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How to Streamline Air Toxics Risk Assessments

Risk assessments have become a necessary ingredient in complying with air toxics policies and regulations

by Richard V. Crume

A number of state and local agencies have developed air toxics policies and regulations for the control of toxic compound emissions from industrial processes. These policies and regulations commonly require that air inhalation risk assessments be performed to demonstrate that public health risks associated with the industrial processes are below established de minimis values. Often the risk assessment must include an evaluation of the potential for both carcinogenic and non-carcinogenic health effects in the surrounding community, including various sensitive receptors (e.g., school students and nursing home residents). A consideration of health effects from multipathway exposures (e.g., the deposition of toxic air contaminants on surface waters, crops, and soils where subsequent human exposure may occur) may also be required.

This article does not attempt to describe risk assessment methodologies and procedures. Instead, various steps are described that can streamline the execution of air toxics risk assessments, increase the likelihood of first-time approval of an assessment, and reduce risks when calculated values exceed de minimis levels.

Air toxics and risk assessments

Air toxics are hazardous air pollutants discharged into the atmosphere by various sources including industrial facilities. The degree of hazard associated with air toxics exposure varies widely, depending on the air contaminant's toxicity; the route, level and duration of exposure; and the size of the exposed population. The principal route of exposure is inhalation, although skin absorption and the ingestion of air-contaminated surface waters, crops, and soils also are possible.

The consequences of exposure to air toxics include both carcinogenic and non-carcinogenic human health effects. These effects are often characterized us-

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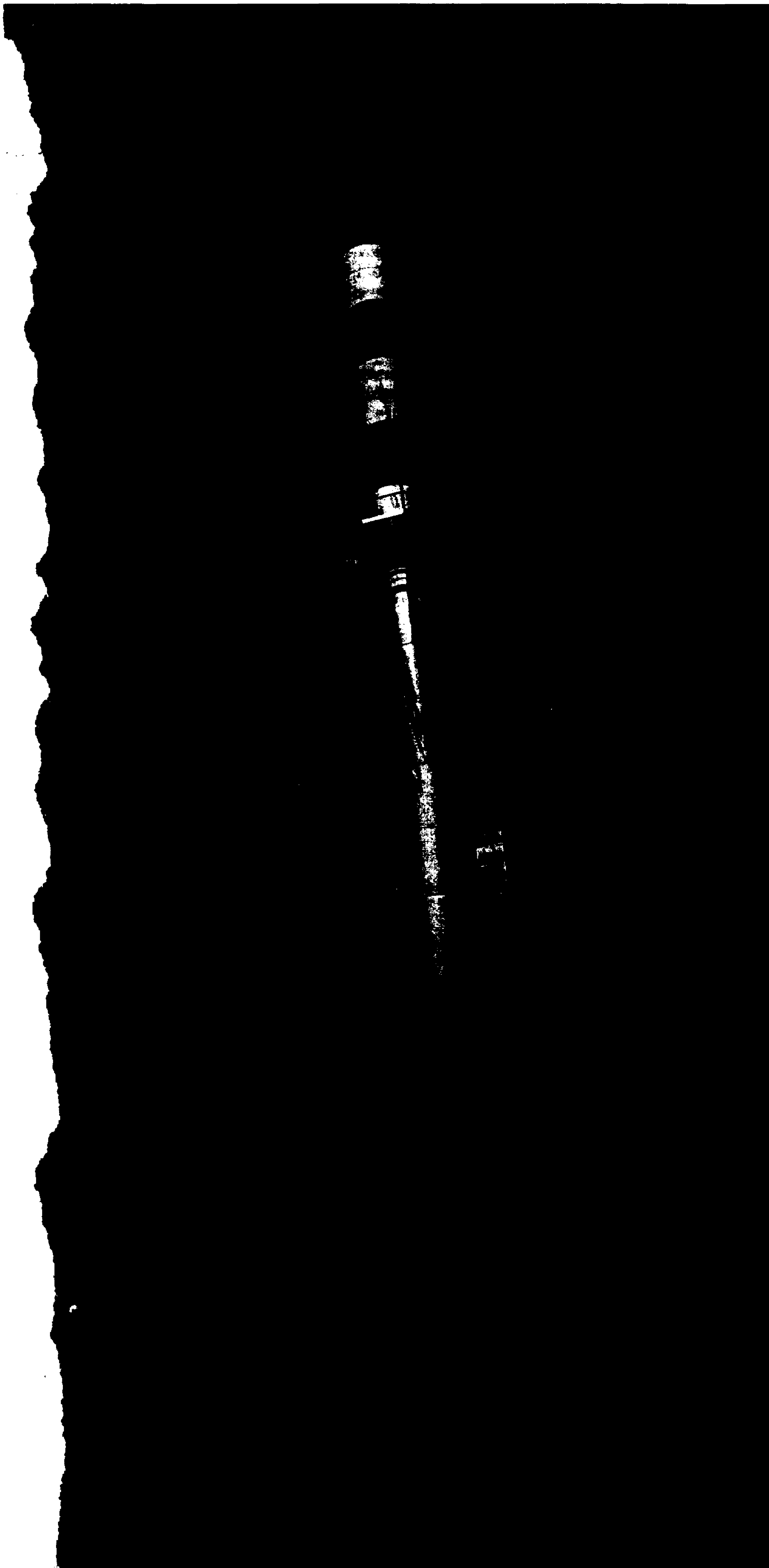

