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Guiding Principles for Air Quality Assessment Components of Environmental Impact Assessments

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1. Introduction

This document is an IAIA "Special Interest Publication." From time to time, IAIA sees value in publishing substantive educational material for distribution to its members or more widely. All such publications would be considered "living" documents, whereby they remain under constant review and are subject to updating and further improvement based on new information or feedback from credible sources; accordingly, some sections are included, with only brief descriptions, with the intention that they be considered "placeholders" and will be revised and expanded in future versions.

As a biophysical effect, impacts on air quality (AQ) are a central focus of many EIAs where significant air contaminants may be emitted from the proposed development; resultant studies are termed "air quality impact assessments," or AQIAs. The scope of this particular document covers the prediction of resultant air quality levels—it does not include human health or ecological impact assessments, which themselves take input from the results of the AQIA. Readers interested in resultant human health and ecological impacts caused by predicted air quality levels are directed to publications and references listed in the IAIA web-site for further information.

The need for this document has originated over years of practice where we have identified areas of uncertainty and inappropriate air impact assessments methods that have been applied. In addition, there is a pressing need for certain AQIA principles to become more widely used which would, we feel, help proponents and reviewers bring more certainty, predictability, and clarity to the assessment process. As such, this document is not a beginner's guide, but rather is intended for experienced air quality practitioners and so presents only specially selected topics and certain concepts that are meant to clarify areas of difficulty. Consequently, the audience for this document includes experienced air quality practitioners representing proponents developing EIA statements, and also reviewers of such documents (regulatory or third-party peer reviewers).

The topics presented in this document are generally presented in the order that one would conduct work items for an AQIA for an EIA.

It is important that readers understand that this document provides guiding principles only and not detailed regulatory or technical advice; in particular cases readers are advised to check with the project legal jurisdiction to obtain any specific requirements set forth.

2. Guiding principles for air quality assessment

This section provides a step-by-step discussion of the various stages of an AQIA, describing the necessary work and areas of common error. We begin with discussion on scoping of the project, describe estimation of emission rates of contaminants, the dispersion modeling of those contaminants, their interaction with baseline air quality levels and finally principles used to govern missing data.

2.1 Scoping of project

The introductory stages of an assessment involve scoping the extent of the project, and thus the air contaminants that could potentially be emitted from the proposed project.

Terms of Reference (ToR) are often developed by proponents prior to initiation of the EIA study in order to provide scoping that is agreed to (by regulators and stakeholders) prior to the study. The intent is to avoid disagreement, as far as possible, at later stages and obtain as much prior agreement as possible. ToR documents are generally prepared at the outset of a study, and are often required by the reviewing body, along with public/stakeholder review of the ToR. The ToR essentially provides a "list of things to do" for the assessment and obliges the proponent to fulfill all requirements listed within the ToR.

Scoping the extent of the project involves identifying which project activities could be emitting air contaminants. This should include clear definitions (and limits) of the "subject" project or facility (the subject of the study), and hence enable ready identification of "subject sources" (of air contaminants). For example, for a proposed coal-fired power plant, it should be clarified if coal mining and coal transportation to the power plant are part of the proposed project. If so, air emissions from those activities must be included in the emissions inventories and the domain of interest must necessarily be expanded to encompass these activities.

2.2 Worst-case impacts

Air quality impact assessments must, at the very least, address the worst-case impacts on AQ (the biggest increases in AQ levels). Information on "average" AQ impacts may also be supplied by a proponent to provide perspective. An assessment of worst-case impacts is required because it answers the basic question "what are the worst effects of this project on my community?"

For air contaminants, maximum emissions and worst-case dispersion conditions must be considered together under maximal production or activity levels so that maximal impacts can be considered and assessed. For example, coal crushing machinery in an open-cast mine or at a power plant may emit dust to the environment. The more coal processed in a day, the greater the dust emissions from that machinery. It is important that the maximum emission rates that could happen, or will be allowed to happen, are assessed; these limits could be set by (i) facility or plant management (management limits), with appropriate oversight, or, (ii) may be limited by the machinery or processes in the facility itself (production/mechanical limits).

