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Control Valve Diagnostics in Safety-instrumented Systems

A Comparison of Architectures

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Control Valves With Diagnostic Functions in Safety-instrumented Systems

A Comparison of Architectures

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Implementing the safety life cycle according to IEC 61511 and IEC 61508 is decisive in preventing systematic failures in field units installed in safety-instrumented circuits. In both these standards, clear requirements for defined procedures, regular testing, documentation of test results, failure analysis and resulting actions are stipulated. These organizational requirements can be effectively supported by state-of-the-art instrumentation. In the field of control valves, the required accessories are readily available on the market. In addition to the higher degree of automation for the validation stages as well as for proof testing and online testing while a process is running, these control valves may even be simpler in their hook-up. Based on the requirements defined in the standards, suitable architectures and their integration into the associated procedures will be presented in the following article.

Keywords: IEC 61511, partial stroke test, proof test, safety life cycle, automated testing, control valves

Methods of testing control valves online while the process is running, such as partial stroke testing (PST), have been discussed much in recent years. During such tests, valves are moved through a certain section of their travel range to verify their proper functioning while the limited travel ensures that the running process is not disrupted. Methods employing mechanical blocking have been around for longer. In these tests, the travel motion is triggered by manually removing the connector from the solenoid valve. Meanwhile, field units have been developed that perform partial stroke tests automatically: in particular, positioners by different manufacturers. This technology is considered mature. The initial concerns, for example that the valves would overshoot and thus disrupt plant operation, have been refuted.

Despite this technical progress and the great potential benefit, the opportunity of online testing is still not used very often. It has become evident that the feasibility and success of online testing depend on the special field units (positioners) themselves as well as on the entire integration into the plant structure and work processes. In the following article, we will present the latest developments in this area.

1. Use in safety-instrumented systems

Publication [1] provides a good overview of the demands placed on diagnostic and test procedures in safety-instrumented systems. A detailed discussion of the effects of partial stroke testing on the probability of failure on demand (PFD), amongst other aspects, can be found in [2]. Publication [3] looks at the categorization of diagnostic and test procedures. On the whole, it is evident that all publications deal with the effects of the test procedure on the rate of random failures. It seems to be more important, however, to understand the entire set of demands specified in IEC 61511 and draw the necessary conclusions concerning test procedures from it. The discussions and publications of recent years were centered around the importance of systematic failures, particularly for final control elements, i.e. control valves [4, 9, 1]. The standard differentiates between systematic and random failures (Fig. 1).

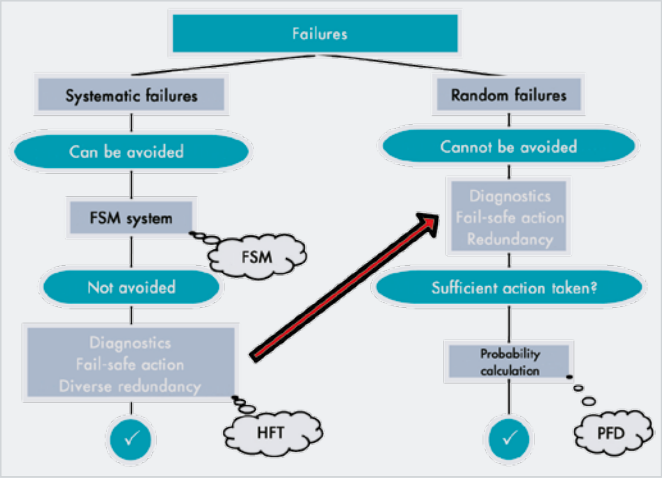

Fig. 1: Causes of failure according to [4]

