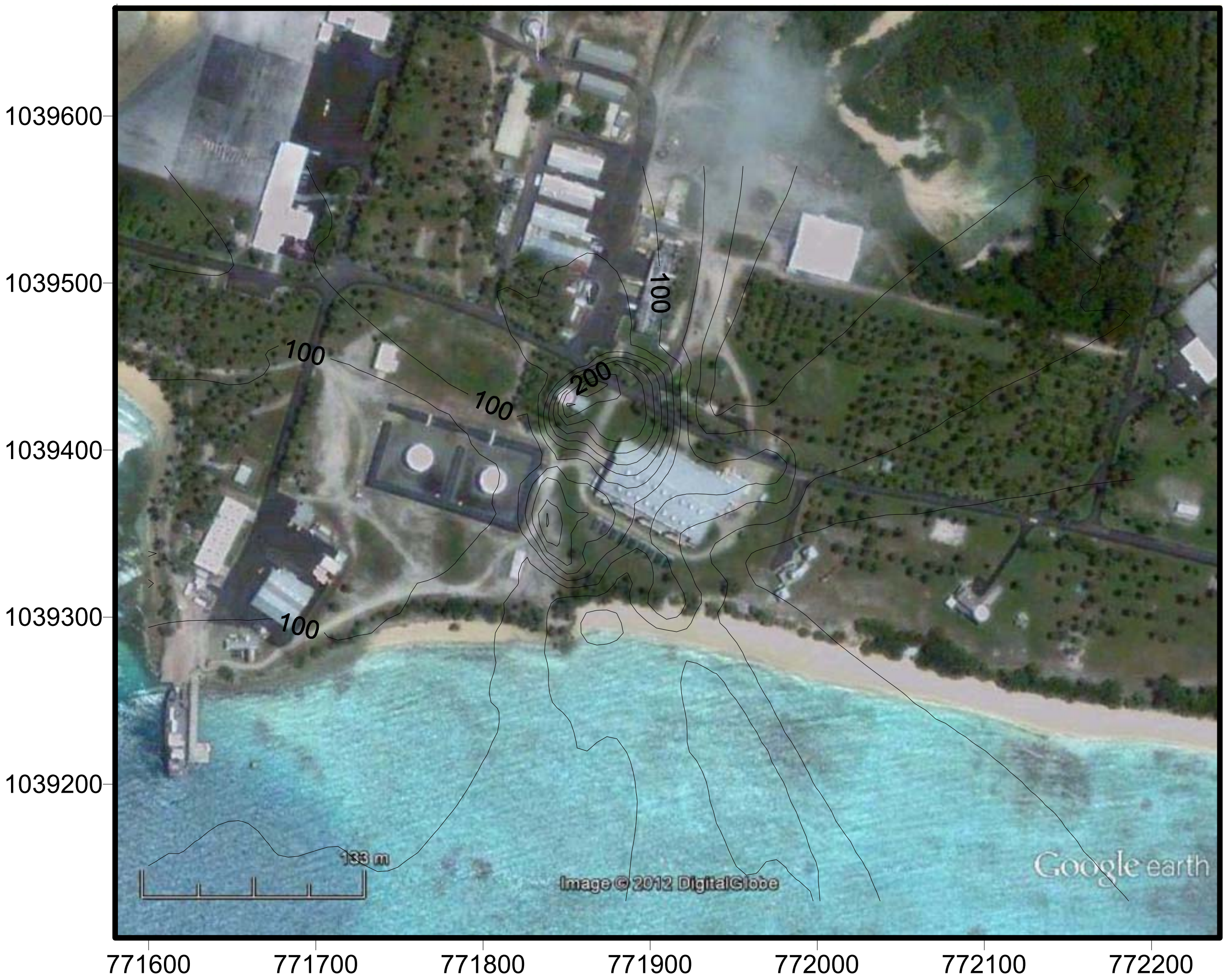


NAAQS: 100 ppb
UES: 80 ppb

UTM Zone 58P / WGS-84

FIGURE 3

99TH PERCENTILE 1-HOUR SO2 ISOPLETHS (PPB)
(Existing Stack Heights)



NAAQS: 75 ppb
UES: 60 ppb

UTM Zone 58P / WGS-84

4.3 Compliance Alternatives. Table 2 also includes control alternatives that will achieve compliance. Simply raising the stack heights to achieve compliance with both NO_2 and SO_2 standards does not appear feasible in this case due to the excessively tall stacks required on these engines. A more moderate increase in stack heights coupled with a control method having a minimum removal efficiency somewhat less than that shown in Table 4 could achieve compliance with the new ambient standards. In the case of NO_2, the method could be selective catalytic reduction (SCR) with urea injection that is capable of 60 - 90% NOx removal efficiency. Replacement of the engines with newer low-NOx emitting engines would also contribute to compliance. For SO_2, the control method could be limiting fuel sulfur content or installation of some type of scrubber system with alkali injection.

