# New Source Review Modeling of $NO_2$ from Intermittent Testing of Emergency Engines

**State of Idaho**
**Department of Environmental Quality**

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# 1 Introduction

When a company proposes to construct or modify an air pollution emissions source, it must obtain an air quality permit to construct (PTC) from the Idaho Department of Environmental Quality (DEQ), unless exempt according to the "Rules for the Control of Air Pollution in Idaho" (IDAPA 58.01.01). The company must submit an application to DEQ to obtain a PTC and demonstrate that operations of the source will not cause or contribute to a violation of any air quality standard. Such a demonstration involves using atmospheric dispersion models that simulate how emitted pollutants will disperse in space and time as driven by meteorological conditions, surrounding structures, and area terrain.

Diesel-fired or natural gas-fired internal combustion (IC) engines tend to have relatively high nitrogen oxides ($NO_x$) emissions, depending on the engine size, power rating, and design. The recently promulgated 1-hour nitrogen dioxide ($NO_2$) National Ambient Air Quality Standard (NAAQS) is very stringent, and demonstrating that sources will not cause or contribute to a $NO_2$ NAAQS violation is frequently difficult when using the standard required methods associated with permitting analyses.

Many industrial facilities have IC engines used for emergency generators or fire-suppression pumps. These engines only operate for periodic testing and during an actual emergency. As such, these sources are difficult to model in a way that accounts for impacts in a reasonably accurate but conservative manner. This DEQ guidance addresses the following issues:

1. Clarification of when emissions from the intermittent operation of IC engines must be included in the air impact analyses for permitting (section 4)
2. Methods that should be used in the air impact analyses to reasonably and accurately account for impacts from intermittent operation of IC engines (section 5)

# 2 Modeling Challenge of Intermittent Sources

For air quality standards that use the maximum observed concentration or second highest concentration as the compliance value, regulatory assessment of pollutant impacts from intermittent sources can be appropriately modeled assuming continual operation. This assumption is appropriate because the source could be reasonably expected to operate during worst-case conditions, and the highest impact is the value used to evaluate compliance. For NAAQS having an averaging period longer than 1 hour (e.g., 8-hour, 24-hour, or annual NAAQS), short-term emissions can often be smeared or distributed over the longer averaging period, calculating an average emissions rate for the period of interest. DEQ should be consulted to discuss the specific characteristics of the case in question.

The main challenge of accurately modeling intermittent sources to evaluate the potential for violating the 1-hour $NO_2$ NAAQS arises because of the probabilistic nature of the standard. The probabilistic form of the NAAQS makes the operational frequency of an intermittent source a key consideration in the compliance evaluation. For example, if the only source at a facility is an intermittent source that operates once every quarter or four times per year, it is nearly impossible for the source to cause or contribute to a violation of the 1-hour $NO_2$ standard unless the background $NO_2$ concentration periodically exceeds the standard. For this example, the source does not operate frequently enough (four times each year) to impact the design concentration,

which is the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour concentrations. The design value at any specific ambient air location is estimated through dispersion modeling by using the 5-year average of the eighth highest of the daily 1-hour maximum concentrations from each year. However, if the facility has additional substantial $NO_2$ sources, the contribution of the $NO_2$ emissions from even a very infrequent $NO_2$ source could measurably affect compliance with the 1-hour $NO_2$ NAAQS at some downwind locations.

Demonstrating NAAQS compliance for permitting purposes typically involves modeling permit allowable emissions over all allowable operation times, which often is continual operation (8,760 hours per year). If a source is allowed to operate during any particular hour of the year, then modeling is performed by assessing the impacts for each hour of the year. Modeling an intermittent source by assuming continual operation would artificially skew the distribution, thereby over-representing the source's impact. However, specific hours during which an intermittent source will operate are usually unknown, and selecting a particular schedule does not ensure that the maximum potential impacts are reasonably represented.

