

IoFirst Methodologies Overview

Introduction

Background

The ioMosaic Facility Initial Risk Screening Tool (ioFirst) presented in this document is a model developed to assist organizations with prioritizing the order in which PHAs are conducted. It is a hazard identification and first level risk screening tool that addresses health, safety, and environmental hazards from acute, episodic releases of hazardous materials, especially those with potential for impact off-site. The ioFirst will be used primarily to determine an initial rank ordering of site or unit hazards related to fixed facilities. It should not be used to perform quantitative risk assessments.

ioFirst includes simplified hazard models, adjustments based on age, incident history and surrounding populations, and a method of combining the scores associated with each unit or site. The hazards and associated models are introduced in Chapter 2.0 along with population considerations and scoring for sites. The hazard models and the hazard criteria are discussed in further detail in Appendix A, Technical Basis and Assumptions. Chapter 3.0 contains the User's Guide, and application examples are provided in Chapter 4.0.

Objectives

ioFirst was developed to meet the need for a hazard identification and initial screening tool to be applied to fixed facilities. During the course of development a number of different decisions and compromises were made, usually regarding options involving algorithms, data availability, clerical effort required to operate the system, and programming complexity. Always, the goal has been to develop a reasonable, user-friendly risk ranking model which balances the need for simplicity with the requirements to be accurate within the limitations of a first screen tool.

The function of the ioFirst scores is to enable comparisons of relative hazards both within and across different sites and ranking of those process units and sites according to their potential to cause major public emergencies involving episodic chemical releases. The relatively more hazardous process units and sites can then be identified for subsequent risk screening. Certain nominal risks may be dismissed after initial screening while others will be so clearly unacceptable that the Company will want to move immediately from screening to implementing specific risk mitigation measures.

ioFirst is, by no means all-inclusive of all conceivable hazards and their ramifications. It does, however, consider the more common, as well as particularly dangerous, hazards that a facility handling chemicals may experience. Results are conservative in that scores are determined for the largest amount of each chemical that could be accidentally released, regardless of the likelihood of such a release.

Models and Scoring

Detailed models were used as a basis for development and testing of ioFirst. The hazards addressed by ioFirst have been divided into three categories: toxic vapor dispersion, fire and flammability, and vapor cloud explosion hazards. In this analysis a hazard exists where direct or indirect effects of the considered hazardous material events are expected

to result in fatalities. For each of the three hazard categories, scoring algorithms have been developed to reflect the maximum hazard distances from the release..

In order to minimize the required user input and difficulty of implementation, an effort was made to limit the number and complexity of the models included ioFirst. Simplifications have been made by assuming the “most likely” or “conservative” conditions, where conservative conditions produce a worst credible scenario. It is important to note that for the events considered by ioFirst the hazard scores are treated with equal weight regardless of the likelihood of the associated events occurring.

The toxic vapor dispersion hazards are those caused by inhalation of airborne hazardous concentrations of toxic vapor. This does not include hazards due to skin or eye contact or ingestion. This model calculates the downwind distance within which vapor concentrations exceed a user specified concentration limit.

The fire and flammability hazard evaluation considers the effects of thermal radiation resulting from pool fires and fireballs. While other events produce fire hazards, such as flame jets, these have not been explicitly included since their hazard areas are generally within those estimated by ioFirst. Solid material fires are also omitted.

Distances to overpressure hazards due to ground level unconfined vapor cloud explosions are estimated by the model. Explosions due to explosives, dusts, and tank overpressurization are not currently included.

The maximum hazard score associated with each process or activity at a site is adjusted by a value representing the exposed population. This value is based on the number of people working at the site and residing near it, the distances to industrial and residential areas, and the presence of special facilities near the site. Adjustment factors for facility age and incident history are also applied. For each unit/site the adjusted hazard distances are combined to give a single value, or unit/site score, for comparison with other unit/site scores.

Accuracy

Accuracy is achieved by comparing ioFirst algorithms with tested detailed models. To test ioFirst, the algorithms were used to generate hazard scores for various quantities of a limited number of common and representative hazardous materials. Detailed models were used with the same input values to obtain estimates for comparison. Results were validated and compared for toxic vapor dispersion, flammable hazards, and unconfined vapor cloud explosion hazards.

IoMosaic is happy to share these results after receiving requests from users and upon our internal review.

Overview of Procedure

This section gives an overview of the application of the ioFirst algorithms and addresses methods for handling materials that require preliminary calculations. The following sections in this chapter give the detailed calculation methodology for each of the three hazard categories, age, incident history and population considerations, and the overall unit/site score.

ioFirst initially computes, for each process unit or facility activity, a set of hazard scores for each chemical used in terms of toxic vapor, fire, and explosion hazards. The scores are representative of the hazard zones for each of these three categories and the single largest of the scores for all of the chemicals used in a process unit or facility activity is the Process/Activity Hazard Score. This value is adjusted by factors that reflect age, incidents and exposed population including employees, contract workers, nearby businesses and residences to produce the Process/Activity Ranking Score. The Site Ranking Score combines all of the Process/Activity Ranking Scores of a unit or site.

Preliminary calculations are needed to determine ioFirst input values for materials that are mixtures of compounds and for materials that react upon release. For materials that react with substances in the atmosphere or decompose when released, the substances and quantities yielded by the reaction are the materials of interest in applying ioFirst. Calculations must be done for such materials to obtain the appropriate quantity of each product. These quantities are found by doing the following for each product:

- ?? converting the quantity of the reactant into moles;
- ?? multiplying this by the ratio of the number of moles of the product to the number of moles of the reactant from stoichiometric considerations;
- ?? and converting the resultant from moles of product to mass of product.

For materials that are mixtures of two or more compounds, the material dependent input values should be those of the mixture. If the mixture properties and toxic vapor limiting concentration are not known, the method prescribed in Appendix B Mixture Property Estimation Procedure, should be used to estimate the required ioFirst input values. Input for mixture property estimation consists of the user input required for ioFirst for pure substances and the mass fraction for each mixture component.

The procedure whereby a Site Ranking Score (SRS) may be generated for a facility or unit consists of the following elements:

- ?? A list is made of the major individual process units and operational activities conducted at the site, together with listings of associated chemicals.
- ?? Each process unit or activity is evaluated for toxic vapor, fire, and explosion hazards, as applicable, to develop a Process/Activity Hazard Score (PAHS).
- ?? The facility, as a whole, is evaluated with respect to the presence of exposed populations both on and off-site to produce an Exposed Population Score (EPS).
- ?? The Process/Activity Ranking Score (PARS) is determined by multiplying the Process Activity Hazard Score by the Exposed Population Score.
- ?? If desired, the Site Ranking Score (SRS) is generated by taking the logarithm (base 10) of the sum of the Process/Activity Ranking Scores for all process units or activities at that site.