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- limit carbon monoxide (CO) in exhaust to 49 ppm at 15% O_2, or;
- reduce CO emissions by 70% or more;
- conduct initial performance test within 180 days of compliance date;
- if not already present , install a closed or open crankcase ventilation system;

- initial compliance date is 3 May 13.

There are also a number of notifications, recordkeeping, and reporting requirements in the rules.

5.2 Area Source Boiler Rules. In March 2011, EPA promulgated new rules affecting industrial, commercial and institutional boilers at new and existing area sources of hazardous air pollutants (HAP) [14]. "Area sources" are defined as sources that are not major HAP sources. The two oil-fired boilers on Roi Namur would be subject to these rules. However, due to their relatively small size, i.e., 1.02 MMBTU/hr, they are not subject to emission standards, but rather to work practice and management practice standards including biennial tune-ups. They would also be subject to notification, reporting and recordkeeping requirements. The compliance date for the initial boiler tune-up was 21 Mar 12, but this was extended to 1 Oct 12 by an EPA letter [15].

6.0 CONCLUSIONS

The foregoing analysis indicates that certain actions will be necessary at the Roi Namur power plant in order to assure compliance with the new NO_2 , SO_2 and $PM_{2.5}$ ambient air quality standards. These may include increasing the height of exhaust stacks, reduction in fuel sulfur content, installation of control equipment, or engine replacement to reduce emission rates.

The promulgation of new NESHAP rules by EPA may also necessitate additional requirements related to reduction of CO emissions from the existing diesel engines. If, however, the engines were replaced to meet the new ambient standards, then the NESHAP rules would not apply. The new boiler rules would require biennial tune-ups for the existing oil-fired boilers. Both sets of rules include notification, reporting and recordkeeping requirements.

REFERENCES

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CHAPTER 3

AIR QUALITY IMPACT REPORT

MECK

JULY 31, 2012

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AIR QUALITY IMPACT REPORT
(AQIR)

MECK ISLAND
U.S. ARMY KWAJALEIN ATOLL
REPUBLIC OF THE MARSHALL ISLANDS

31 JULY 2012

PREPARED FOR:

Teledyne Brown Engineering

PREPARED BY:

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CONTENTS

1.0 INTRODUCTION

In December 1995, the U.S. Army Kwajalein Atoll (USAKA), after consultation with the Republic of the Marshall Islands (RMI), promulgated Environmental Standards and Procedures which are now in their twelfth edition [1]. Specific processes for addressing activities with potential environmental impact are detailed. In the case of air pollution, sources which have the potential to emit regulated pollutants above specified thresholds require preparation of various documents including Notices of Proposed Activity (NPA) for existing sources and Notices of Continuing Activity (NCA) for existing sources, both of which are necessary predecessors to Documents of Environmental Protection (DEP), the primary mechanism for environmental review and ultimate approval or denial of an activity. Ambient air quality standards are also included for new and existing sources.

A required component of NPA's and NCA's for air pollution sources is an ambient air quality impact analysis, the minimum contents of which are detailed in the USAKA Environmental Standards (UES). These UES air quality requirements are linked to U. S. Environmental Protection Agency (EPA) requirements that have been amended or expanded in recent years. It is therefore the purpose of this report to update the 2005 air quality analysis [2] for Meck, a flat 55-acre coral and fill piece of land, with its 2.75 MW power plant and 850 lb/hr incinerator.

2.0 EXISTING SOURCES

2.1 Power Plant. The existing power plant (Facility No. 5030) is located on the west central part of the island (Figure 1) and consists of five 550 kWe Caterpillar Model 3508 diesel engine generator sets. Additional descriptive data used in this analysis are summarized in Table 1.

2.2 Incinerator. A multiple chamber, starved air incinerator designed to combust nonhazardous waste including municipal solid waste, construction waste, and operations solid waste is located about 100 meters south southwest of the power plant (Figure 1). The incinerator consists of a ram feeder and primary and secondary combustion chambers each equipped with two oil-fired burners. Table 2 summarizes analysis parameters.

