

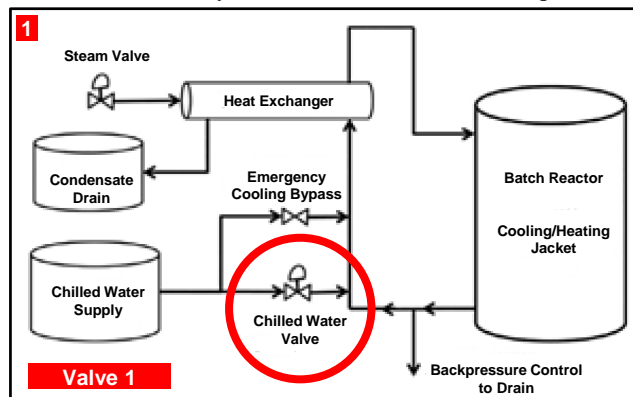
Can a “fail open” valve fail closed?

June 2020

Clearly the answer is **YES** or we would not have asked the question! On piping and instrumentation diagrams (P&IDs) or other process safety information (PSI), valves may be indicated as “fail open,” “fail closed,” or “fail in last position.” This indicates what the valve does in case of utility failure – usually instrument air or electric power failure.

In the batch reactor system in Figure 1, the reactor contents were initially heated with steam on the heat exchanger. When the batch reached the required reaction temperature, steam was shut off and chilled water was turned on to the heat exchanger to control the reactor temperature. The water flow was controlled by Valve 1, which was a “fail open” valve; it required instrument air pressure to close the valve.

On the day of the incident, the reactor temperature began to increase, causing a high temperature alarm. The operator observed the signal to Valve 1 as “full open”. The reactor temperature continued to increase, eventually triggering high temperature and low cooling water flow alarms. The operator was unable to troubleshoot the problem over a 7-minute period and did not open the Emergency Cooling Bypass to increase cooling water flow to the reactor. The emergency shutdown system intervened and dumped the reactor to a containment pit. There were no injuries, but an environmental release occurred.

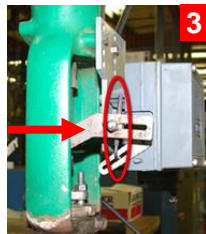


Did You Know?

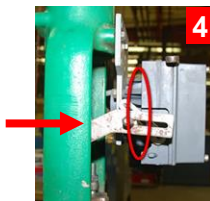
- A mechanical linkage connects Valve 1 positioner (grey box) that receives the control signal to the valve actuator.
- With a working linkage the valve stem moves from an open (2) to closed (3) position as the air pressure signal changes. When the linkage failed (4), the valve remained closed.
- Recognize that a valve may fail to operate for many reasons other than loss of utility:
 - ✓ a mechanical component could fail or be missing,
 - ✓ valve components may be rusty or dirty causing it to stick
 - ✓ material inside the valve can cause it to stick.



Valve open



Valve closed



Open signal with
damaged linkage

What Can You Do?

- Identify the failure position for safety critical valves in your plant. Note that P&IDs typically indicate the loss of utility (e.g. power, air, etc.) failure state of the valve.
- Recognize that a valve may fail to operate for many reasons in addition to loss of utilities. It is important to observe valve operation in the field to detect valve problems and report them.
- If you participate in hazard identification activities such as Process Hazard Analyses (PHA), Management of Change (MOC) reviews, or design reviews, consider the consequences of failure to operate as intended for valves. This includes potential consequences if the valve fails to operate or fails in a position other than its designed loss of utility failure position.

Reference: Dee, S. J., Cox, B. L., and Ogle, R. A., "When the Fail Open Valve Fails Closed: Lessons from Investigating the Impossible," American Institute of Chemical Engineers, Process Saf Prog 38: e12031, 2019.

What if that “fail open” valve fails closed?

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