Hints for Reactor Emergency Pressure Relief

Emergency Relief calculations, especially for reactions, can be difficult and time consuming.

The following approach looks first at the scenario, to see whether the need for difficult (e.g. two-phase relief) calculations can be avoided and simpler and superior basis of safety put in place.

Figure 1 below is the basis for the following discussion.

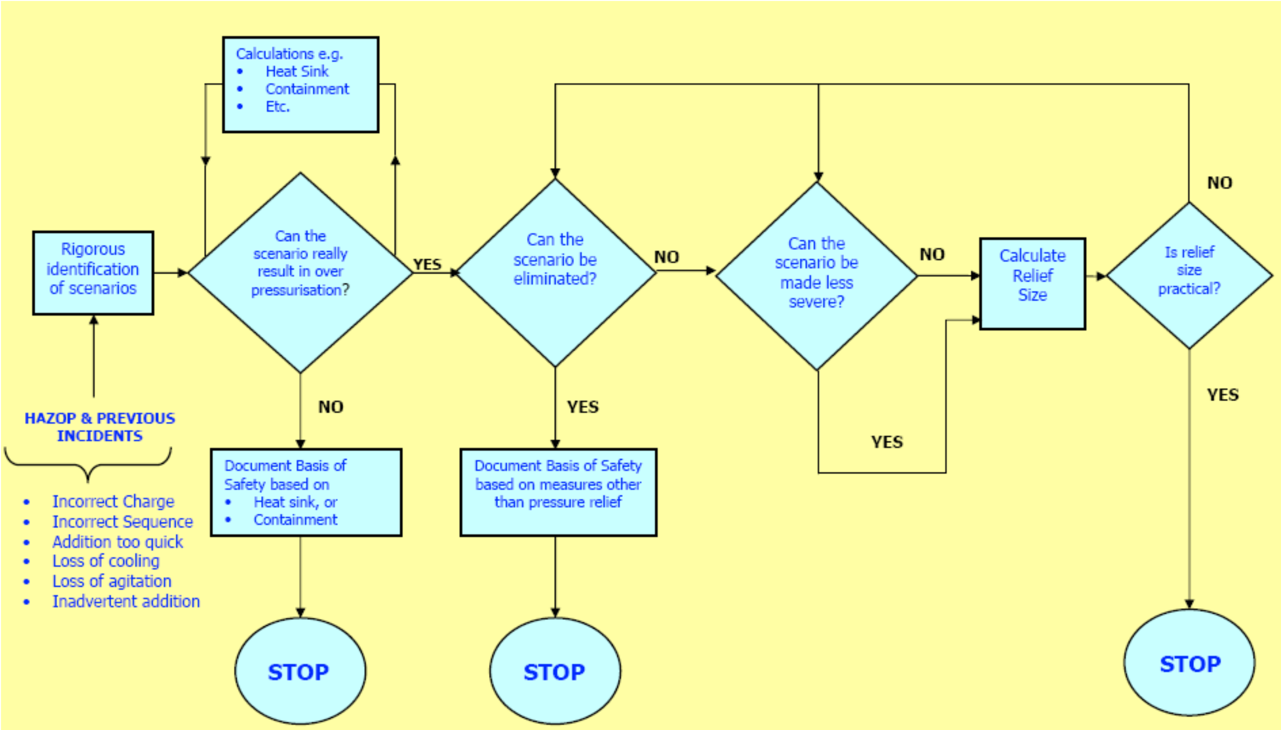
1. Ensure that a rigorous identification of scenarios has been carried out.
In other words, check out the HAZOP! If the system hasn't been subject to a HAZOP, then perhaps it should be before you start thinking about pressure relief sizing.

Typical scenarios to be considered include:

- Wrong materials
- Incorrect charge sequence
- Addition too quick
- Loss of cooling
- Loss of agitation
- Inadvertent addition
- Etc.

The above should ideally be identified in a team based review or HAZOP. This is the critical step so often overlooked.

Figure 1



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2. Don't jump straight into a relief sizing calculation based around peak heat or gas generation rates.

In the case of exotherms or heat input, it may be the case that there is sufficient heat sink and that the contents will not boil, no matter how high the rate of heat input. For exotherms, simply add the adiabatic temperature rise to the starting temperature and compare this to the expected boiling point of the mixture.

For gas evolution, it may be the case that the total volume of evolved gas is incapable of exceeding the pressure rating of the vessel, again irrespective of the rate of gas evolution.

With luck, you may find that it is possible to demonstrate a sufficient Basis of Safety based on these simple calculations, and without recourse to relief sizing.

3. Look at eliminating the scenario and/or consider different approaches to providing a basis of safety.

Relying on a bursting disc may not necessarily be the best solution. Options may include:

- Reducing the quantities of reactants
- Increasing the heat sink
- Provision of alternative control measures (e.g. instrumentation and controls)
- Etc.

4. If elimination is not feasible, try making the scenario less severe.

Similar measures to those above can be considered.

5. If the calculated relief size is impractical, repeat steps 3 and 4 above as necessary.

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Other Hints and Rules of Thumb

1. Set the bursting disc at as low a pressure as possible.
   This should be done for two reasons:
   - Firstly, the rate of reaction leading to the event is often a function of temperature. Setting the relief setting lower will ensure that pressure and temperature and hence the rate of heat generation does not build up as far as they otherwise might.
   - Secondly, assuming turbulent flow, the capacity of the relief system will increase by approximately the square root of the ratios of the differences between the respective set pressures and the maximum allowable pressure during venting. So if the maximum allowable pressure is 6.6 bar during relief, a bursting disc set at (say) 2.6 bar should be capable of handling a relief flowrate of approximately √2 times that of a bursting disc set at 4.6 bar (all things being equal).

2. Don't delegate the task to the freshest graduate in the office, at least not before older and (hopefully) wiser heads have been involved in scenario identification and the exploration of alternative bases of safety.

3. An excellent resource is the HSE Workbook for Chemical Reactor Relief System Sizing downloadable from the HSE website at http://www.hse.gov.uk/research/crr_htm/1998/crr98136.htm

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