3.0 NEW AMBIENT AIR QUALITY STANDARDS

3.1 PM2.5. In October 2006, EPA promulgated new standards for particulate matter (PM) [3]. The new 24-hour standard for PM less than or equal to 2.5 micrometers (μm) in diameter ($PM_{2.5}$) was set at 35 μg/m^3 based on a 3-year average of the 98th percentile values. The annual $PM_{2.5}$ standard of 15 μg/m^3 was retained, but the annual PM_{10} standard was revoked. The effective date of these standards was 18 Dec 06.

3.2 Lead (Pb). In November 2008, EPA promulgated a new ambient air quality standard for lead (Pb) [4]. The new standard is a rolling 3-month average of 0.15 μg/m^3 evaluated over a 3-year period. The effective date of the standard was 12 Jan 09.

FIGURE 1
MECK ISLAND

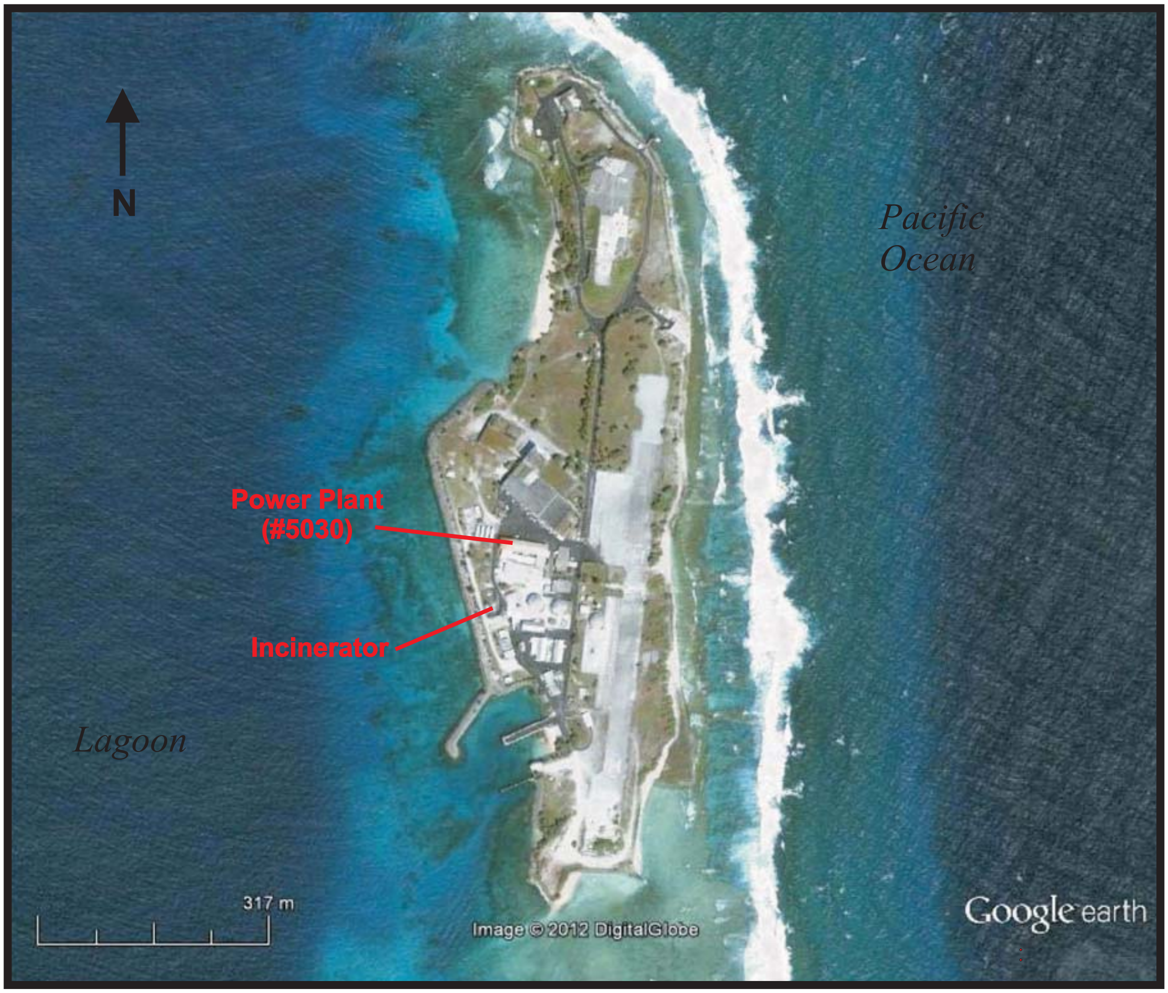

TABLE 1

MECK POWER PLANT

Parameter	Value	Units
Model	CAT 3508	n/a
No. of units	5	n/a
Unit rating	550	kW
Stack height	13.7	m
Stack diameter	0.20	m
Exit gas velocity	76.6	m/sec
Exit gas temperature	815	deg K
Exit gas volume	2.48	m^3/sec
Fuel type	Diesel	n/a
Fuel use (max rate per unit)	39.4	gal/hr
Fuel sulfur (DEP limit)	1.0	%(w)
Fuel sulfur (CY 2010 max)	0.58	%(w)
PM2.5 emission rate	0.28	lb/hr
Pb emission rate	n/a	lb/hr
NOx emission rate	17.27	lb/hr
SO_2 emission rate (1% S)	5.45	lb/hr

TABLE 2

MECK INCINERATOR

Parameter	Value	Units
No. of operating units	1	n/a
Unit rating	850	lb/hr
Stack height	8.3	m
Stack diameter	0.91	m
Exit gas velocity	6.5	m/sec
Exit gas temperature	1,033	deg K
Exit gas volume	4.3	m^3/sec
Fuel type	Diesel	n/a
Fuel use (max rate)	13.5	gal/hr
Fuel sulfur (DEP limit)	1.0	%(w)
PM2.5 emission rate	0.4	lb/hr
Pb emission rate	1.70E-05	lb/hr
NOx emission rate	1.61	lb/hr
SO_2 emission rate (1% S)	3.29	lb/hr

3.3 NO2. In February 2010, EPA promulgated a new 1-hour ambient air quality standard for nitrogen dioxide (NO_2) to supplement the existing annual standard [5]. The standard is 100 parts per billion (ppb) based on the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations. The effective date of the standard was 12 Apr 10.

