

# Pressure Relief Design Considerations From a PSM Compliance Standpoint (Part Two)

BILL LAPE, SCS ENGINEERS

**I**n the first article of this series, some of the factors that affect the relief capacity of a relief system that are often overlooked were highlighted to raise awareness of what is needed to properly document the safety relief design. In this article, we will discuss some of the pitfalls associated with internally relieving relief valves.

It has long been held that the best way to relieve overpressure in an ammonia refrigeration system is to have the safety relief valves (SRVs) relieve into another part of the system, often simply on the opposite side of the downstream isolation valve. While this can be a viable option, it is often fraught with pitfalls.

One of the common pitfalls centers on selecting a proper set pressure for the internally relieving SRV. Typical SRVs used in ammonia refrigeration operate on differential pressure between their inlet and their outlet. So, an ammonia safety relief valve with a set pressure of 150 psig will pop at 150 psig, if the outlet pressure is atmospheric pressure. When installed to relieve into another part of the system, the pressure in that part of the system must be added to the SRV set pressure to get the actual popping pressure of the SRV.

For instance, let's say that we have a surge drum on a product silo that is tied back to a suction accumulator with dual SRVs with set pressures of 150 psig. For argument's sake, let's assume that the surge drum SRVs have a set pressure of 150 psig, which is often the case. If the SRVs on the surge drum relieve to atmosphere, they will open at 150 psig. However, if they are piped to relieve into the suction header on the opposite side of the isolation valve for the surge drum, we must take the 150 psig set pressure of the surge drum SRVs PLUS the suction pressure in the header and the accumulator. If the suction pressure typically operates at 30 psig, then the internally relieving SRVs will not pop until the pressure in the surge drum exceeds 150 psig plus 30 psig, or 180 psig. If the Maximum Allowable Working Pressure (MAWP) of the surge drum is 150 psig, then this installation is not

compliant with IIAR2 or the Boiler & Pressure Vessel Code. Moreover, we know the suction line is connected to the accumulator with its own relief valve, so before we place an order for a surge drum with a 200 psig MAWP, we have to ask ourselves, "What is the absolute worst-case pressure that will be seen on the low side of this system between the suction accumulator and the surge drum?" Note that this is not the worst case that is likely to happen. It is the worst case that is allowable by the installed engineering controls. In this case, the absolute worst-case pressure would be 150 psig, equal to the set pressure of the suction accumulator SRVs that discharge to atmosphere. With this, to internally relieve the surge drum, it needs to have an MAWP of 300 psig, equal to the set pressure of the SRVs on the accumulator plus the set pressure of the SRVs on the surge drum. This can be reduced if SRVs with a lower set pressure, say around 75-100 psig are selected to relieve the surge drum. With a set pressure of 100 psig, a 250 psig MAWP for the surge drum will suffice.

For new construction, this is all part of the design process, but what do you do if the surge drum has an MAWP equal to the MAWP of the accumulator? There are a couple of options. First, a balanced SRV that is not affected by back pressure can be used to relieve the surge drum. These are typically bellows-type valves that can be found through an internet search. Be careful when selecting such valves that their materials of construction are compatible with ammonia. Another option is a little more controversial but is code compliant.

The Boiler and Pressure Vessel Code requires that a direct, spring actuated, SRV with the ASME mark be used to relieve any equipment that is built to the Boiler & Pressure Vessel Code and is stamped with the ASME mark. It does not state that alternative means of relieving pressure cannot be used in conjunction with the ASME stamped SRVs. So, the surge drum could be equipped with ASME SRVs with a set pressure of 150 psig that relieve to atmosphere

AND a reseating relief regulator that is set to relieve at some point below 150 psig, typically 75-100 psig, that that will prevent the surge drum pressure from ever reaching the 150 psig set pressure of the atmospheric reliefs. The bulk of the overpressure relief is accomplished by the reseating relief regulator that keeps the ammonia in the system, and the vessel meets code because it is ultimately protected by the atmospheric reliefs that would only pop if there was a failure of some sort with the reseating relief regulator. Note that the reseating relief regulator CANNOT be used by itself to protect an ASME stamped piece of equipment, such as a thermosiphon oil cooler. It MUST be used together with an ASME stamped SRV.

Another pitfall that is often encountered when piping SRVs to relieve internally is interposing isolation valves. It is generally accepted that the isolation valve immediately downstream of the internally relieving SRV discharge must be locked, or car sealed, open. However, this also applies to any other isolation valves between the SRV discharge and the next ASME SRV. For example, from our scenario above, an isolation valve in the outlet of the surge drum relief piping would need to be locked open, as well as the isolation valve in the suction line to the accumulator. While there are some instances in Non-Mandatory Appendix M of the ASME Boiler & Pressure Vessel Code that do not trigger a need for locking elements or administrative controls, the calculations to document these cases exceed what most facilities can, or are willing, to do. So, the easiest way to comply with the ASME Boiler & Pressure Vessel Code is to lock ALL isolation valves between this surge drum and the accumulator SRVs.

The purpose of this article was to discuss some of the pitfalls associated with internally relieving relief valves. In the next article, we will discuss the considerations that impact the discharge piping of relief valves.