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Fail Safe Position of Flare Connected Control Valves

Mojtaba Habibi

Process Engineer at Petroleum Engineering and Development Company (PEDEC)

Top Contributor

Dears,

As you know flare connected control valves are widely used by designers to get rid of accumulated pressure at some sections of a plant. I want to discuss about the fail safe position of this flare connected control valve. My points are as follows:

1. The control valve should be designed as "fail safe". One good definition for "fail safe" is the position that route the system energy to minimum state. Following this definition the fail safe position of flare connected control valves can be selected as FO.
2. Most of time these control valves are considered in parallel with BDV which always is FO. So the concern is that if both of the PCV and BDV are specified as FO then the flare network may be overloaded in case of instrument air failure.
3. Most of the time for the equipment which is provided with BDV and PCV, ESDV is considered at inlet and outlet sides of the process lines. So in case of instrument air failure the ESDVs will be failed to closed position and the peak flow rate resultant from simultaneous opening of BDV and PCV may not be as high as raised as a concern at previous item of my points. Is that true justification?
4. One proposed solution is to provide separate air volume bottles for BDV and PCV. In this case can we ensure flare will not be overloaded? or these separate air volume bottle just make some time delays?
5. Another solution can be to specify PCV as FC. This can be a good option but at the same time is difficult to prove because most of the operation guys and clients believe on the concept that I have expalined at item 1 of my points.
6. I heard 2 other drawbacks of PCV which is specified as FO. First is that philosophy of permissive blowdown may be blemished. Second is that plant can not be kept at pressurized shutdown state (plant will be depressurized and all of the start-up activities should be repeated from zero to 100)

So at the end which one you prefer: FO PCV or FC PCV?

Let me know your idea and experiences.

All The Best,
Mojtaba

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S M Kumar

Process Design Consultant

Top Contributor

S M

Mojtaba: Your scenario is based on instrument air failure. It does not happen all times. Once in a while event, for which you don't have to design a plant. And instrument air receiver is usually provided with adequate reservoir volume from Pnormal to Pmin to take the plant to safe shut down. (1) Keep PCV as FO. As long as air is available. it will remain shut to maintain upstream

pressure. (2) If you want, add air bottles only to selected BDVs

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Saeid R. Mofrad

Principal Process Engineer at Petrofac (P.E.)

Top Contributor

1. In line with your definition (which I do agree with), all control valves which are source of pressure and energy should be fail closed. But it may not work for all services, for example if liquid level control valve is FO, it may cause gas break through and pushing downstream system in maximum energy state. In other hand, using FC LCV may cause liquid overfilling of upstream vessel and risk of overpressure, liquid release to flare, etc. so we should search for a solution with minimum drawbacks.

In this particular case, though FO seems to be Ok with respect to system protection, it causes major process upset because of depressurizing not-isolated (running) process system. Most probably you won't be able to operate the plant anymore, unless route to flare is manually closed or unit shutdown initiated. It causes loss of hydrocarbon and unnecessary flaring as well. I believe, FC is the right selection because:

- Plant can continue normal operation as valve is required when system pressure goes beyond the capacity of process control valve (PCV to flare is normally closed)
- In case of plant overall air or power failure; all PCVs will not open at the same time.
- Process system is anyway protected by PSHH (most probably) and relief valve (for sure)

2. If flare is able to handle the flow rate from all BDVs and PCVs at the same time, PCV can be retained as FO.

Apart from instrument air failure, power failure can also cause simultaneous wide opening of all FO PCVs and BDVs. See below comment to see how to prevent these scenarios.

3. It is not completely true because:

- In case of local failure of instrument air supply to PCV and BDV of single equipment, they will open at the same time when equipment inlet and outlet ESDVs are open. PCV and BDV will depressurize the system with much higher flow rate than designed depressuring rate.
- When plant/unit wide instrument air failure takes place, most probably SDVs are closed when all FO PCVs and BDVs of that section of plant/unit open. Considering number of PCV and BDV in each plant/unit, the resultant flow rate can be considerably high.

Without calculation it is hard to make any conclusion because I remember an oil separation plant where simultaneous opening of all BDVs did not overload the flare.

4. Adding air volume bottle will help to keep BDV functional but not for PCV as it consumes air continuously for operation. In view of this, it will provide some delay in opening of all FO PCVs which does not help much.