If the cause of a failure can be pinpointed – and be it after the failure occurred – and appropriate action can be taken to reliably prevent such a failure from occurring again, the failure is systematic. In control valves, areas for systematic failures include proper component selection and sizing to match the specific media, pressures and temperatures as well monitoring the ambient conditions [5]. The major tool for mastering systematic failures is the introduction of a safety life cycle or functional safety management (FSM) system. Fig. 2 illustrates the claim for a structured procedure of systematically following step after step in different stages, such as safety analysis, definition of requirements, definition of sizing, higher-level implementation, validation, operation and maintenance. Publication [4] looks at these aspects in more detail. If all steps are followed, systematic failures can normally be reduced to a minimum. The remaining risk, i.e. undetected systematic failures, is reduced by three mechanism as shown in Fig. 1:

- Diagnostics and tests
- Fail-safe action of the equipment used (if it fails, it must fail to a safe position)
- Redundancy, preferably diverse redundancy

Far from any probability statement, this approach underlines the importance of diagnostics and tests, particularly while the process is running. Safety-instrumented systems are implemented based on the safety analysis. In the vast majority of cases, the control valves installed in these systems are expected to shut off or open a pipeline on demand. Checking the proper functioning of these control valves online while the process is running can expose systematic failures that have remained undetected up to this point. This can be explained by a simple example: If the actuator sizing does not take all operating stages into account, the functional test (validation) of the control valve performed during cold commissioning may well indicate proper functioning. However, only a partial stroke test performed online can really show whether the valve is stuck during a critical operating situation, e.g. due to critical media or improperly estimated pressure conditions at the valve.

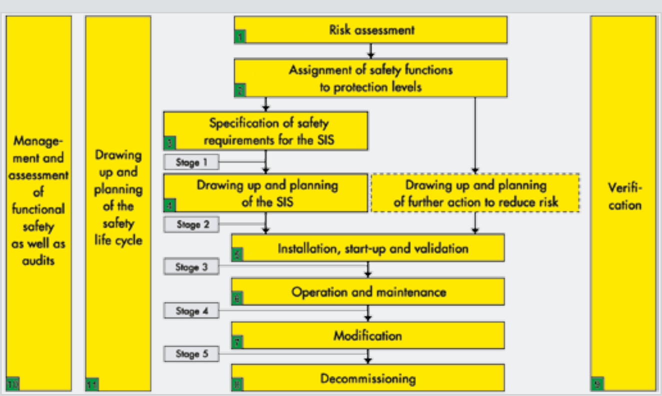

Fig. 2: Safety life cycle according to IEC 61511-1, Fig. 8

According to IEC 61511, sections 15 and 16 as well as VDI 2180-3 and VDI 2180-5 [6, 7, 8], some requirements raised in the safety life cycle and explicitly stated in the standards must be complied with; they include:

- There must be defined, reproducible procedures
- Procedures must be documented
- Test results must be documented, in the case of failure as well as when everything works fine
- Test results must be analyzed and conclusions must be drawn for future improvement
- All operating stages must be taken into account for the test
- Control valves must be tested under operating conditions, particularly at the full operating pressure

The last two requirements in particular are not met when the safety-instrumented system is subjected to a functional test while the plant is shut down, which is often done in practice. On the whole, the list shows that automated testing complies far better with the safety life cycle requirements than manual test procedures assessed by human monitoring. VDI 2180-3, section 2.2.3.2 [7] explicitly demands that equipment for automatic function monitoring (e.g. transit time or position monitoring, plausibility check, step or time monitoring) be used. The requirements placed on the safety-instrumented system must be defined. Based in this, the requirements for the control valve can be deduced. They are as follows:

- Response time: How much time does the valve have to reach the intended fail-safe position upon demand?
- Which leakage rate or cross-section of flow must be reached? This allows requirements for the exact valve position to be deduced.

- Which actuator force or torque must be produced? How high is the required reserve or safety factor that allows all operating conditions and ageing processes to be mastered safely?

Additional requirements may arise based on the specific application [5, 8]. Based on these requirements, diagnostic and test procedures are to be assessed by their degree of diagnostic coverage (DC, proof test coverage). This can be done by performing a failure modes, effects and diagnostic coverage analysis (FMEDA), for example.

