MINIMIZING RISK WITH LOW-CHARGE AMMONIA SYSTEMS

Packaged Refrigeration for Your Facility

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THE REDUCED RISK OF LOW-CHARGE REFRIGERATION

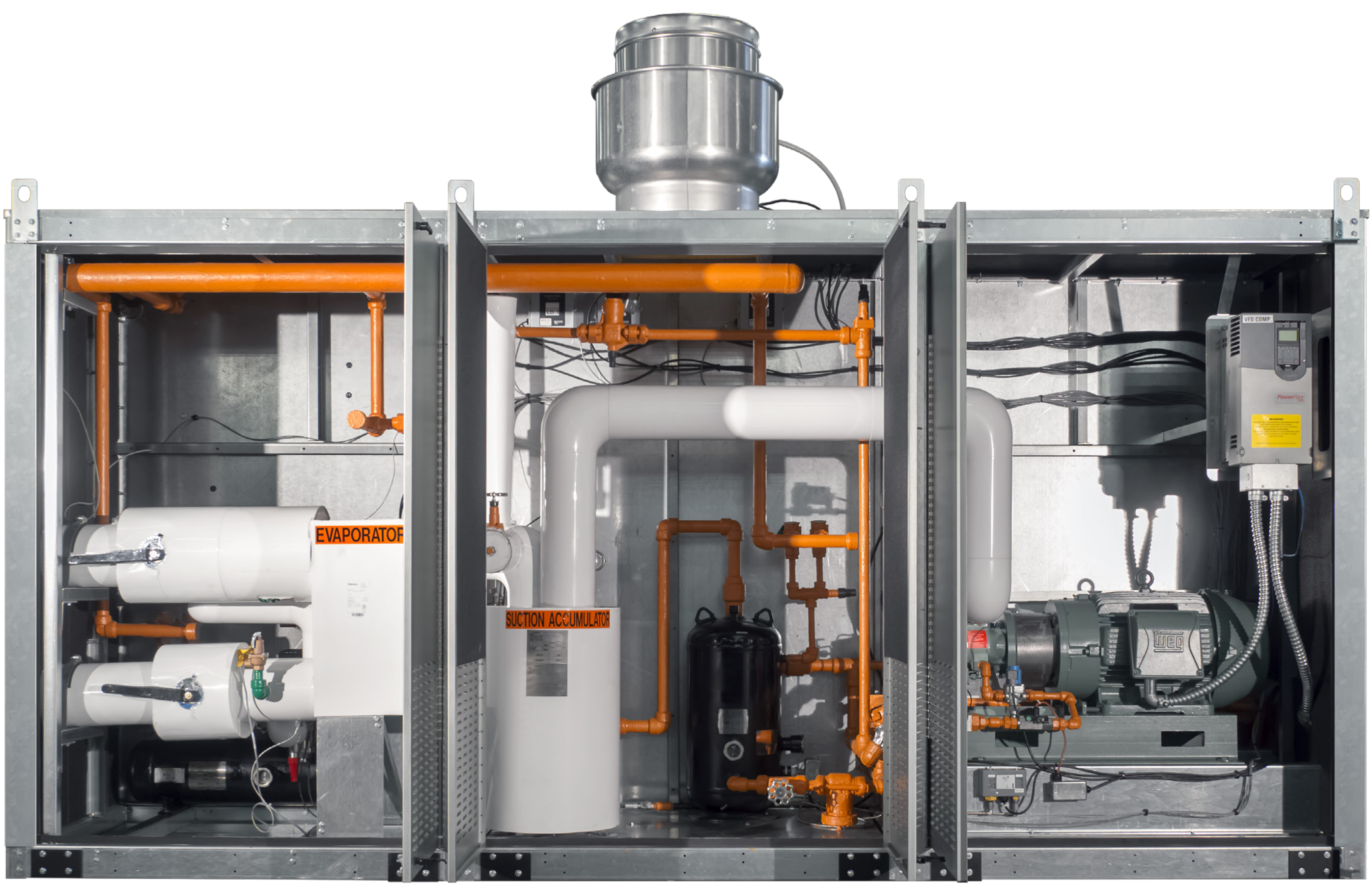
Quantitative Risk Analysis for Zero Zone Ammonia Systems

Zero Zone is proud to bring high-quality, innovative refrigeration systems to our industrial customers. Our refrigeration packages are engineered to perform at your facility with trouble-free, energy-efficient operation. Real world experience with natural refrigerants, like ammonia, is a value-added feature of Zero Zone refrigeration products.