In subsequent dispersion modeling, worst-case emissions are then combined with a range of meteorological conditions (simulated by modeling with long (such as five years) meteorological datasets) to ensure that worst-case emissions are reasonably combined with worst-case meteorological conditions to provide worst-case impacts on AQ.

In identifying worst-case emissions scenarios, it is important to bear in mind that AQIAs are usually considered one contaminant at a time, and so resultant AQ levels of individual contaminants are compared individually against relevant standards or limits or evaluated individually for health or ecological impacts. In some cases, the maximal emissions and operating scenario for one contaminant may not necessarily be the maximal emissions and operating scenario for others. In cases where scenarios are different, for different contaminants, they must be identified and assessed separately. Likewise, if such a differential analysis is not offered by the proponent, the reviewer must be satisfied that the maximal emissions and impacts scenarios are relevant to all contaminants emitted equally.

In general, the operational scenario assessed for the subject sources should be that which causes the highest impacts at receptors; it is the responsibility of the proponent to test all likely scenarios and find the one(s) that cause the highest impacts on a contaminant-by-contaminant basis. It is also the responsibility of the proponent to demonstrate to the public that it has tested all scenarios and found the worst-case scenario, which must then be used in the air assessment. In parallel, reviewers shall familiarize themselves sufficiently with the proposed operations so that they can satisfy themselves that all operating modes have been accounted for by the proponent and that the worst case is being assessed.

In particular, many air-emitting operations, such as manufacturing facilities, run their operations on a fairly constant and predictable basis, making air emission estimates relatively straight-forward. However, other air-emitting operations do not run on a consistent basis, but their operations change on an hourly, daily, monthly, or even annual basis. For example, dust-emitting gravel extraction operations may go through different extraction phases where aggregate is extracted and processed in different locations relative to surrounding sensitive receptors (e.g., residences). In cases such as those, the proponent must provide clear evidence that the worst-case operational scenario has been accounted for in their analysis; the reviewer must also recognize operating scenarios with different potential emission variability and demand those alternative assessments where they have not been offered by the proponent. In some cases, where the worst-case impacts scenario is not obvious, a repeat study, for each operational scenario, may be required to compare air quality impacts and define the worst case. As a consequence, defining all possible operational scenarios at the outset, by the proponent (and demanded by the reviewer), is an important part of scoping for the air impact assessment and best achieved by a thorough description of the proposed process operations. As a further example, consideration should be given to whether start-up/shut-down emissions from power generation plants (when emissions are often relatively high) should be included as an operational scenario and therefore be subject to an AQIA.

2.3 Characterizing and quantifying emissions from the subject source

2.3.1 Identifying sources and demonstrating full identification

With most projects that are subject to EIAs, there are generally numerous actual and potential sources of air contaminant emissions. For example, a proposed coal-fired power plant project can include dust sources such as supporting open-cast mining (and its various sub-operations), the power plants themselves (and their various sub-operations), coal transfer to/from storage and handling equipment and operations, associated chemical and water treatment operations, waste (ash and/or slag) handling and disposal, etc.

The ToR will often define the project components that should be assessed; therefore it is very important that sufficient description be provided to appropriately identify and characterize all project sources that may emit air contaminants. Thus the ToR may need to be termed in suitably high-level language to allow a comprehensive and all-inclusive assessment.

In order to correctly identify all emission sources, it is important that detailed information on processes (that will lead to air emissions) are provided. For example, process flow charts for proposed waste water treatment plants showing locations and characteristics of air emissions. Provision of such detailed information will be required to allow review and confirmation that all emissions points from sub-processes have been properly accounted. The proponent may need to generate facility layouts to comprehensively identify air contaminant emissions. It is important that all sources be identified because even weak sources of air emissions, when situated close to receptors, can have a significant impact on AQ at those receptors.