ing risk assessment practices, as specified in various state and local air toxics policies and regulations. Risk assessment is used to express the likelihood that individuals within an exposed population will suffer adverse health effects as a result of exposure.

The adverse effect is death from cancer when the contaminant is a carcinogen, while exposure to non-carcinogens may lead to a variety of fatal or non-fatal health effects.

Risk is expressed as a probability. For example, in an exposed population of one million, if one person would be expected to die from lifetime exposure to a toxic air contaminant, the risk of death associated with the contaminant is one in one million, or 10^{-6}. Risk calculations often are based on worst-case exposure scenarios, such that the risk is more likely overestimated or conservatively calculated and resulting health protection measures are more certainly sufficient.

Regardless of whether worst-case or typical-case assumptions are used, environmental toxicologists consider risk assessment results to be upper bound estimates of risk, where the true risk lies somewhere between the calculated value and zero.

Air toxics risk assessments are applied in a variety of situations. For example, as part of a state's permitting procedures, new industrial facilities may be required to use risk assessment techniques to demonstrate that risks are below specified de minimis values.

Additionally, both new and existing facilities may be required to perform risk assessments in situations where catastrophic releases of toxic air contaminants are possible. Finally, risk assessments may be performed for a vari-

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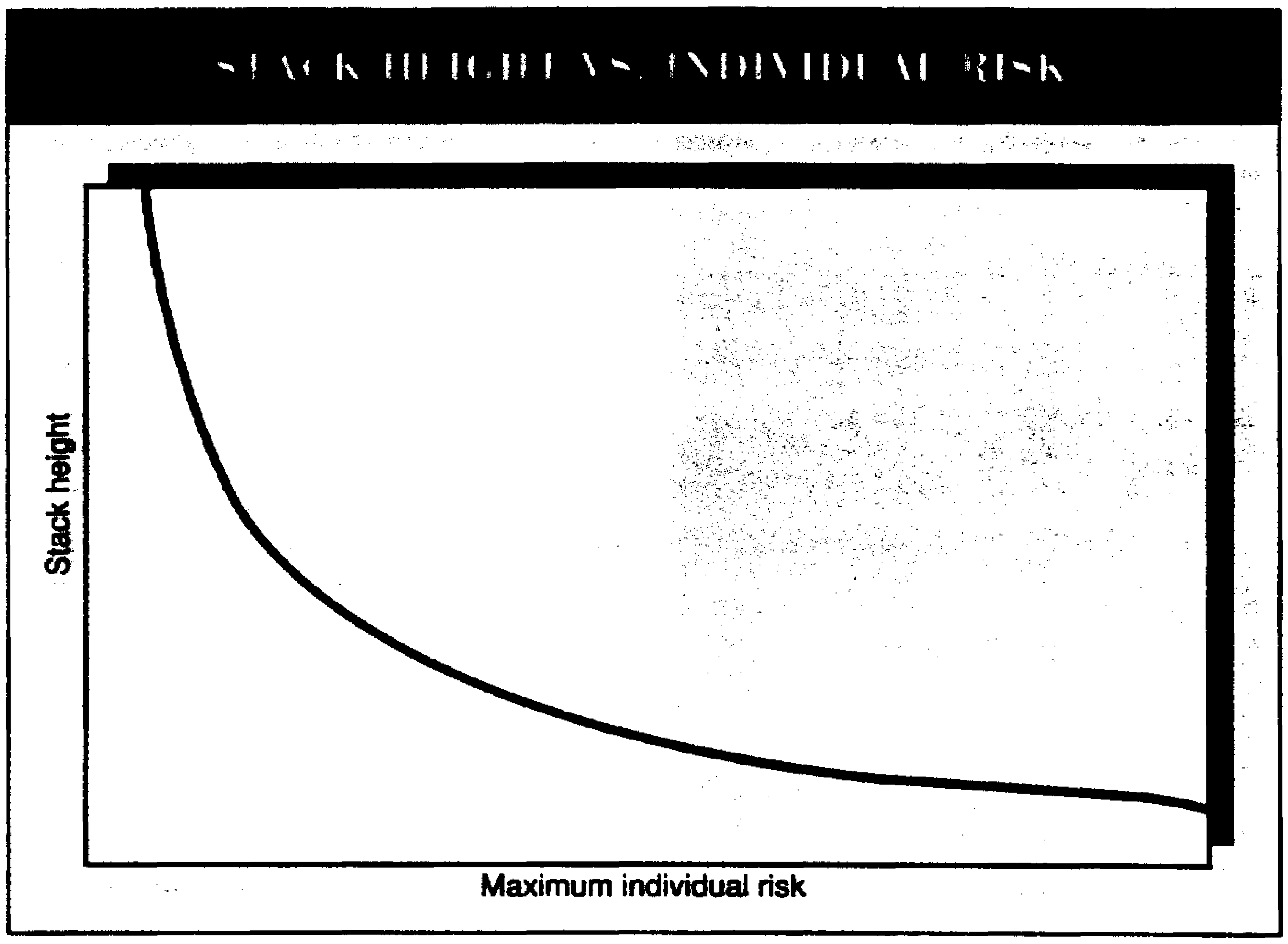