# 3 Regulatory Requirement for Modeling

An air quality impact analysis is typically required for a company to obtain a PTC for a new or modified source or a Tier II Operating Permit for operating an industrial process that results in the emissions of regulated air pollutants.

## 3.1 General Modeling Requirements for Permitting

The "Rules for the Control of Air Pollution in Idaho" state that a permit cannot be issued unless it is demonstrated to the satisfaction of DEQ that emissions from the proposed source or modification do not cause or significantly contribute to a NAAQS violation (IDAPA 58.01.01.203.02 and .01.403.02). To demonstrate, all sources that could measurably impact the design value must be included in the analyses; an appropriate background value is added to account for sources that cannot be easily incorporated into the model.

## 3.2 Guidance Memorandum for Intermittent $NO_2$ Sources

The US Environmental Protection Agency (EPA) provided guidance on modeling intermittent $NO_2$ sources in a March 2011 memorandum from Tyler Fox, leader of the air quality modeling group, to regional air directors.[1] The memo identifies the problem with modeling intermittent sources as a continuous source:

> We are concerned that assuming continuous operations for intermittent emissions would effectively impose an additional level of stringency beyond that intended by the level of the standard itself. As a result, we feel that it would be inappropriate to implement the 1-hour $NO_2$ standard in such a manner and recommend that compliance demonstrations for the 1-hour $NO_2$ NAAQS be based on emission scenarios that can logically be assumed to be *relatively continuous or which occur frequently enough to contribute significantly to the annual distribution of daily maximum 1-hour concentrations* [emphasis added]. EPA believes that existing modeling guidelines provide sufficient discretion for reviewing authorities to exclude certain types of

[1] Tyler Fox, "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard," March 1, 2011. Available at *http://www.epa.gov/region7/air/nsr/nsrmemos/appwno2_2.pdf*.

> intermittent emissions from compliance demonstrations for the 1-hour $NO_2$ standard under these circumstances.

The key to the above criteria is whether a specific source could actually operate continuously enough and frequently enough to contribute to the design value that is compared to NAAQS. The design value is the specific statistical value that is evaluated against the standard. DEQ asserts that evaluating source operational continuity and frequency, as a potential for impacting $NO_2$ NAAQS compliance, is a technical criterion rather than a policy call, a view that is supported in the memo by the following reference to 40 CFR 51, Appendix W:

> While the guidance [Appendix W] establishes principles that may be controlling in certain circumstances, the guideline is not "a strict modeling 'cookbook'" so that, as the guideline notes, "case-by-case analysis and judgment are frequently required."

The memo further states that Appendix W, "emphasizes the importance of 'the exercise of professional judgment by the appropriate reviewing authority' in determining which nearby sources should be included in the model emission inventory."

The cornerstone of the technical argument on modeling intermittent sources is in determining what sources are continuous enough or frequent enough "to contribute significantly to the annual distribution of daily maximum 1-hour concentrations." The memo does not discuss what constitutes a significant contribution to the annual distribution. DEQ's interpretation of EPA's statement is that a "significant contribution" in this context would be an impact that could potentially change the project's status with regard to NAAQS compliance. Therefore, if the 5-year average of the eighth-highest of daily maximum 1-hour concentrations at any ambient air receptor could increase by a margin that could exceed the NAAQS, then the source was continuous enough or frequent enough that it should be accounted for in the modeling analyses.

The EPA memorandum also does not provide guidance on how the reviewing authority can determine what characteristics of an emissions source might facilitate a significant contribution to the annual distribution of daily maximum 1-hour concentrations, and primarily the design value that is the acceptance criteria for NAAQS compliance demonstrations. To address this concern, DEQ performed various analyses of hypothetical sources to evaluate the level of emissions and operations that may cause a measurable impact on the design value. Attachment A summarizes these analyses in more detail.

# 4 Determining Modeling Applicability

Modeling applicability largely depends on whether the engine is operated at a site with other $NO_x$ sources.