2.3.2 Identifying contaminants released

Once sources have been identified, generally the next stage is to identify the contaminants being emitted. For example, fossil fuel combustion at a proposed power plant may emit sulfur dioxide (SO_2), oxides of nitrogen (NOx), particulate matter (PM, usually by size fraction) and other trace contaminants. It is important that all contaminants that could be emitted be included in the assessment unless excluded by specific agreement during ToR development.

Various jurisdictions may provide screening methods to screen out contaminants emitted at very low levels, or insignificant sources of a particular contaminant; this may save time and resources by diverting effort from negligible contaminants towards contaminants that may be of significant potential concern. Screening methods would include the use of emission thresholds and exclusion of relatively minor sources of specific contaminants. The use of screening methods tends to be very jurisdiction-specific and so it is important that the proponent confirm the acceptability of screening methods used.

Air quality screening methods, and their results, should be provided in detail to allow reviewers to confirm their conclusions.

2.3.3 Defining the contaminants of potential concern

Once all contaminants that can be emitted have been identified, these become the "contaminants of potential concern" (CoPCs) for an air quality assessment focused on the impacts of "subject" facilities. Such a definition is important, as it dictates the list of contaminant emissions to be considered for associated baseline AQ levels. Again, this is a consequence of the fact that most AQIAs are conducted on a contaminant-by-contaminant basis.

Typical contaminants of potential concern included in the majority of AQIA:

- Particulate matter (PM, PM10 and PM2.5)
- Sulfur dioxide (SO_2)
- Nitrogen oxides (NO and NO_2)
- Carbon monoxide (CO)
- Volatile organic compounds (VOCs)
- Odor

In specific circumstances this list could include other air pollutants such as benzene, dioxin and furans or heavy metals.

2.3.4 Fugitive dust emissions

In regards to dust emissions in particular, dust particles vary in size and composition. The total amount of dust in the air is known as Total Suspended Particulate (TSP), or in some jurisdictions, Suspended Particulate Matter (SPM). The size fractions of dust particles can vary from very fine particles, less than 2.5 micrometers (μm) in aerodynamic diameter through to larger particles. Dust particles smaller than 10 μm in aerodynamic diameter are known as "PM10." The finer dusts (especially those smaller than 2.5 μm in aerodynamic diameter, termed "PM2.5") are associated with human health effects. In many jurisdictions, TSP emissions are regulated as are the PM10 and PM2.5 size fractions. Assessing fugitive dust emissions are often a problematic aspect of AQIAs. Fugitive dust sources are sources that emit from an area or volume rather than a confined process stream (vent or exhaust stack). These would include dust emissions from, for example, roads (paved and unpaved) and aggregate and mining activities. Sometimes defining the source characteristics of such emissions (of, for example, a volume source) can be difficult.

Fugitive dusts also vary by composition. For example, open-cast coal mine road dust may contain the same minerals contained in the overburden soil or the coal deposit itself, or both. If the road surface material in this example contains quartz (a common mineral in rocks and soils; a form of crystalline silica) then the dust raised from that road may be an inhalation hazard, since crystalline silica has known health effects if inhaled. A comprehensive AQIA must assess all species of fugitive dusts.

2.3.5 Accounting for spatial and temporal variability

In any air assessment, one must also consider the locations of sources of emissions at the facility (e.g., rock crushers within a mine producing dust or excavators operating near the mine boundary) and how individual source emissions vary over time.

In the example of dust emissions from mining activities in an open-cast mine, the location of mining machinery, as close as permissible or likely possible to property boundaries, must be assessed if it is allowed and intended to move to those locations during excavation. Alternatively, management may impose their own siting limitations on mobile machinery; for example, to ensure that dust emissions are suitably mitigated by distance dilution.

While it is necessary to consider the maximal emissions that could happen for each individual source, it is also necessary to consider the coincidence of air emission sources (e.g., all dust sources that may emit at the same time). For example, if material handling causing dust emissions may occur at the same time as vehicle movement on roads also causing dust emissions, then this combined scenario should be assessed. A proponent is always free to show that the coincidence of certain emissions is not possible or not permitted at their facility.

