How safe and reliable are your Emergency Shutdown Valves?

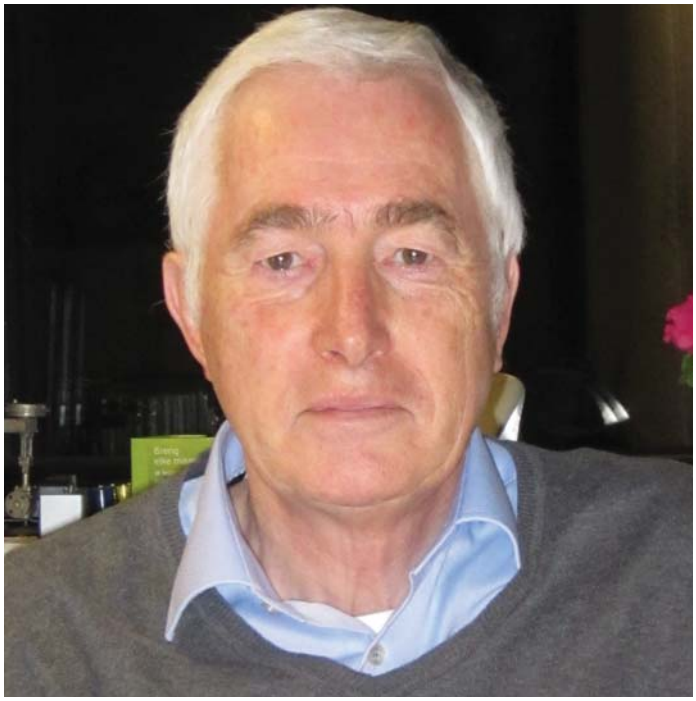
A few years ago, the discovery of a broken actuator spring on an Emergency Shutdown Valve (ESDV) delayed the start-up of a world-scale petrochemical facility. Commissioned to conduct a broad investigation of ESDV reliability, consultant Henk Hinssen has unearthed numerous issues which, he says, need to be addressed in order to improve their reliability and ensure plant safety. Intrigued, Valve World drove down to Belgium to ask Mr. Hinssen about progress to date.

Mr. Hinssen, what exactly is your investigation focusing on?
In a nutshell, a client has commissioned me to assess whether their current approach to emergency shutdown valves in upstream applications is fit for the application.

Just for the record, what types of ESD valves are we talking about?
I'm specifically looking at the trunnion-mounted metal-seated ball valves fitted with spring-return Scotch Yoke pneumatic actuators that are commonly found in upstream applications. But many of my findings can equally apply to valves in downstream petrochemical applications.

How have you set about this project?
As I'm not an upstream engineer the first thing I did was to talk to as many end users as possible about their experiences and also to thoroughly read all applicable standards. I also met with companies making valves and actuators for those applications.

How come we haven't heard of this topic before?
This topic is very well known to end users' organizations like WIB. We have published several documents about them. In summary those ESD valves should be handled as engineering products just as control valves, which is mostly not the case today. In fact, someone commented that ESD system reliability is all about realising a successful marriage between the valve engineer and the actuator engineer and I'd say that is spot on!



Consultant Henk Hinssen wants to open up discussions on Emergency Shutdown Valves

You have been using several terms in this respect, such as ESD, SIS-ABV and SVRP. Can you clarify the differences?
An ESD valve is an emergency shutdown valve. Some branches of engineering refer to this as an SIS-ABV, which is short for safety instrumented systems - automated block valve. I have coined the term SVRP which is short for SIS valve assemblies reliability prediction, as I would like to develop a tool that can effectively size & select those devices based on torque. I say torque, because that's what's needed to move the valve to its safe position.

What kinds of potential problems have you discovered in ESD systems?
Consider the actuator spring for a fail close application, which once compressed might remain energised for up ten years. How do you know it will work on demand? What effect can ambient temperature changes, or particles in the process fluid, or deformation of the elastomeric seats have on the torque required to operate the valve? That's why we need to know torque on demand figures. As a side note, some end users have in fact started to request data on dormancy performance from their valve suppliers.