Part of any ammonia project is a consideration of the potential risks should a refrigerant release occur. When the amount of ammonia in a system is small, the risks of a refrigerant release with offsite impacts become very low. This is driving a trend toward low-charge ammonia systems in the refrigeration industry today.

For an owner/operator of a facility with refrigeration, an awareness of the potential impacts of an ammonia release is required for large systems over the regulated threshold charge amount. For small systems, the requirements are not as clear. The use of quantitative risk analysis (QRA) can be helpful in putting perspective on the reality of ammonia risks.

Zero Zone has worked with our colleagues at Kensington Consulting of Berkeley, CA, to review potential consequences for an ammonia release from a sample of various small-charge ammonia systems. Using recognized and widely used analysis methods and assessment criteria, the study shows that ammonia can be applied with very low risk. The findings of this study are summarized here, and offer perspective on the relative risk of releases from small-charge systems.



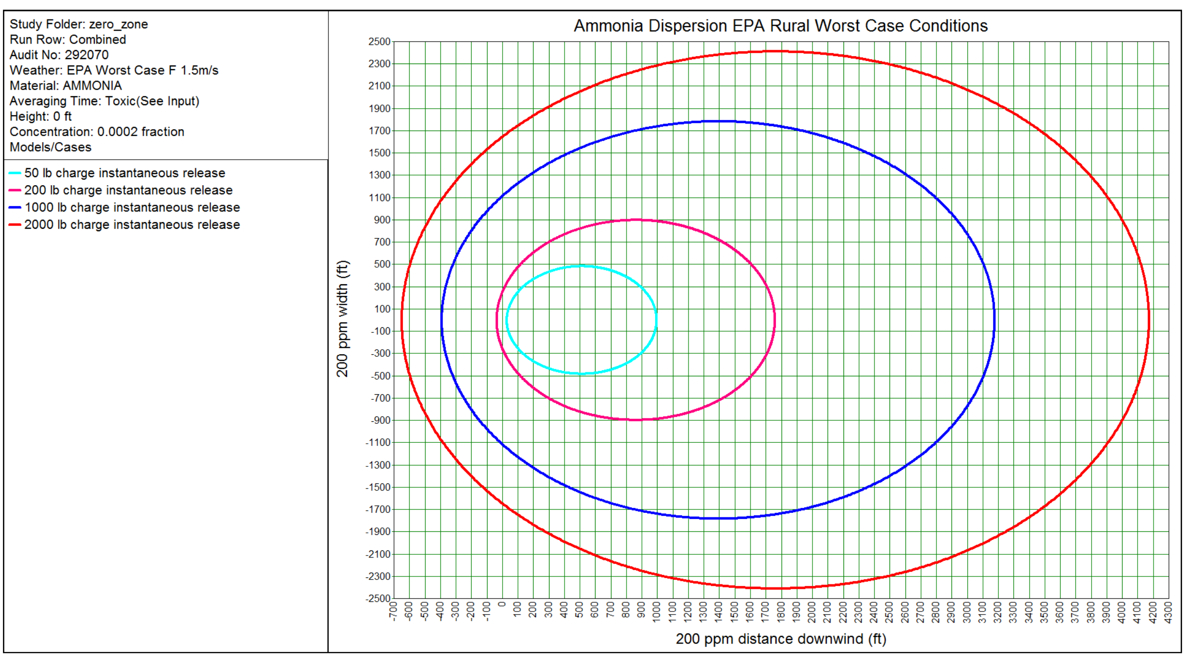
Those who know ammonia are aware that it has a strong odor, which gives it a "self-alarming" quality. When people smell ammonia, they want to leave the area. Studies have shown that, aside from the unpleasant odor, short-term exposure to low levels of ammonia vapor has no lasting effect. When the natural human "flight response" is considered, the likelihood of ill effect is reduced even further.

Designing a refrigeration system to minimize ammonia charge is an effective way to reduce risk. As the following third-party analysis illustrates, for a very small charge system, the risk of a serious public injury can become statistically insignificant.