2.3.6 Quantifying emission rates

The next step is to quantify the emission rates for each contaminant from each source. In this document we will not expand on the usual methods described in detail elsewhere (e.g., source testing, emission factors, mass balance techniques, etc.).

A basic general methodology for the estimation of emissions is described in the *Atmospheric Emission Inventory Guidebook* (EMEP/EEA, 2009). Typical emission factors can be obtained from published databases such as the US EPA or the European CORINAIR database. Updates of this document may provide further discussion.

2.3.7 Temporal resolution of emission rates

One issue that occasionally causes difficulty is the temporal resolution of the emissions data. This can be an issue when emissions vary markedly over short periods of time. In quantifying AQ impacts, proponents usually are required to calculate air concentrations over averaging times consistent with air quality standards. For example, in Ontario (Canada) the provincial ambient air quality criterion for TSP is 120 µg m^{-3} averaged over 24 hours, so air quality modeling results for TSP should be expressed as concentration averaged over 24 hours for direct comparison to the criterion (most dispersion models consider concentrations hour-by-hour and then sum up to get, for example, 24 hour average concentrations; this is because meteorological data is typically recorded hourly)

Some jurisdictions provide guidance that allows proponents to estimate emissions averaged over the same time period (e.g., 24 hours) as the AQ standard or criterion. However, in some cases, a finer timescale may be required (in quantifying temporal variations in emissions) if emissions predominantly occur during periods of poor atmospheric dilution. For example, although a 24-hour averaged dust emission level could be quantified, there may be certain dust-emitting processes or activities which occur predominantly at dawn or at dusk, perhaps due to production scheduling; dawn and dusk are times when atmospheric dilution of emitted contaminants by meteorological diffusion is usually poorest. In this case it would be more appropriate to estimate hourly dust emission rates for dispersion model input, and use those to calculate 24 hour averaged dust levels in the air. This is because use of longer emissions averaging periods artificially "smoothes-out" short periods of high emission, or emission periods that may coincide with poor dispersion conditions (dawn/dusk); avoidance of such coincident periods may lead to underestimates of airborne concentration.

As a further example, coastal (next to a major lake or sea) sources of air pollution may emit during specific meteorological events that are common in such areas, such as on-shore or off-shore flows. Switching from on-shore to off-shore flow often occurs within a 24-hour period and so any emissions variability that occurs over a 24-hour period may need to be explicitly accounted for as predominant emissions under a specific flow regime may markedly affect the direction of contaminant dispersion and thus AQ impacts (recirculation entrainment may also affect concentrations, especially during stagnant (high pressure, low wind speed) periods).

In general, it is best to explicitly account for temporal variations in emissions in as detailed a way as possible.

2.4 Modeling air concentrations

One way to determine airborne pollutant levels resulting from emissions from subject sources would be to measure the levels of all substances emitted to the surrounding community. However, actual measurements will not be available for proposed projects, as they have not been constructed yet; this is often the case in an EIA. Instead, we rely on predicted changes in air quality (using air quality computer models) to assess estimated changes in air pollution levels.

To assess the levels of an air contaminant surrounding a set of facilities due to emissions from those facilities, most jurisdictions require the use of quantitative computer models that predict the dispersion of contaminants from a discharge point (or points) to a receptor in the surrounding community ("dispersion models").

In its simplest form, a dispersion model requires input on (1) the sources of pollution, including the emission rate, (2) meteorological data such as wind speed and turbulence, and, (3) topography (complex terrain and/or building downwash). The model then mathematically simulates the pollutant's transport and diffusion through the air. The model output is an air pollutant concentration level for a particular time period at one or more specific receptor locations in the area surrounding the subject facilities.