## 4.1 Intermittent Engines Only $NO_x$ Source at Facility

If the intermittent engines are the only source of $NO_x$ emissions at the facility, modeling $NO_2$ will not be required if the following conditions are met:

- Engines will be tested 7 or fewer times each calendar year. There is no restriction on the hours of testing per day.

- If the facility has multiple engines, all engines will be tested on the same day. (By testing all engines on the same day, the total days of $NO_x$ emissions during any given year is limited to 7, and with less than 8 days per year, it would be statistically impossible for such a source to cause or contribute to a violation of the NAAQS.)
- No co-contributing point sources of $NO_x$ are nearby. (Nearby will be defined on a case-by-case basis considering distance; quantity of emissions; characteristics of the source such as stack height, stack temperature, flow rate, etc.; and meteorology.)

If these criteria are *not* met for the facility in question, $NO_2$ modeling applicability will be determined on a case-by-case basis considering the following:

- Number of intermittently operated engines
- Operational frequency and duration of engines
- Size and horsepower rating of engines as it relates to the magnitude of $NO_x$ emissions
- Location of engines with regard to the ambient air boundary of the facility
- Other characteristics affecting pollutant dispersion

## 4.2 Intermittent Engines with Other $NO_x$ Sources

If intermittently operated engines are present at a facility along with other continuous $NO_2$ emissions sources, emissions from the engines can be excluded from the analyses if the following conditions are met:

- Engines will be tested no more frequently than once every 3 months.
- If the facility has multiple engines, all engines will be tested on the same day.
- The engines exhaust from a stack of at least 15 feet from ground level and at least 100 feet from the ambient air boundary of the facility.
- The engines are rated at less than 300 horsepower, or less than 500 horsepower if they are EPA-certified Tier II or greater.

If these criteria are *not* met for the facility in question, $NO_2$ modeling applicability will be determined on a case-by-case basis considering the following:

- Number of intermittently operated engines
- $NO_x$ emissions from other sources at the facility and the location of such emission points
- Operational frequency and duration of engines
- Size and horsepower rating of engines as it relates to the magnitude of $NO_2$ emissions
- Location of engines with regard to the ambient air boundary of the facility
- Other characteristics affecting pollutant dispersion

# 5 Modeling Procedures for Intermittent Sources

All atmospheric dispersion modeling performed for the purpose of air permitting should be performed after all data and methods are agreed upon through a DEQ-approved modeling protocol. The procedures provided here should be used as a guide when developing the protocol.

If the intermittent source(s) in question must be included in the air impact analyses, a two-tiered approach may be used to demonstrate $NO_2$ NAAQS compliance.

## 5.1 Tier 1 Intermittent Source Modeling

Tier 1 modeling is performed using traditional modeling methods/approaches for intermittent sources. This approach assumes the source will be operating continuously at the maximum allowable hourly rates (for the case of modeling a pollutant with a 1-hour NAAQS) during all potential operating hours. For example, if the source is an emergency generator that will be tested for 1.0 hour every week between 7 a.m. and 7 p.m., then the maximum allowable hourly rate would be put into the model input file and an emissions factor adjustment would be used to turn off emissions during hours ending 1-7 and 20-24 (as specified by the model input format). If compliance with the $NO_2$ NAAQS cannot be demonstrated using this Tier 1 approach, the Tier 2 method described in Section 5.2 should be used.

## 5.2 Tier 2 Intermittent Source Modeling

Tier 2 modeling involves using a customized emissions input file that provides hour-by-hour emissions rates for the intermittent sources. The emissions file represents one possible actual emissions scenario for the source(s) based on the proposed allowable operational schedule of the source. If the example source above is used, an hour of emissions would be put into the file for a randomly selected hour each week during the potential operational hours of 7 a.m.–7 p.m.