An interesting trend can be observed for sensors: as manufacturers are thriving for the highest possible degree of diagnostic coverage, binary monitoring units (e.g. limit switches for filling level, temperature or flow rate) are frequently replaced by analog sensors. This is done because the plausibility of analog signals can be checked more easily, for example by analyzing the noise performance and correlation with process values measured at other measuring locations. In the field of control valves, this would correspond to using an analog position transmitter with continuous measurement over the entire travel range instead of the commonly used inductive limit switches. As far as we know, such a hook-up is very rarely implemented in practice.

Automated tests present themselves for the following stages in the valve's life cycle:

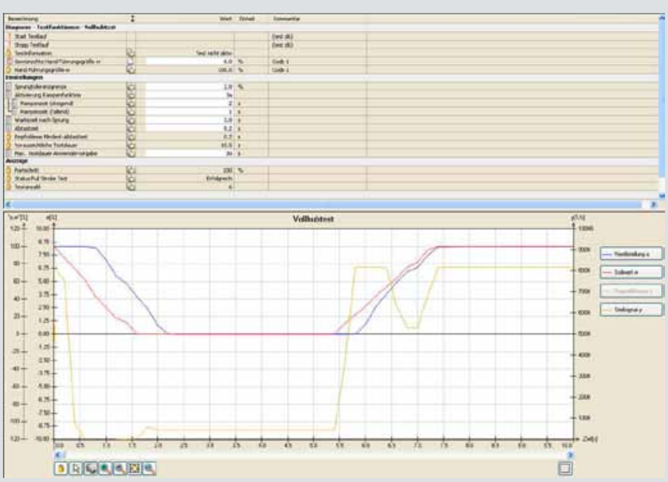

Fig. 3: Full stroke test

- Validation during start-up
- Proof testing
- In-process testing
- Testing during scheduled or unexpected shutdowns

In addition to systematic failures, random failures need to be taken into account as well. In mechanical systems, the cause of failure is usually easily detectable. It can be rooted out by changing the design or process accordingly. As a result, random failures are far less significant in mechanical systems. Reasons for this are discussed in detail in publication [9] for example. The standard [6] demands the use of the tools – diagnostics, fail-safe bahavior and redundancy – for random failures as well. In addition, mathematical (probabilistic) proof of the achieved reliability is demanded.

Accoding to [6], the probability of failure on demand is simply calculated as follows:

Formula 1: $PFD = ½ \cdot \lambda_{du} \cdot T_{PR}$

If a test method, such as PST, with a higher test frequency than the proof test interval is applied, the PFD becomes

Formula 2: $PFD = ½ \cdot \lambda_{du} \cdot (1–DC) \cdot T_{PR} + ½ \cdot \lambda_{du} \cdot DC \cdot T_{PST}$

T_{PR}: proof test interval
T_{PST}: partial stroke test interval
λ_{du}: rate of dangerous undetected failures

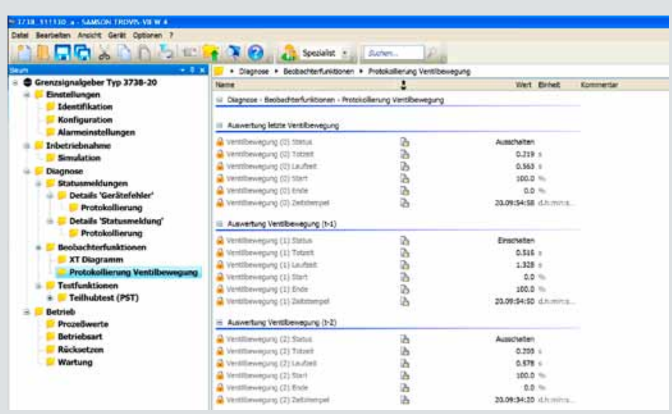

Fig. 4: Logging of valve movements

Fig. 5: Automated valves (left: solenoid valve and limit switch mounted separately, right: state-of-the-art limit switch with integrated solenoid valve)