Dispersion modeling represents a simplification of actual events. For a particular location and time period, dispersion modeling is not as accurate as site-specific measurements of airborne contaminants. The most common air dispersion models used in AQIA are generally accurate within a factor of 2 when compared to actual measurements (as ranked comparisons), but may be even more inaccurate when model results are compared to measurements at specific locations and times (paired comparisons). However, modeling does allow a prediction of changes in air pollution levels when plant facilities are modified, and does allow estimates to be made at many locations ("receptors") and for long periods of time (e.g., years). It is also the only way to estimate air quality levels from a proposed facility not yet developed.

Many air dispersion models are available in various jurisdictions around the world. In general, certain types of models may be more appropriate for certain situations. For example, in cases of emissions near lakes or seas, on-shore or off-shore air flows may significantly impact air quality and thus models that explicitly model those phenomena may be required. Often, however, a regulatory agency may prescribe certain models as being acceptable. It may be useful for a proponent to suggest the air dispersion model to be used in the ToR and seek prior agreement (from regulators) on this choice.

A comprehensive listing of air quality models can be found at the European Environmental Agency's Model Documentation System (EEA, 2011), at the US EPA (2011) and FAIRMODE (2011). The user must be careful to ascertain whether the selected dispersion model is being applied to a situation for which the model was designed. Advanced models include chemical schemes that allow simulation of secondary pollutants such as ozone and PM2.5.

2.5 Incorporating appropriate meteorological data

While it is obvious that the meteorological data to be used in the model should preferably be measured at the subject site or sites, site-specific data are often not available. Data from airport weather stations is most commonly used in lieu of site-specific data for pollution dispersion modeling. However, these stations may or may not be situated close to the site of the proposed subject facility and so one must carefully consider whether the data is appropriately representative for the site of the subject facility. In fact many governmental environment departments provide guidance on the appropriateness of meteorological data or specify pre-approved and prepared datasets to be used for AQIA modeling.

For certain EIAs, where available data from existing weather stations is of questionable relevance to the specific site, it may be feasible to establish a meteorological station at the site. This is especially justifiable (or perhaps should be demanded) where the project planning process takes many years to complete, affording sufficient time to collect appreciable meteorological data. The amount of data collected may be sufficient for modeling purposes or, if not of sufficient temporal length, at least could be used to verify longer data sets from other areas.

Recent advances in meteorological modeling have allowed the use of model–generated meteorological data (e.g., using MM5 or WRF) to allow the production of data nominally specific to a site. However, the modeled data itself may be subject to verification (depending on jurisdiction) by independent comparison against measured meteorological data, or just accepted as is, again dependent upon jurisdiction.

2.6 Estimated air quality levels in the surrounding community

As pollutants from the proposed facilities ("subject" sources) disperse through the air, they will add to pre-existing levels of those same pollutants (present at so-called "background" or "baseline" levels) that have been emitted from other sources. For example, if PM2.5 is emitted from a subject source it will be considered a CoPC for the study. However, PM2.5 may also be present in the area before the project is constructed and operating due to emissions from many surrounding "non-subject" facilities, e.g., from public roads, agricultural operations as well as from other industrial facilities, etc. Baseline AQ levels may form a substantial portion of "cumulative" levels at any particular receptor.

2.6.1 Spatial/temporal variations in baseline AQ levels

Baseline levels of air pollutants are not the same at all locations. For example, background levels will be higher closer to a non-subject source, as they will be affected by emissions of CoPCs from that non-subject source. A specific example would be consideration of major roadways in the area. These roadways will emit PM2.5 (for example) due to automobile exhaust and road dust. Roadways will also be emission sources of oxides of nitrogen (NOx). Therefore, locations closer to roadways will experience higher background levels of PM2.5 and NOx, for example; in layman's terms, these may be called pre-existing "hotspots." Thus significant concentration gradients may exist close to these non-subject sources; if these hotspots coincide with areas of significant impact from the subject source then relatively high, and potentially problematic, AQ levels may potentially occur.