Don't the valve makers have torque on demand figures?
Not in my general experience. After all, most trunnion-mounted ball valves are manual valves and are fitted with a hand wheel, not an actuator, so torque figures are not relevant for those. Fortunately a number of the valve makers do have such data and are willing to share. I have also obtained an interesting document from the AWWA (American Water Works Association) showing the dynamic torque testing results of butterfly valves. They are currently working on a similar document for ball valves.

Many manufacturers offer valves and actuators with SIL certificates, even up to SIL 3. Surely that's a sufficient indication of the safety?
Read the certificates, and look for the word "torque" anywhere. You won't find it, yet torque is probably the most critical factor in an ESD valve system. So to my mind, SIL ratings are creating a false sense of security in this particular domain.

You have done a lot of research. How are you recording everything?
In a Microsoft Access database. I'm listing all the parameters to size and select those ESD valves, from both the technological as well as the organisational viewpoint. To date I have over 300 parameters or characteristics to deal with. I have assembled experiences and learnings and matched those with those characteristics. This has taken a long time but is throwing up some very interesting points where the experts disagree. These are areas which need further research and I am labelling such cases as "controversials".

Can you give an example of a controversial?
Take the choice of actuator design. Some experts prefer a scotch yoke actuator, whilst others believe a rack and pinion actuator is better. Or a balanced actuator versus a non-balanced design.

What do you mean by balanced?
This refers to the actuator's centre of gravity, which should ideally be in line with the valve stem. Have you ever seen a 1.5 million Nm spring-returned scotch-yoke actuator for a 60" trunnion mounted ball valve? Such a constellation is huge, incredibly heavy and fitted with a very long spring can. So when bolted to the valve the centre of gravity is nowhere near the valve stem, which creates additional challenges, especially torque challenges.

I see you have listed air supply as another controversial. What's the problem here?
Many operators specify the air pressure supply as a range, say between 4 barg and 12 barg. But that is a huge range, making it almost impossible for a manufacturer to design a suitable actuator. If he needs to design the actuator to operate properly at 4 barg but also at 12 barg, then the torque might be so great as to break the valve stem!

What are you going to do with all this knowledge?
Obviously I am providing on-going updates to my client and ultimately I will deliver my recommendations for best practices with their ESD valves. But this is an important critical topic which the whole industry should really be aware of. I am therefore delighted to say I have the go-ahead from my client to discuss my work in general terms with others. For example, I am planning a presentation at the 2016 Texas A&M Instrumentation & Automation Symposium. I'd also like to use the Valve World channels – the magazine, online and face-to-face – to raise awareness about this problem throughout the industry.

Can you give an example of a "best practice"?
Pre-qualification work of both valve maker and actuator maker is essential, whereby you must definitely assess how well they work together. For example, you should ask both parties who will be doing the stress analysis on the drive train. If this isn't properly engineered, it can affect the valve stem. I'd also recommend asking for references, to show that the valve and actuator combination is field-proven.

Your background is in instrumentation. So did you pick up any new valve technology insights from your visit to the valve and actuator manufacturers?
Definitely. For example, I'd never heard of equalizing holes in ball valves. Without an equalizing hole the torque required to operate the valve can jump from 10,000 Nm to 70,000 Nm! Also, I was not aware of the significance between a symmetrical torque curve and a canted torque curve. Again, that is fundamental when specifying a scotch-yoke actuator for tight shut-off duty.

I understand the team at CONVAL have also become involved; I thought they made sizing software for control valves?
Correct, my client has been using that software for a number of years for control valves and requested CONVAL to develop a module to size and select ESD valves based on torque.

Mr. Hinssen, thank you verymuch for discussing details of this very valuable and worthwhile project with us.
My pleasure. However, I would like to add that this is very much work in progress, so if any readers want to share their own experiences and insights as regards ESD valves, then please do get in touch with me via henk.hinssen@gmail.com.