Figure 1. An individual's maximum risk can be reduced by increasing stack height.

ety of other purposes, including compliance with the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Superfund Amendments and Reauthorization Act (SARA).

Examples of air toxics policies and regulations for California are presented in Table 1. Although California leads the nation in air toxics policies and regulations, several other states also have active air toxics programs.

Steps can be taken in planning for and conducting an air toxics risk assessment that will streamline the assessment process, increase the likelihood of first-time approval of the assessment to avoid repeated revisions, and ultimately reduce risk to an acceptable level. These steps include:
- Preliminary contacts with air regulatory agencies;
- Preparation of a risk assessment protocol document;
- Use of screening techniques; and
- Use of model refinements, process technology and emission controls to reduce risk.

Preliminary contacts

An important first step in conducting an air toxics risk assessment is to become familiar with the risk assessment requirements of the air regulatory agency with jurisdiction over the emission source in question. Although usually not required, a preliminary meeting with the local air regulatory agency can provide valuable insight regarding how the risk assessment should be performed and documented, and what information should be provided to ensure future acceptance of the final assessment without major revision.

Most agencies make available risk assessment guidelines and reference documents. However, these materials seldom provide the detailed information needed to perform the entire assessment. An added problem is that air toxics risk assessment policies are becoming more sophisticated and policies and reference documents may not be up to date. Thus, initial contacts with the regulatory agency take on critical importance in determining how to perform the assessment.

When regulatory agencies require assessments to be repeated or extensively revised, a common reason is that the risk assessment was not designed with appropriate objectives in mind. These objectives may include the calculation of one or more of the following measures of risk:
- *Maximum individual risk* — the risk of death from cancer for a hypothetical adult exposed at the point of maximum predicted ambient air concentration for a 70-year period, 24 hours per day.
- *Risk for the maximum exposed individual* — same as the maximum individual risk, but for the point of actual exposure for the adult living closest to the emission source.
- *Excess cancer burden* — the increased incidence of cancer death in the community surrounding the facility, usually based on either a 70-year exposure period or on the actual expected operating lifetime of the facility.
- *Sensitive receptor evaluation* — calculation of the maximum individual risk for high-risk individuals such as children, asthmatics and the elderly.
- *Non-carcinogenic effects* — potential health problems associated with compounds causing non-carcinogenic acute or chronic health effects.
- *Multipathway risks* — calculation of risk, taking into account non-inhalation exposure routes such as the ingestion of air toxics including contaminated soil, fish, water, and crops or the absorption of air contaminants through the skin.
- *Worker effects* — adverse health effects in on-site employees as well as in workers in nearby facilities.

Target populations and points of exposure for these measures of risk are summarized in Table 2.