The specific hours of operations can be selected using a computerized random number generator. This approach is necessary because it is not possible to otherwise predict specific hours during which engine testing will occur. Microsoft Excel has functions that can randomly generate a value from a specified population of values. Risk assessment software designed for performing Monte Carlo simulation analyses can also be used to generate a hypothetical operational schedule. Once the randomized engine testing operational schedule is determined, the applicant can construct the hour-by-hour emissions input file for AERMOD from the spreadsheet. Emissions values of 0.0 grams per second are entered for hours when engine testing does not occur.

DEQ modeling staff should be consulted when developing the randomized testing schedule and emissions input file. DEQ will usually require the applicant to run three scenarios of randomized emissions of engine testing to account for potential variability between modeling runs caused by a different randomized engine testing schedule. DEQ may waive the requirement of multiple scenarios, considering the following conditions:

- Modeled impacts from a single modeling run are well below the significant impact level (SIL) or NAAQS (less that 60% of the NAAQS—113 micrograms per cubic meter) after accounting for background concentrations. Alternatively, if the applicant can show that inclusion of emissions from engine testing does not measurably contribute to $NO_2$ design values at receptors where total $NO_2$ impacts are greater than 60% of the NAAQS, the subsequent analyses of additional testing scenarios may not be necessary.
- All emissions points using a randomized schedule are a minimum of 50 meters from any ambient air boundary.
- Any other specific conditions that demonstrate that impacts from engine testing will not contribute to a modeled NAAQS violation.

# 6 Contact Information

Contact the DEQ stationary source air modeling coordinator at (208) 373-0112 for any questions and additional information regarding data and methods for assessing air quality impacts from intermittently operated sources.

# Attachment A. Analyses Supporting DEQ Policy

DEQ's stationary source air modeling group has performed analyses to evaluate the potential for intermittent emissions from engine testing to significantly contribute to the annual distribution of daily maximum 1-hour $NO_2$ concentrations. The analyses involved a large $NO_x$ emissions source (22 pounds $NO_x$ per hour) with a nearby emergency generator that is intermittently operated. The generator engine was modeled with a $NO_x$ emissions rate of 20 pounds per hour. Table 1 provides the modeling parameters used in the analyses.

**Table 1. Modeling parameters for intermittent source modeling analyses.**

| Parameter | Continuous $NO_x$ Source | Intermittent Source |
|---|---|---|
| $NO_x$ emissions | 22 pounds per hour | 20 pounds per hour |
| Stack height | 20 meters | 5 meters |
| Stack temperature | 450 kelvin | 770 kelvin |
| Stack flow rate | 18 meters per second | 45 meters per second |
| $NO_2/NO_x$ ratio | 0.3 | 0.22 |
| Modeled operations | Continuous | Testing of 1 hour every week or 1 hour every month |
| $NO_2$ chemistry | Plume Volume Molar Ratio Method (PVMRM) | |

Hours of emissions from the intermittent source were selected based on the specified schedule of 1 hour per week or 1 hour per month. The specific hour of operation for each week or month was randomly selected for each week or month using a computerized random number generator.

Figure 1 shows $NO_2$ concentration contours for the continuous $NO_x$ source only. Figures 2 and 3 show the combined impacts of the continuous source and the intermittent source with 1 hour per week operation and 1 hour per month operation, respectively. In this example, the intermittent emissions from engine testing clearly has a measurable effect on the $NO_2$ design value. The scenario of weekly testing for 1 hour shows a substantial increase in impacts associated with engine testing. The scenario of monthly testing exhibited only a small increase; however, that impact did measurably affect the modeled $NO_2$ design value.