EPA Release Scenarios

Three ammonia release scenarios are reviewed with 50, 200, and 1000 pound charges. Begin the analysis by calculating the distance to toxic endpoint (200 ppm) expressed in miles using the rural formulas from EPA's *Supplemental Risk Management Program Guidance for Ammonia Refrigeration Facilities (2004)*. Worst-case conditions are assumed with a catastrophic release of the entire charge over 10 minutes. Typically, sites will have lower alternate case release rates as allowed by the regulation. For this illustration, we have used the one extremely conservative release rate.

FIGURE 1: EPA Calculated Worst-Case Conditions



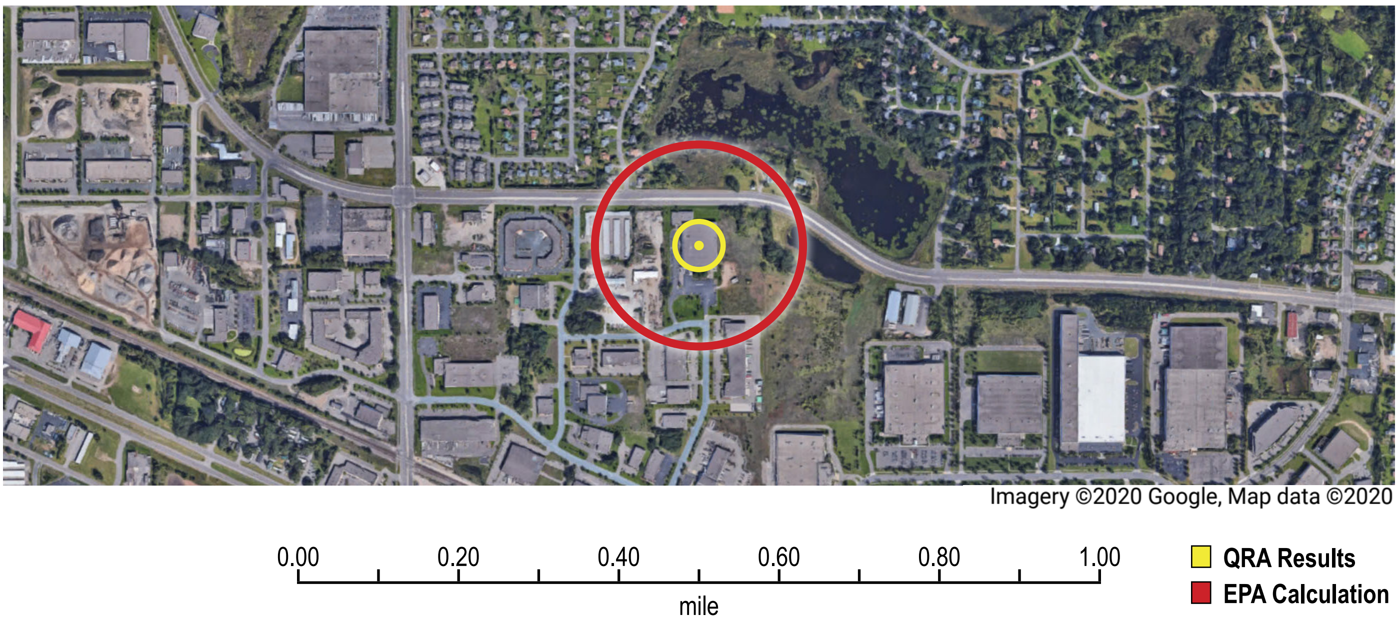
Release Scenarios with Computational Modeling

Output for the worst case is presented in **FIGURE 1** as ground level 200 ppm concentration (EPA toxic endpoint) footprints. The EPA results are not accounting for the probability of a catastrophic release event. For an evaluation of risk, it is necessary to apply a quantitative risk analysis (QRA) to the scenario. For this analysis, a packaged rooftop ammonia system is considered. The location is an industrial office park with adjacent residential areas.

A relationship linking exposure time, concentration, and likelihood of a release is determined using industry standard Gaussian dispersion software and widely accepted statistical methods. If we assume an overly conservative frequency of once per 10-year period for a catastrophic release, we can apply a set of criteria which are well within accepted practice. Accounting for these realities, even with very conservative assumptions, shows how the area of risk is dramatically smaller than reflected by the EPA footprints.