The formula shows that diagnostic and testing procedures are directly incorporated into the calculation result. As a result, diagnostic procedures can be used to target a longer test interval. This seems to be a realistic approach for many applications, but it must be analyzed for each individual case. The approximate result is that a 50 % test coverage doubles the service life between two complete proof tests during a plant shutdown. Publications [2], [11] and [12] go into more detail on this. This calculated value is only valid when the failure rate is constant. However, if the failure rate increases over the examined period, for example due to wear or ageing, this is the decisive mechanism. For example, to achieve an uninterrupted service life of five years, it is easy to furnish mathematical proof for achieving this service life if the failure rate is low. It must be observed that effects relating to the process, ageing, wear or other mechanisms can impair the constancy of the failure rate that was assumed.

Nevertheless, the statistical data are to be handled cautiously in this context: none of the publications dealing with probability of failure calculation that the authors are aware of includes a calculation of error, which means that the reliability of the calculated values is not assessed in any way. This can lead to be calculated values being trusted without justification. Publication [10] for example mentions that different databases listing the specifications of electronic components often differ by more than one decimal power.

2. Workflow requirements

Field units offer a wide range of diagnostic functions. Their benefit to the users not only depends on the performance they promise, but on how they can be integrated into everyday operation.

We will briefly outline the opportunities for control valves based on the use of positioners or smart limit switches. Fig. 3 shows an automated full stroke test, Fig. 4 an assessment listing parameters. Positioners or smart limit switches can perform such measurements on site as well as record and assess them [11, 12]. Fig. 5 shows two hook-ups: a butterfly valve with solenoid valve and inductive limit switches (left) and a state-of-the-art ball valve with electronic limit switch (right). The parameters for the dead time, the transit time until the valve reaches the end position, the exact measurement of the achieved end position as well as the required actuator force are detected by the integrated travel and pressure measuring system. The results are plotted in the travel vs time diagram and saved in the positioner as characteristic times and values. Moreover, friction forces can be deduced from the stick-slip effect. The stick-slip effect typical of an actuator with high friction would become visible in the travel vs time diagram.

A comparison of these measurements with the demands stipulated in the standard shows that the proper functioning of the control valve within the safety-instrumented system can be assessed thoroughly. The exact degree of diagnostic and test coverage is to be determined individually in each case; one way to do this is to compare the potential sources of failure determined during the risk assessment and the diagnostic features of the field unit used. The moveability of the valve and the exact reaching of the end or intermediate position can be assessed without any problems. Additional measurements may only be necessary when stringent tightness requirements need to be met.

A single test, however, does not mean that this method is integrated into the operating process. Table 1 gives an overview of the sequence of all necessary steps. Apart from the automation of a test, it is of particular importance that the results can be recorded and saved. A database to save the results of all tests performed must be available. Saving and archiving as well as the assessment are particularly important, for an individual test as well as for trending based on several tests or in correlation with other process data. The rows on the left in Table 1 list the necessary steps while the columns to the right contain proposals on how the tasks are to be distributed among the available resources (positioner and asset management system). Of course, the exact distribution of tasks can be discussed; what becomes evident, however, is the necessity of having a higher-level system with greater resources than the field unit.

3. Architectures of the safety-instrumented system

Assuming the availability of a PST-capable positioner, the resulting hook-up of field units is as indicated in Fig. 6a and assessed in Table 2. Following the classic design, the safety-instrumented circuit is equipped with a solenoid valve for emergency shutdown and limit switches to indicate the valve position. The desired PST function is supplied by a positioner that is pneumatically connected ahead of the solenoid valve. The test is started locally at the positioner; the measured data and assessed test results are transmitted to the higher-level asset management system using digital HART® communication. The HART® protocol can be integrated, for example using suitable isolation amplifiers available on the market (for examples see publications [13, 14]). This hook-up has been and still is used in practice; it is suitable for performing the test on site, particularly for the operating staff. In larger plants with many valves and less operating staff, the time and efforts involved in performing the test are a significant drawback. A number of alternative hook-ups is possible; the most favorable is shown in Fig. 6b:

There is no solenoid valve and the positioner is used for emergency shutdown and to perform the test. To implement this hook-up, the positioner must comply with IEC 61508 or IEC 61511 requirements. Such positioners are readily available. With this hook-up, there is less wiring and a greater test depth can be achieved as it includes only one pneumatic unit that also performs the test.