3.4 SO2. In June 2010, EPA promulgated a new 1-hour ambient air quality standard for sulfur dioxide (SO_2) and revoked the existing 24-hour and annual SO_2 standards [6]. The new standard is 75 ppb based on a 3-year average of the 99th percentile of the yearly distribution of 1-hour daily maximum concentrations. The effective date of this standard was 23 Aug 10.

In accordance with UES §3.1-3, the ambient concentration of any criteria pollutant shall not exceed 80% of the respective national ambient air quality standard; therefore, the UES air pollutant standards based on the new NAAQS are as shown in Table 3.

TABLE 3

UES AIR POLLUTANT STANDARDS

Averaging Time/Pollutant	UES
1-hour NO_2	80 ppb
1-hour SO_2	60 ppb
24-hour $PM_{2.5}$	28 $\mu g/m^3$
Annual $PM_{2.5}$	12 $\mu g/m^3$
3-month Pb	0.12 $\mu g/m^3$

4.0 AMBIENT IMPACT ANALYSIS

4.1 Model Input. Impacts of the new 1-hour NO_2 and SO_2 ambient standards were assessed based on modeling of the aforementioned power plant. Modeling was conducted in accordance with the latest U.S. EPA modeling guidelines [7] and specific guidance for the new 1-hour standards [8, 9, 10]. Given the simple, i.e., flat, terrain of the island, the latest edition of the AERMOD model (ver. 12060) [11] was selected for use along with five (5) years (2005 and 2007 - 2010) of surface and upper air data from Kwajalein. Data from 2006 was not used because the number of missing data hours exceeded EPA guidelines [12]. The AERMET program (ver. 11059) [13] was used to process the raw data into data files suitable for use with AERMOD. A receptor grid with 10-meter spacing was generated by the AERMOD model to cover the potential impact area around the power plant.

Stack parameters and emission rates input to the model were derived from data presented in Tables 1 and 2. Emission rates were based on EPA emission factors [14]. The initial model runs were intended to determine whether the facilities in their existing condition could comply with the new ambient standards. If initial compliance was not possible, then additional runs were made in order to identify design changes, e.g., increased stack height, which would allow compliance.