Equally, baseline levels may not remain constant over time; using the example of major roadways again, baseline levels for PM2.5 and NOx near roadways are usually higher during rush-hour periods than during low-traffic periods.

It is important that the proponent (and reviewer) properly account for these spatial and temporal variations to ensure that impacts on AQ levels are not underestimated. Conservative screening methods such as the use of a constant, maximal (over space and time) baseline level could be permissible as long as the proponent can guarantee that the proposed baseline level will never underestimate actual levels.

2.6.2 Local vs. regional components of baseline AQ

In theory, distant sources of air contaminants will contribute to baseline air quality levels at locations in the vicinity of the project; in practice, however, it is found that only sources within a relatively short distance will cause significant variations in background levels within the domain of interest for the EIA. Beyond that distance, emissions from all non-subject sources will "merge" together to become spatially homogeneous through turbulent mixing.

One way to account for this duality is to divide baseline air levels into "regional" and "local" components; this method is well established and formalized in various regulatory modeling guides and regulations around the world. For example, the Province of Alberta (Canada) Air Quality Model Guideline describes methods of dividing the background into these two components. In addition, the United States regulatory air quality dispersion modeling is guided by the "Guideline on Air Quality Models" and describes division of background into local and distant sources.

In many applications of this method, close-by non-subject sources are explicitly modeled as additional sources (of a particular contaminant) within the modeled domain, whereas regional background is arithmetically added as a numeric constant. Variations of these methods also exist where, for example, regional background is supplied as output of regional-scale air quality models.

To classify baseline AQ levels further, emissions from local, anthropogenic ("man-made"), non-subject sources can be divided into mobile (on-public-roads vehicle emissions) and stationary sources (e.g., local industries). Mobile sources (e.g., on-road vehicles) emit CoPCs via tailpipe emissions and via re-suspension of road dust (causing, for example, emissions of PM2.5). In assessing background concentrations, biogenic ("natural") emissions should also be considered.

2.6.3 Project-specific baseline air quality measurements

The "local vs regional" division of baseline AQ levels is one of a number of methods available to estimate baseline levels. More generally (and for example), the Province of British Columbia (Canada) "Guidelines for Air Quality Dispersion Modeling in British Columbia" provides advice, listed in order of preference, about different techniques that could be used to estimate background concentrations of CoPCs. The BC modeling guide indicates the order of preference as, sequentially:

1. Top preferred: "a network of long-term ambient monitoring stations near the source under study"
2. Second most preferred: "long-term ambient monitoring at a different location that is adequately representative"
3. Third most preferred: "modeled background"

Where insufficient pre-existing data are available, or more accurate estimates of background are required, the proponent can conduct measurements in the area surrounding the project. As with gathering site-specific meteorological measurements, the proponent may have sufficient time to measure pre-existing background at appropriate receptors. Likewise, reviewers may also demand that baseline AQ be measured in the area of the proposed facility for some time before the EIA is conducted, in order to collect sufficient data for statistically meaningful analysis; this may be addressed within the ToR.

2.7 Unavailable input data and conservative estimates

Air practitioners experienced in AQIA for EIAs will be well aware of the problem of not having site- and project-specific input data for various aspects of emissions estimates, dispersion modeling and baseline AQ evaluations. It is so common, in fact, that it is routine practice to make assumptions or utilize surrogate data in place; however, the manner in which those substitute data are chosen is critical. Occasionally the choice of surrogate data is not carefully considered (by proponents or recognized as such by reviewers) because the principles behind making appropriate choices for surrogate data are misunderstood or sometimes abused. We therefore provide an extended explanation on this topic, as it is often a key point (or should be a key point) of discussion in AQIAs for EIAs.

To explain the appropriate methods to choose substitute data, and where inappropriate choices can be made, the example of a proposed gravel pit and the attempt to estimate road dust emissions from unpaved roads within that (yet to be constructed) pit will be used. We will use this example in the North American context since that is the major experience of the first author of this document, but the principles apply elsewhere and for other types of emitting processes.