The positioner is connected directly to the safety PLC (Programmable Logic Controller) using a 4 to 20 mA signal. Certified output boards are available on the market.

The HART® protocol is tunneled to the level of the isolation amplifier by the safety PLC without additional patching. In

Steps	Positioner	Asset management system	Assumption
Triggering	Manual or automatic	Manual or automatic	
Method	Ramp or step response		
Real-time recording of results	Travel vs time diagram, coefficients		Real-time data transmission not possible
Reading results from the field unit	Travel vs time diagram, coefficients	Travel vs time diagram, coefficients	
Saving results	Travel vs time diagram, coefficients	Travel vs time diagram, coefficients	
Test assessment	On-site diagnostics	Diagnostics, link to process data	
Alarm generation	On-site alarm generation	Alarm generation and inclusion of process data	
Archiving		Long-term archiving in the database	
Trending over several tests		Comparison of individual results over several tests, diagnostics, alarm generation	

Table 1: Partial stroke testing routine

	Solution A	Solution B	Solution C	Solution D
Safety-instrumented control	Solenoid valve	Positioner	Solenoid valve	Solenoid valve
Partial stroke test	Positioner	Positioner	Solenoid valve	Solenoid valve
Travel feedback	Limit switch	Limit switch, alternatively: transmitter	Limit switch, alternatively: transmitter	Limit switch
Actuator pressure measurement	Positioner	Positioner	Optional: transmitter	
Pneumatic test	No	Yes	Yes	Yes

Table 2: Architectures of the safety-instrumented system

practice, data are mostly transmitted to the asset management system using the existing Ethernet connection between the PLC and the basic process control system (BPCS). Fig. 7 shows the associated circuit diagram. What is special about this architecture is the parallel, simultaneous functioning of the HART® communication. This is much quicker than the serial operation of a multiplexer. The communication functions can be restricted as required. This guarantees that the recorded test results can be read from the field units without accidentally changing the parameter settings.

The most favorable solution shown in Fig. 6b allows diagnostic data to be read and prevents the field unit settings from being changed by mistake. Assessment is based on the following criteria:

- The positioner is powered by standardized signals:
  +20 mA indicate normal operation in end position
  +12 mA indicate the start of a PST
  +4 mA indicate emergency shutdown.
  Certified positioners for reliable emergency shutdown at 4 mA (instead of 0 mA) are readily available on the market.
- Emergency shutdown is also possible while the test is running as the positioner will give it priority.
- The test is triggered by an external signal and performed locally by the positioner. This allows for a high control accuracy while stroking the valve as defined for the test.
- The data as shown in Fig. 3 are recorded and saved in the positioner. As a result, millisecond sampling rates (e.g. for the valve position and actuator pressure) can be achieved, which has a positive effect on the accuracy of the measured values as well and thus ensures a high diagnostic coverage.
- The operator or human-machine interface (HMI) is represented in the safety-instrumented system. This makes it possible to simply save a set of standardized rules for locking and unlocking the safety-instrumented circuit.
- The travel is fed back by an analog signal. This has some benefits over indication by two limit switches: less wiring, a higher measuring accuracy and better diagnostic options.
- In the case of large valves that require a high air capacity from the controlling components, an analog booster (e.g. Type 3755 by SAMSON [15]) can be mounted into the connecting line between the positioner and actuator (dotted line in Fig 6b). Certified boosters are readily available on the market.