4.2 Modeling Results. Results of initial modeling with existing stack heights are depicted in Table 4 and indicate non-compliance with the 1-hour NO_2 and SO_2 standards and with the annual $PM_{2.5}$ standard. Modeling results for lead (Pb) were not listed in the table because the highest modeled 1-month Pb concentration was 0.0009 $\mu g/m^3$ and thus any 3-month average would be

TABLE 4

AERMOD MODELING RESULTS AND CONTROL ALTERNATIVES FOR COMPLIANCE

	1-Hour NO$_2$ (UES = 80 ppb)				**1- Hour SO$_2$ (UES = 60 ppb)**			
***Scenario:**	**1 Gens**	**2 Gens**	**3 Gens**	**4 Gens**	**1 Gen**	**2 Gens**	**3 Gens**	**4 Gens**
Concentration (ppb) with existing 45' stacks	79.6	165	254	347	72.9	151	226	295
Stack height ** required to comply OR	n/a	**100'**	**>100'**	**>100'**	**60'**	**75'**	**84'**	**87'**
Minimum pollutant removal efficiency OR	n/a	52%	69%	78%	18%	61%	74%	80%
Maximum fuel sulfur content	n/a	n/a	n/a	n/a	0.82%	0.39%	0.26%	0.20%

	24-Hour PM$_{2.5}$ (UES = 28 μg/m^3)				**Annual PM$_{2.5}$ (UES = 12 μg/m^3)**			
***Scenario:**	**1 Gens**	**2 Gens**	**3 Gens**	**4 Gens**	**1 Gens**	**2 Gens**	**3 Gens**	**4 Gens**
Concentration (μg/m^3) with existing 45' stacks	4.8	10.7	17.3	24.1	2.3	5.7	9.9	14.5
Stack height required to comply OR	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**58'**
Minimum pollutant removal efficiency	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

* "Scenario" is the number of generators operating simultaneously with the incinerator

** Stack heights ≥100' are not likely to be feasible for the engines in this plant due to back pressure and structural factors.

several orders of magnitude below the new ambient standard. Figures 2, 3 and 4 depict the extent of the NO_2, SO_2, and $PM_{2.5}$ non-compliance areas around the power plant.

4.3 Compliance Alternatives. Table 4 also includes control alternatives that will achieve compliance. Simply raising the stack height to achieve compliance appears feasible for $PM_{2.5}$ but not for NO_2 due to the excessively tall stacks that would be required for these relatively small engines. A more moderate increase in stack height coupled with a control method having a minimum removal efficiency somewhat less than that shown in Table 4 could achieve compliance with the new ambient standards. In the case of NO_2, the method could be selective catalytic reduction (SCR) with urea injection that is capable of 60 - 90% NOx removal efficiency. Replacement of the engines with newer low-NOx emitting engines would also contribute to compliance. For SO_2, the control method could be limiting fuel sulfur content or installation of some type of scrubber system with alkali injection.

FIGURE 2

98TH PERCENTILE 1-HOUR NO2 ISOPLETHS (PPB)
(Existing Stack Heights)

NAAQS: 100 ppb
UES: 80 ppb

UTM Zone 58P / WGS-84

FIGURE 3

99TH PERCENTILE 1-HOUR SO2 ISOPLETHS (PPB)
(Existing Stack Heights)

UTM Zone 58P / WGS-84

NAAQS: 75 ppb
UES: 60 ppb

FIGURE 4

ANNUAL PM2.5 ISOPLETHS (UG/M3)
(Existing Stack Heights)

UTM Zone 58P / WGS-84

NAAQS: 15 ug/m3
UES: 12 ug/m3

5.0 NEW NESHAP STANDARDS

In March 2010, EPA promulgated national emission standards for hazardous air pollutants (NESHAP) for existing stationary compression ignition reciprocating internal combustion engines (RICE) located at non-major sources (i.e., "area sources") of hazardous air pollutants (HAP) [15]. "Existing" was defined as engines installed prior to 12 Jun 06. The major requirements in these rules that could affect the Meck power plant units because they are rated >300 bhp include the following:

- limit carbon monoxide (CO) in exhaust to 49 ppm at 15% O_2, or;
- reduce CO emissions by 70% or more;
- conduct initial performance test within 180 days of compliance date;
- if not already present , install a closed or open crankcase ventilation system;
- initial compliance date is 3 May 13.

There are also a number of notifications, recordkeeping, and reporting requirements in the rules.

6.0 CONCLUSIONS

The foregoing analysis indicates that the existing facilities on Meck can comply with new 3-month average lead (Pb) standard. However, certain actions will be necessary at the Meck power plant in order to assure compliance with the new NO_2 , SO_2 and $PM_{2.5}$ ambient air quality standards. These may include increasing the height of exhaust stacks, reduction in fuel sulfur content, installation of control equipment, or engine replacement to reduce emission rates.

The promulgation of new NESHAP rules by EPA may also necessitate additional requirements related to reduction of CO emissions from the existing diesel engines. If, however, the engines were replaced to meet the new ambient standards, then the NESHAP rules would not apply.

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