5. Let your client know about the risk of using FO PCV and take his advise how to design the system!. They may consider instrument air and power failures as very remote cases too.

6. Normally closure of SDV is considered as permissive for blowdown not PCV position. PCV may temporarily open when pressurized shutdown is initiated because of pressure fluctuation (sudden closure of SDVs and all) but it will close when pressure is reduced below its set point. Complete depressurization is not expected. Normally PCV set pressure is higher than system pressure at pressurized shutdown condition.

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Saeid R. Mofrad

Principal Process Engineer at Petrofac (P.E.)

Top Contributor

1) Simultaneous opening of fail open PCVs and all BDVs can happen if instrument air fails. To prevent this scenario followings can be done:

- Provide separate air volume bottle for each BDV
- Make flare PCVs fail closed otherwise check the flare capacity for simultaneous opening of all FO PCVs

Note: Total IA failure can be considered a remote (less probable) scenario due to following:

- Number of IA compressors
- IA buffer vessel
- Instrument Air compressor is supplied from emergency diesel generator which will cater the IA requirement during ESD
- IA System is able to cut off non-essential users during low pressure in IA header

2) Simultaneous opening of fail open PCVs and all normally energized (NE) BDVs can happen if electrical power fails; to prevent this scenario followings can be done:

- NE BDV can be supplied from two independent UPS systems (even location of UPS should be different) so that failure of both supplies at the same time is not envisaged.
- Normally de-energized (NDE) BDVs can be added parallel to NE one. Both will be supplied from common UPS and utilized for fire and adiabatic depressurization purposes. In case of total power failure (main power supply and UPS due to any reason) NE BDVs will open only. Flare system capacity shall be checked for all NE BDVs.
- NDE valve can be used with two independent UPS supply systems (even location of UPS should be different) so that failure of both supplies at the same time is not envisaged.
Note: with NDE valves, local fire (around valve) can cause power (cable) failure or instrument (tube) air which finally ends up with non-operational BDV. It is where BDV is more required to depressurize the system. Therefore adequate safety measures shall be taken for reliable functioning of BDV during fire (which may be difficult to achieve).
- Make flare PCVs fail closed or provide two independent UPS supply systems (even location of UPS should be different) so that failure of both supplies at the same time is not envisaged.

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Mojtaba Habibi

Process Engineer at Petroleum Engineering and Development Company (PEDEC)
Top Contributor

Mojtaba

Dear Saeid,

About this point of you "Adding air volume bottle will help to keep BDV functional but not for PCV as it consumes air continuously for operation":

1. Do you mean BDV does not consume the instrument air continuously?
2. The provision of air volume bottles for BDV, make some delay or totally resolve instrument air failure concern for the BDV?
3. What is the sizing criteria (or specification) for volume air bottles to be provided for BDV?

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S M Kumar

Process Design Consultant
Top Contributor

S M

Saeid: Second point in your 2nd comment. "Simultaneous opening of fail open PCVs and all normally energized (NE) BDVs can happen if electrical power fails;" I am unable to understand why electrical failure will pen FO PCVs. Could you elaborate. I thought and as you mention reserves in Inst Air Receiver + Emergency Air Compressor should keep the PCV shut.

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Process Design Engineer

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Mojtaba: Regarding your third comment to Saeid, please find below relevant section from DEP: 3. The design requirements of air volume bottles (a.k.a. secure instrument air buffer vessel) for BDV is mentioned in section 3.2.2 of DEP 32.45.10.10-Gen Feb 2011, which states that "Upon instrument air supply failure, the Secure Instrument Air (SIA) system SHALL [PS] maintain sufficient pressure in the buffer vessel to allow for at least three valve strokes, based on an initial pressure in the SIA vessel equal to the minimum Instrument Air Header pressure."
Further, it is mentioned that "The SIA vessel shall be supplied from the Instrument Air Header via a filter. Two non-return valves shall be installed to prevent back flow from the SIA system in the case of loss of Instrument Air Header pressure. The non-return valves shall be of the ball or poppet type and mounted in the vertical line with flow up and marked as Class 1 on the Process Engineering Flow Scheme. Bleeding devices such as regulators shall not be used downstream of the non-return valves. A low pressure alarm shall be provided to indicate low air pressure in the SIA, set at the minimum pressure that is required for three valve strokes."