Other viable hook-ups need to be explained further:

Fig. 6c shows a hook-up where the performance of the test is completely implemented in the safety PLC: the pneumatic actuator is controlled by the solenoid valve, the control loop controlling the test is closed by an analog position transmitter. To achieve a diagnostic depth similar to solution B, a pressure transmitter to measure the actuator pressure is included. This hook-up offers the benefit that all the rules for performing the test and assessment can be saved in the PLC, which makes the configuration certifiable. A drawback, however, is the lower sampling rate, which may be pushed to under 100 ms when state-of-the-art equipment is used. The sampling rate is important for the achievable control accuracy of the test (overshooting) and the quality of diagnostics. As a result, solution C is preferably used for large valves with transit times greater than 5 s.

Fig. 6b can also be used in the special case where a control valve is integrated into the emergency shutdown routine. This

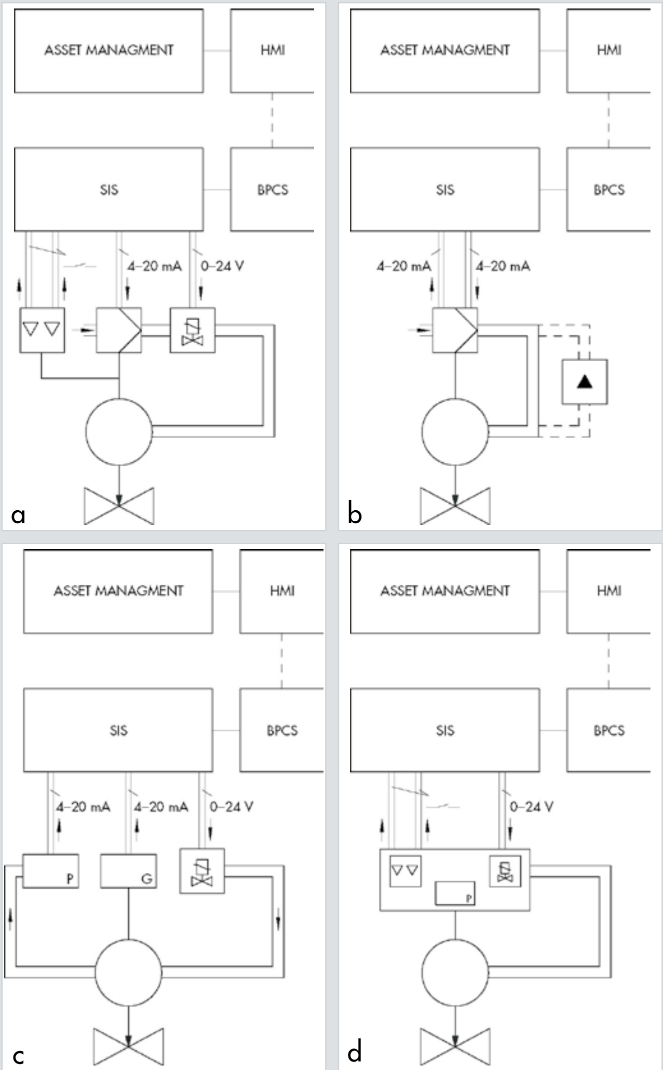

Fig. 6: Possible architectures

integration is frequently encountered in German and European plants. Publication [15] deals with an analysis of the safety-related aspects of this hook-up. As usual, this classic hook-up includes a positioner controlled by the control system and a solenoid valve actuated by the PLC. Two wires need to be installed in the field in this case. According to the figure, a very simple and elegant solution would be possible as well: a positioner could be used for actuation, emergency shutdown and the test. It would be controlled by the PLC only. The necessary control algorithm would have to be saved in the PLC in this case. Examples of such applications are found in excess