Sometimes, one or more of the above measures of risk are erroneously excluded from a risk assessment due to miscommunication with the regulatory agency or incorrect assumptions about what logically should and should not be included in an air toxics risk assessment for a given facility. Because different agencies have varying philosophies about the purposes and objectives of risk assessments, it is important to discuss the objectives of the risk assessment with the appropriate agency as a first step in designing a risk assessment study. Other important topics to raise with the agency include:
- What de minimis values have been established by the agency in determining the levels at which calculated risks are considered significant?
- Is the use of emissions factors satisfactory, or will emission testing will be required?
- What are the requirements for the use of specific dispersion models or risk assessment methodologies?
- Should the worst-case, worst-plausible case, average or typical values be used for emission rates and other critical parameters?
- What reference sources should be

used to determine compounds of interest to the agency and to determine appropriate unit risk factors?
• Should risks be calculated over a 70-year lifetime period or over the expected operating lifetime of the facility?
• Should 24-hour community exposure be assumed, even when many residents may spend 8 to 10 hours per day working outside the community?
• At what distance from the facility site should excess cancer burdens be calculated? Often these distances are expressed in terms of 10^{-7} or 10^{-6} risk levels.
• What are acceptable risk-screening approaches?
• Are future revisions or amendments expected to the agency's risk assessment policies?

Although the question of de minimis values may not seem important from the viewpoint of conducting an air toxics risk assessment, knowledge of the de minimis value may be very useful in determining the degree of refinement required by the assessment.

For example, if the de minimis value is relatively stringent — a maximum individual risk of 10^{-6}, or one cancer death in an exposed population of one million — the use of precise dispersion models and assumptions may be necessary to determine whether risk is below the de minimis value. On the other hand, if the de minimis value is less stringent — a maximum individual risk of 10^{-5} or higher — more conservative, less costly dispersion models and assumptions may be adequate to demonstrate compliance with the de minimis value. The level of the de minimis risk value may have a significant impact on the required complexity of the assessment, affecting costs as well as time for completion.

Protocol document

Before an air toxics risk assessment is performed, a protocol document that outlines all procedures and assumptions to be used in the study should be prepared. Preparation of a protocol document not only provides an opportunity for all parties to consider and agree upon the risk assessment methodology, it also gives the regulatory agency staff who review the protocol the opportunity to sign off on the proposed risk assessment plan.

A well-written protocol document that has the approval of all interested parties can minimize the revisions, corrections and associated delays required later in the study, more than justifying the extra time and expense required to prepare the document.

The protocol document should specify all models, procedures, parameters and assumptions to be used in the risk assessment. The document also may be an appropriate place to remind interested parties that risk assessment is not an exact science, and the many inherent uncertainties in the process are accommodated through a series of conservative, health-protective assumptions.

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CALIFORNIA AIR TOXICS POLICIES AND REGS

Law	Requirement
[illegible]	[illegible] to perform an air toxics emission [illegible] measure emission rates. In some [illegible] may also be required.
[illegible]	[illegible] Prevention Program to be pre- [illegible] catastrophic releases of acutely [illegible] materials.
[illegible]	[illegible] regulation of toxic air contaminant emissions from [illegible] based on risk assessment [illegible]
Proposition 65	Requires the public to be informed about potential health hazards.
Air District Rules and Policies	The South Coast and Monterey Bay Air Quality Management Districts both have established rules requiring risk assessments for new air emission permit applicants. The Bay Area Air Quality Management District has an air toxics policy with [illegible]

Screening techniques

Considerable time and cost savings can be realized through the use of screening techniques. A good example of a screening technique is the use of the PTPLU dispersion model in place of the standard Industrial Source Complex (ISC) model. Although the ISC model provides more precise results than PTPLU, ISC is more expensive and time-consuming to run. If the regulatory agency will allow use of screening models such as the PTPLU, and if the screening model will provide results that are sufficient to demonstrate compliance with the de minimis value, its use should be considered.

Another screening technique involves the use of worst-case values for a variety of risk assessment parameters such as emissions factors. Worst-case values usually are easier to select and justify than more realistic values and many regulatory agencies encourage or require their use. The hazard associated with worst-case values is that their use may result in an artificially high estimate of risk. In fact, using worst-case values throughout a risk assessment can lead to calculated risks that are three or more orders of magnitude higher than a best estimate.

Risk reduction

In situations where calculated risk values exceed de minimis values, steps often can be taken to refine the calculations such that the calculated risk values are reduced. For example, where screening techniques have been used, portions of the risk assessment can be repeated using more refined and realistic models and assumptions.

If the risk values are still unacceptable, risk can be reduced further by implementing various process modifications. These include:
• Reducing hours of operation or operating capacity;
• reducing feed rate or modifying feed composition; and
• increasing stack height.

In the case of stack height, calculations can be performed to determine what height would result in sufficient dilution of the plume such that the de-

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