Tanks Inside Of Buildings – to Vent or Not to Vent, That is the Question

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Some TankTalk readers may consider it inappropriate to misuse a common stanza from the Shakespeare play “The Tragedy of Hamlet” and I hope the title doesn’t offend you or inhibit your enjoyment of the arts. However, the title paraphrases a question that is commonly asked of ICC staff because of the issues surrounding AST installations inside of buildings.

The storage of flammable and combustible liquids in ASTs inside of buildings requires the fire code official to apply more rigorous provisions from the 2012 International Fire Code® (IFC®) and NFPA 30, Flammable and Combustible Liquids Code. For tanks designed to store liquids with a closed cup flash point temperature below 200°F (Class I, II and IIIA liquids) at atmospheric pressure, the requirements are justified because flammable and combustible liquids exhibit much higher heat release and burning rates when compared to many ordinary combustibles found in buildings. One of the requirements pertains to the termination of normal vent and emergency vent of ASTs inside buildings, and that’s the subject of this article.

TINBIDs (Tanks Inside of Buildings) are fairly common in commercial development projects. Over the past 10-15 years, the demand for standby power systems that provide an alternative source of electrical energy to computer servers and similar equipment has increased dramatically. Designers commonly specify engine-driven generators with integral sub-base ASTs to limit the floor area of the standby power source. The TINBID requirements in Chapter 57 of the 2012 IFC become applicable when any AST containing Class I, II or IIIA liquids is installed indoors. The IFC requires a construction permit to install a TINBID as well as an operational permit to ensure that it is properly maintained in accordance with all of the IFC requirements.

Normal Venting
In addition to the requirements for tank construction, volume limits and overfill protection, the IFC has requirements for terminating a TINBIDs normal vent and emergency vent. The purpose of the normal vent is to maintain the pressure inside of the tank when liquids are introduced into or are withdrawn. All storage tanks are designed to resist the vacuum and positive pressures generated when liquid is introduced into or withdrawn. Improperly sizing a tank’s normal vent or obstruction of the vent can cause excessive negative pressure to generate inside the tank, causing the tank to collapse into itself. IFC Section 5704.2.7.3 has a number of provisions to ensure the normal vents are properly terminated. For Class I, II and IIIA liquids the IFC requires termination of the normal vent outside the building. It should be located at least 12 feet above the finished ground level and a minimum of 5 feet from building openings and lot lines that can be built upon. The 12-foot elevation of the vent is necessary to ensure that the surrounding air mixes with the vapor being exhausted from the tank so the atmosphere is maintained below 25% of the liquid’s lower flammable limit.

PV vents are required by IFC Section 5704.2.7.3.2 on the normal vents of TINBIDS containing Class IB or IC liquids to limit the potential release of flammable vapors. A PV vent only operates when product is withdrawn or added to the tank. In lieu of a PV vent, the 2012 IFC will now permit the installation of in-
line flame arrestor. A flame arrestor is a mechanical device designed to absorb and dissipate the energy of a flame. If a flame arrestor is selected as a means of protecting the tank’s normal vent, it must be designed and installed in accordance with API 2028. Note that when specifying flame arrestors, a number of technical concerns must be addressed including:

- Properly sizing the flame arrestor. A flame arrestor operates by absorbing heat using highly conductive metal such as brass or aluminum installed so it fills the cross-sectional area of the vent pipe. Improperly sized arrestors can obstruct the flow of air during liquid dispensing or withdrawal operation. Such an obstruction can cause transfer pumps to cavitate or create a vacuum pressure which could damage the primary containment.
- Debris loading. Class I liquids commonly act as solvents and can be electrically conductive. As a result, vapors with a positive electrical charge can attract and accumulate dust, dirt and other debris. Because the solvent may adsorb or detract water, the removal of moisture causes the debris to accumulate. The design of the normal vent needs to accommodate the maintenance and cleaning of the flame arrestor of debris.