Hope that helps.

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**Saeid R. Mofrad**

Principal Process Engineer at Petrofac (P.E.)

Top Contributor

Mojtaba,

BDV needs instrument air just to open and close on demand; it does not consume air continuously. Providing air volume bottle sized for 3 strokes of BDV with conditions / arrangement explained by Lee to prevent BDV from opening in IA failure.

Kumar,

In case of power failure, signal from controller to valve (I to P convertor) approaches Zero. Direct acting I/P convertor which is receiving zero input signal will send opening command to control valve. Providing SIA will help in case of IA failure not power (UPS) failure.

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[Obumneme Uyaemesi](#) likes this**S M Kumar**

Process Design Consultant

Top Contributor

S M

UPS failure? Thanks. Kumar

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**VIMALESH AGNIHOTRI**

Senior Process Engineer at Engineers India Limited

VIMALESH

Dear Kumar, Saeid, Mojtaba and lee,

First of all thanks for such good and elaborated discussion. Now i want to know about the conclusion of discussion?

whether we have to kept PCV as FO or FC?

What is standard practice worldwide for such kind of PCVs?

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**S M Kumar**

Process Design Consultant

Top Contributor

S M

Based on my experience: FO

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**Mojtaba Habibi**

Process Engineer at Petroleum Engineering and Development Company (PEDEC)

Top Contributor

Mojtaba

Dear Vimalesh,

The conclusion depends on your engineering judgments based on above mentioned points.

In my view this should be FC.

I have seen at many Hazop reports that the fail safe position of flare connected control valves are selected as FC because of the points which are explained by Saeid.

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**Saeid R. Mofrad**

Principal Process Engineer at Petrofac (P.E.)

Top Contributor

I have used both FC and FO for control valve to flare. FC is my first option which needs least extra provisions.

FO if it is mandatory by client can be made safe as explained in earlier posts.

To answer Kumar's question about possibility of failure of UPS, it happened during start up of one of our plant when power failure was followed by UPS failure (UPS did not take up). That is why in my company total power (main and UPS supply) failure is the basis for designing control valve to flare and BDV. You follow your company approach or client experience.

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[Obumneme Uyaemesi](#) likes this**Ayrat Burgulakov**

Process Commissioning Engineer

Saeid, is there written recommendation on flare PCV fail-safe positions in API guidelines or other

Ayrat

standards? I have situation where the flare PCVs were added based on HAZOP recommendations, but fail-safe positions were not specified in the same report and have been chosen later by engineer alone.

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Yury Papitsich

Automation and control specialist at PCI Services

1. In this case use only FO FCV/BDV for flare subsystem.

Yury

1. Lack of IA is a "classic" plant ESD.

1. To prevent accidental activation and ESD (instrument failure or loss of power) for "critical" instruments use "voting", based on the data from 2 or 3 transmitters. It is normal practice. Well, you can use SIL2/3.

4. Extra IA line - EXTRA problems/cost with controlling her condition, logic etc.

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Saeid R. Mofrad

Principal Process Engineer at Petrofac (P.E.)
Top Contributor

Ayrat,

API-521 does not have any specific guideline in this regard and as I mentioned before both FO and FC is acceptable in this application if the system is suitably designed for that.

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Ayrat Burgulakov

Process Commissioning Engineer

Thank you for reply, Saeid.

Ayrat

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Farshad Zamiri

Senior Process Engineer at Genesis Oil and Gas Consultants

Farshad

Saeid,

As you know we might have staged (sequenced) flare and blow-down schedule for avoiding oversizing a flare network especially in brownfield projects. As the status of the BDVs are F.O (both in terms of instrument air supply and solenoid valves located on the I.A supply line), if the UPS failure is a credible scenario to consider, then the staging is not possible in any plant and we always have to size the flare for the full release load from all the BDVs. If we consider the solenoid valves as NDE, then in the case of fire, the cables may be damaged and since the solenoid valves have been selected as NDE in this case, they will not cut out the I.A supply to the actuator and so the BDVs will not open. Then what's your recommendation to cover the UPS failure case? Is two completely independent UPS enough to cross-out the loss of 24 V failure from the flaring scenarios?

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