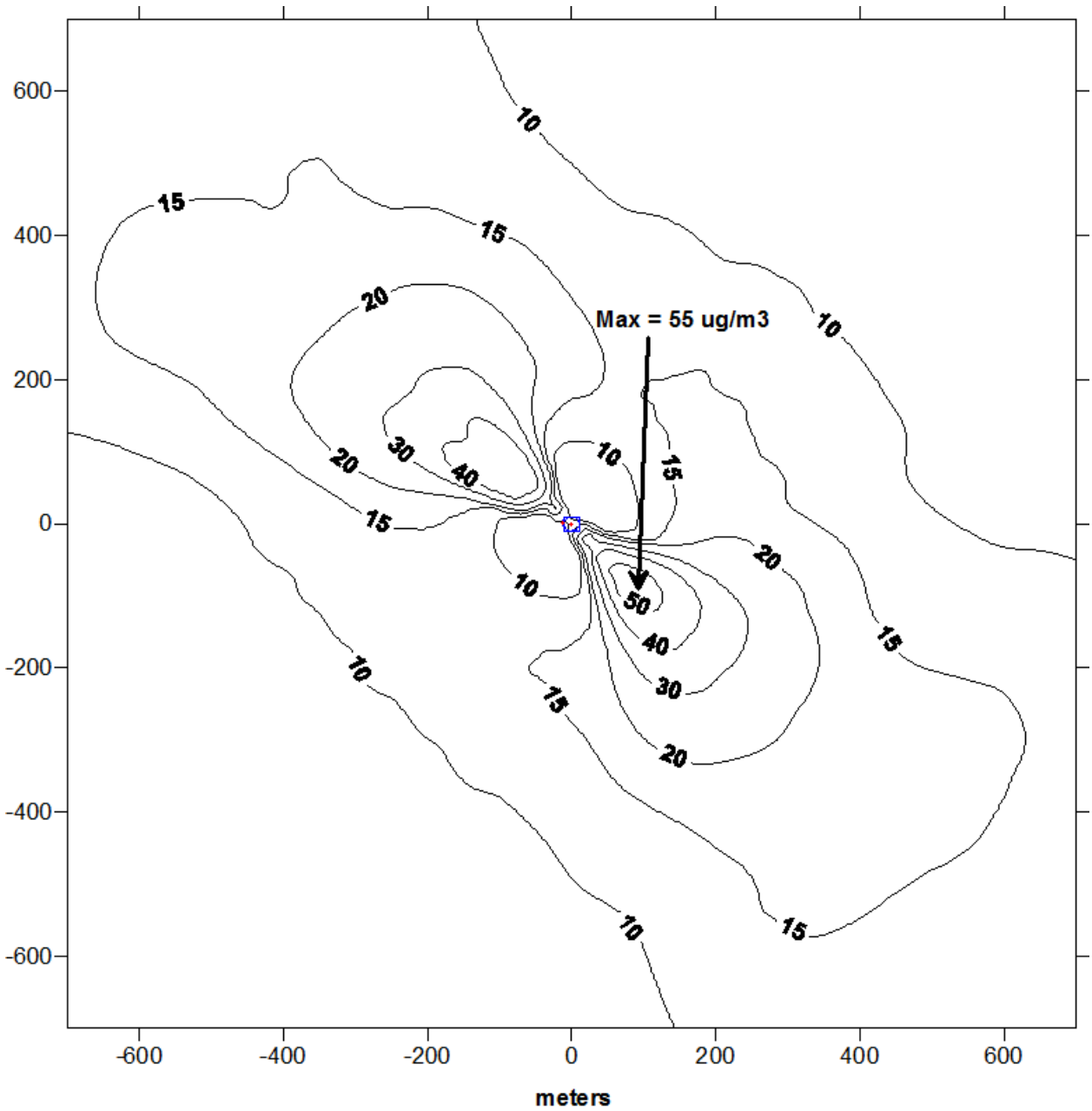


**Figure 1. $NO_2$ modeled impacts from continuous source only.**

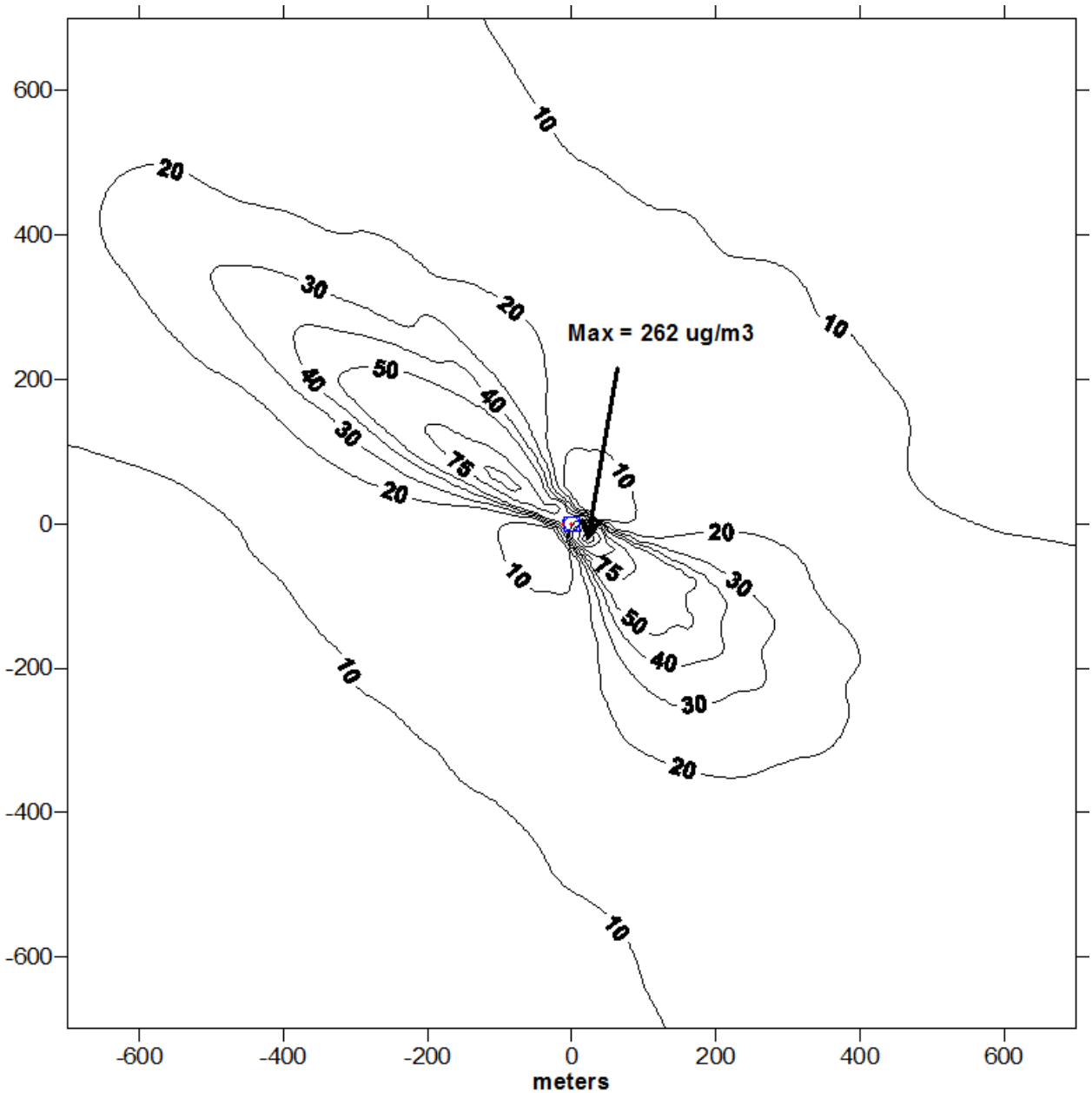