A common method to predict dust emissions from roads is to use the United States Environmental Protection Agency (US EPA) AP-42 emission factors (EF). An important input variable within these equations is the silt level of the future road. If a proponent is attempting to estimate road dust emissions, site-specific measurements will obviously not be available as the roads do not yet exist. Instead, the proponent must estimate or predict the silt levels in some fashion. Potential methods include measuring silt levels on unpaved roads that already exist in the area and ensuring (arguing) that those unpaved roads would closely match the intended roads in the gravel pit; the validity of the choice then rests on the evidence provided by the proponent that silt levels on the roads would likely match closely.

More commonly, however, a proponent usually examines pre-existing data from similar operations and selects a value based on that data. For example, the AP-42 document on unpaved roads (s. 13.2.2, Unpaved Roads) presents measured values for silt content on unpaved roads in the gravel extraction, stone quarrying and processing industry and shows them to be variable. For sand and gravel processing, the range provided is 4.1 to 7.1% for plant roads based on 3 samples from one facility. For stone quarrying and processing the range provided is 2.4 – 16% based on 10 samples from two facilities. Given the very limited datasets, one must be very careful as to their representativeness for any proposed gravel pit.

A key underlying principle that guides the choice of surrogate data is that the choice must be made on a "conservative" basis. A conservative assumption (or choice) is one which does not underestimate the true value, with a high degree of certainty. A conservative approach is necessary in AQ assessments to ensure that impacts are not under-estimated. Of course, in this case, the "true" value is unknown as we cannot measure silt levels on a road that has not been constructed; in any case, if we had the true value we would use that value without bothering to make conservative assumptions. In the example given above, the simplest conservative approach would be to choose the highest value, or value that maximizes emissions (i.e., a silt level of 16%). This could also be considered a simple default approach. Using an average value would not be considered conservative and therefore not acceptable for EIAs.

Even so, it is possible that a reviewer may question the use of such a value as it is based (in this case) on such a limited dataset. The reviewer may feel that the proposed site may have characteristics that are outside that range represented by the sites surveyed in the US EPA AP-42 dataset. If the reviewer feels as such (especially if the reviewer feels that values may be higher at the proposed site), the reviewer then may require the proponent to use some alternative technique to predict silt levels, or even conduct dispersion model sensitivity tests to quantify the effects of this uncertainty on predicted AQ levels (if predicted AQ values are not sensitive to silt levels, there is little point in taking issue with this). Generally, (in this example) the onus is on the proponent to prove that the characteristics of the proposed site are within the range of the sites represented in the dataset.

Conversely, a proponent may feel that the characteristics of the site will be within the range represented by the dataset but that the upper limit of the data is not truly representative of the site and thus unrealistic. The proponent is free to argue against the upper limit and suggest an alternative, and obviously must provide clear and unequivocal evidence of the alternative value. In such cases the reviewer must also be satisfied that the proponent has presented sufficiently sound arguments for an alternative value.

Bearing the above considerations in mind will help ensure that the actual AQ impacts will not be underestimated by the predictions; this is the essence of the conservative approach in air quality assessments for EIAs.

There may also be other situations where site data is not available even if the site exists or if study resources may be too limited to collect data. In yet other situations it may be desirable to use a screening approach where conservative estimates are first used in place of (more costly) collection of site-specific data. In those cases, proponents must choose surrogate data based on the same conservative criterion described above.