**Emergency Venting**

With the exception of ASTs larger than 12,000 gallons that contain Class IIIIB liquids that are located so they cannot be affected by a release of Class I or II liquids, IFC Section 5704.2.7.4 requires all TINBIDS be equipped with a means of emergency venting. Emergency venting is a pressure relief device designed to protect the tank from being overpressurized beyond its design limits so it does not rupture. The IFC requires the emergency vent be installed and maintained in accordance with NFPA 30, Section 22.7.

Installation of a TINBID introduces additional requirements for the tank’s emergency vent. The IFC prohibits the discharge of an emergency vent inside a building. The primary reason for this provision is the emergency vent’s function. When an emergency vent opens, it depressurizes the storage tank by relieving vapor generated by a fire. This vapor, if not discharged outside the building, could add vaporized fuel to an unwanted building fire. If enough vapor is released before it finds a fire or ignition source, the resulting flash fire could create a vapor cloud explosion, causing severe damage to the tank and building, as well as potentially injuring or killing building occupants.

An issue that impacts the design of emergency venting systems terminated outside a building is the addition of pipe and fittings beyond the outlet of the storage tank can create a backpressure inside the tank. This backpressure results from friction of the liquid vapor moving across the interior of the pipe and fittings. NFPA 30 Section 22.7.4 requires piping that is extended more than 12-inches beyond the ASTs emergency vent opening be evaluated for this pressure loss. Analysis routinely finds the pipe and fitting diameters may need to be increased beyond the diameter of tank’s emergency vent opening to accommodate for this backpressure. The calculations are based on a derivative of the Darcy-Weisbach equation – as a result, the design of emergency vent extension piping should be supervised by a registered professional engineer.

Because of the importance of emergency vents and the additional design challenges that arise for vents protecting TINBIDS, the 2012 IFC was revised to permit the termination of the emergency vent inside the building when combustible liquids are stored in protected aboveground storage tanks. A protected AST is defined in IFC Section 202 as A tank listed in accordance with UL 2085 consisting of a primary tank provided with protection from physical damage and fire-resistive protection from a high-intensity liquid
pool fire exposure. The tank may provide protection elements as a unit or may be an assembly of components, or a combination thereof. Exception 2 of IFC Section 5704.2.7.4 allows the emergency vent to be terminated inside the building when the tank is storing Class II or IIIA combustible liquids. For Class IIIB combustible liquids, the emergency vent has always been permitted to be terminated indoors.

The code was revised based on calculation of vapor pressure of ultra low sulfur diesel stored in a UL 2085 AST. As a condition of listing a protected AST, UL 2085 prohibits the thermocouple measuring the primary containment from exceeding a maximum temperature of 400°F. Vapor pressure calculations determined that at 400°F, the vapor pressure of the diesel is below the 2.5 PSIG opening pressure specified in NFPA 30, Section 22.7.3.10.1. Based on the fire-resistance and insulating quality of the materials used in the fabrication of protected ASTs, the emergency vent for these tanks storing Class II and IIIA liquids will not operate inside a building.

The change in Section 5704.2.7.4 was developed in response to a code change that was approved in 2009 IFC. IFC Section 603.3.1 was modified to allow increased quantities of fuel oil inside of a building without changing the occupancy to a Hazardous occupancy. The requirements in the 2009 IFC permit up to 3,000 gallons of fuel oil inside a building when:

1. The fuel oil is stored in a Protected AST,
2. The entire floor housing the TINBID is protected by a NFPA 13 compliant automatic sprinkler system,
3. The fuel oil piping system is designed and constructed in accordance with the International Mechanical Code, and
4. The PAST is located not more than 2 stories below the building’s grade plane.

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Readers seeking additional information about changes to the 2012 IFC are encouraged to purchase the Significant Changes to the 2012 IFC. This four-color illustrated soft cover provides a detailed analysis of the purpose and intent of the significant code changes to the 2012 IFC. The book can be purchased from the ICC Book Store at http://www.iccsafe.org/Store/Pages/Product.aspx?category=15065&cat=ICCSafe&id=7404X12

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ABOUT THE AUTHOR

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