**Figure 2. $NO_2$ modeled impacts from combined sources with intermittent source operating 1 hour per week.**

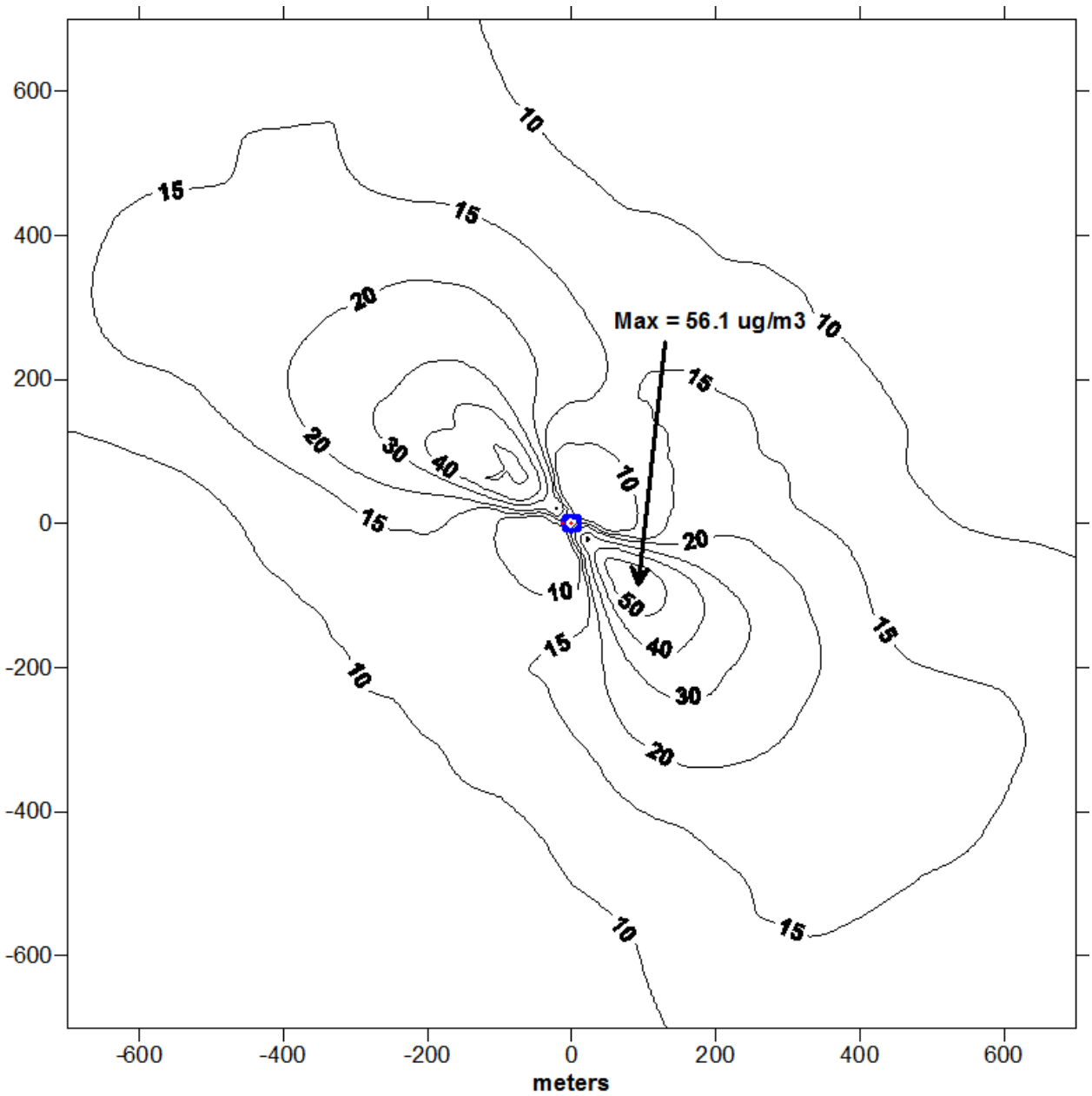


**Figure 3. $NO_2$ modeled impacts from combined sources with intermittent source operating 1 hour per month.**