As an alternative to the conservative approach, the proponent may have access to a large dataset of silt levels which then allows a more refined choice of input values based upon considering the frequency distribution of the silt data. Assuming values presented by the proponent are from the same population (as the subject site, which the proponent needs to justify) the proponent may suggest an alternative to the absolute maximum value where some percentile is used, say the 95th percentile value. If the dataset truly represents the conditions at the subject facility then the 95th percentile value provides 5% chance of underestimating the true value. Further, if more than one input variable is chosen on this basis, then the joint probability of underestimating the true value is even lower, further assuring conservatism in the final AQ predictions. Taking the example of two variables with input values chosen at the 95th percentile value, for each variable the chance of underestimating the actual value is 5% or 0.05; with two variables at this level the combined chance of underestimating both is 0.05 x 0.05 = 0.025 or 2.5%. Such a probabilistic approach is not common in AQIAs and so it is imperative that agreement is reached on the methods to use and AQ level acceptability criteria beforehand, preferably as part of the ToR development (i.e., is a 95th percentile choice acceptable for each input variable and to how many input variables can this be applied?).

An even more refined approach would be to consider a fully probabilistic approach for the uncertainty in the choice of input values. Probabilistic assessments of uncertainty in model inputs, and their propagation through to model output, have been the subject of many studies. A review is provided by Hanna (2007); studies providing particular advice for uncertainty caused by small datasets (e.g., n=3) include Frey and Rodes (1996), Frey and Bammi (2002), Frey and Li (2003), Frey and Zhao (2004) and Zheng and Frey (2004). Such uncertainty assessments are usually conducted after sensitivity studies have identified model inputs worth worrying about. In essence, the conservative approach obviates the need for a probabilistic assessment of uncertainty as it ensures no underestimates with a high degree of certainty; the conservative approach can also be considered to be the simplest way of dealing with uncertainty in model inputs. However, providing results of an assessment on a probabilistic basis is not usual and usually requires that agreement is reached on the methods to use the results beforehand, preferably as part of the ToR development.

Issues in AQIAs with unavailable input data and adopting assumed data, as described above, largely lie with emissions estimates but the principles of conservative estimation also apply to other aspects of AQIA, such as dispersion modeling, estimating baseline AQ levels, etc.

2.8 Use of air quality assessment modeling results

In EIAs a health impact expert frequently provides an opinion in the form of a human health risk assessment based upon the community-level exposure to CoPCs estimated by dispersion modeling, as described above. This is especially the case when air quality guideline values (e.g., for PM2.5) may not be fully protective of human health.

In addition, an ecological expert could also provide an opinion in the form of an ecological risk assessment for the environmental-level exposures of CoPCs estimated by the modeling.

3. Summary

Various important aspects of AQIAs under EIAs have been highlighted in this document:

1. The Terms of Reference of the EIA should be sufficiently clear and encompassing to incorporate all sources of air emissions to be included in the AQIA.

2. Worst-case air quality impacts are assessed by considering a combination of maximal emissions combined with worst-case (poor dispersion) meteorology.

3. All potential sources of air emissions must be identified in order to fully identify all contaminants potentially emitted (Contaminants of Potential Concern). These can include components (species) of fugitive dusts.

4. Project emissions can vary in time and space; these variations should be recognized and accounted for.

5. Emission variations over a finer timescale than the air quality standard averaging period may be necessary to avoid underestimating air quality impacts.

6. Spatial and temporal variations in baseline air quality levels must be recognized and accounted for.

7. Assessment input data, if not garnered in a site-specific accurate manner, may be estimated as long as it is estimated in a fully conservative manner or on a (more refined) probabilistic basis.

4. Acknowledgments

The first author would like to thank his colleagues, Nicole Shantz, Phil Fellin, and Lucas Neil, for reviewing preliminary drafts of this paper.

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Acronyms and abbreviations

AQ	Air quality
AQIA	Air quality impact assessment
CO	Carbon monoxide
CoPC	Contaminants of potential concern
EF	Emission factor
EIA	Environmental impact assessment
IAIA	International Association for Impact Assessment
NOx	Oxides of nitrogen
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
SO_2	Sulfur dioxide
PM	Particulate matter
TSP/SPM	Total suspended particulates/suspended particulate matter
PM10	Dust particles smaller than 10 µm in aerodynamic diameter
PM2.5	Dust particles smaller than 2.5 µm in aerodynamic diameter
ToR	Terms of reference
US EPA	United States Environmental Protection Agency

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February 2017