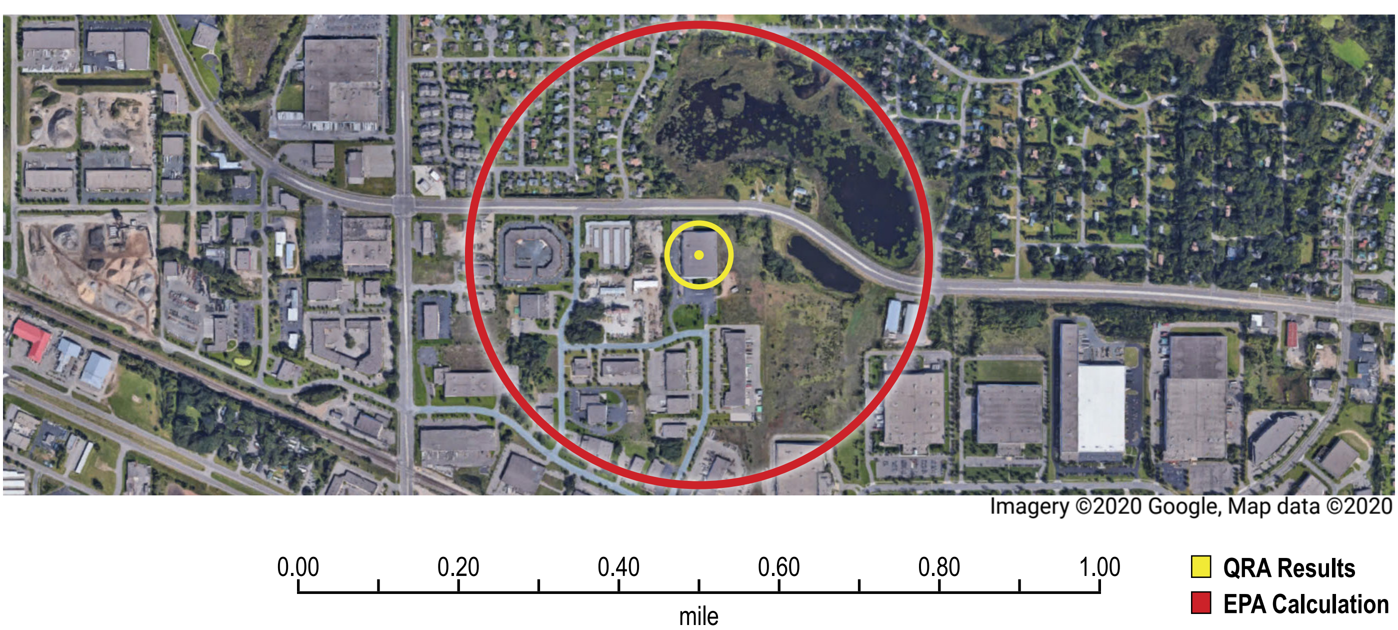
It is important to differentiate between the EPA worst-case scenario and actual risk to the public. The quantitative risk analysis allows a likelihood of serious public injury to be defined. Differences between the QRA computational modeling and the EPA calculation are compared directly for various ammonia charges. In **FIGURES 2-4**, the red circles represent the EPA calculated area and the yellow circles represent the results of the quantitative risk analysis. The yellow circles show the area beyond which there is less than a 1:1,000,000 years chance of serious public injury.

FIGURE 2: 50 lb Release Risk Contours



Note: For a 50 lb release, QRA shows there is no potential for serious public injury at ground level at this facility.

FIGURE 3: 200 lb Release Risk Contours



Note: For a 200 lb release, QRA shows the likelihood of serious public injury outside the property line is less than 1:1,000,000 years.

FIGURE 4: 1000 lb Release Risk Contours

Conclusions

The above images are useful in showing the results of a conservative quantitative risk analysis. We can see that the risk of an offsite consequence and serious public injury goes down dramatically as the system charge gets smaller. The smaller circles represent the area where there is a 1:1,000,000 years chance for serious injury.

When considering a low-charge ammonia system for your refrigeration, it is important to consider more than the EPA defined worst-case scenario in the risk assessment.

Note: The above summary is a sample based on one location. To have an accurate result at other facilities, the analysis must account for the specific conditions of the site.

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WP-03 REV C