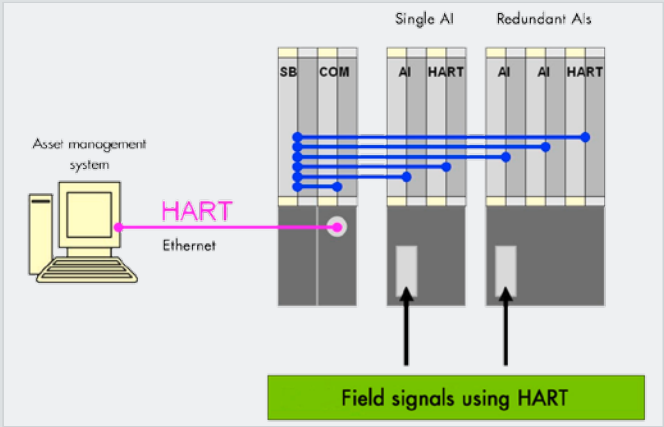

Fig. 7: Tunneling of HART® signals

pressure valves used in turbo machine control or in the burner management in fuel control systems. The PLC is connected to the control system via Ethernet and receives commands from it during normal operation (e.g. a demand). Such applications are also frequently found on the market as the necessary systems are readily available (e.g. HIMax® system with FlexSILon® libraries).

Fig. 6d shows a solution based entirely on the classic signals (NAMUR signal for limit switches according to IEC 60947-5-6, 24 V to energize the solenoid valve). In this case, a device is used that combines the functions of a limit switch and solenoid valve but also possesses diagnostic functions thanks to using analog travel measurement and a microprocessor. The benefit of being able to use the existing wiring is outweighed by having to do without communication as there is no standardized protocol for this kind of signal transmission. Nevertheless, it is possible to transmit the internal diagnostic results (e.g. a canceled PST) by a status contact (NAMUR signal) to the higher-level control system (also see [16]).

Table 2 provides a short summary of the different architectures. All solutions have in common that they employ components that are readily available on the market and can also be used outside the safety-instrumented system. As a result, the use of components that are proven in use – as demanded by plant operators – is possible [17]. In this article, we do not deal with tailored, manufacturer-specific instrument hook-ups that use proprietary architectures and wiring. A fieldbus protocol, such as PROFIBUS or FOUNDATION™ fieldbus, can be used instead

Fig. 8: SAMSON Type 3755 Volume Booster

of the HART® protocol. According to the latest developments in this field, however, the safety-related signals still need to be transmitted over discrete wiring.

4. Integration into the processes on site

Table 1 lists the necessary steps to be performed. Experience with some initial installations have shown that individual tests on field unit level can be performed without any problems and produce reliable results. If, however, a large number of units in a large plant is to be tested at regular intervals, the main problems arising are the following:

- The rate for transmission of the test results saved locally in the field units does not meet the requirements. With the current state of the art, it does not seem to be possible to read complete data records from a large number of units once weekly, let alone daily. This limitation is less due to the communication protocol used (HART®); rather, it is caused by the entire architecture of the control system. Of course, the data transmitted to uphold operation need to have priority over diagnostic data.
- Assessment options: asset management systems are available from different manufacturers. They allow field unit records containing diagnostic data to be read and saved. However, there is no satisfactory solution available yet that allows isolated measured values to be viewed and linked to other measured values using a definable algorithm. For example, it may be necessary to indicate the measurement history of a value (e.g. the valve’s zero position) recorded over several tests (Fig. 8). In practice, it does not seem to be possible yet to link a value with process data collected by other field units (e.g. to check the plausibility of the valve position versus the flow rate). Table 1 gives an overall overview of the necessary steps and how they can be distributed among the field unit and the higher-level asset management system. The field unit is in charge of quick data recording and on-site control. It is better to have the higher-level system perform the long-term archiving, trend assessment and complex alarm management as the processing speed and memory capacity are limited by the energy consumption. The system can also process data from different units and assess them based on device-unspecific criteria.

5. Summary

In field units installed in safety-instrumented systems – particularly if they are in direct contact with the process medium –, the probability of failure on demand is determined by how systematic failures are handled. The necessary implementation of the safety life cycle can be supported by using state-of-the-art instrumentation. Thanks to modern field units and safety-related control mechanisms, effective yet simple architectures can be implemented using components that are readily available on the market. Further developments need to be made in asset management systems concerning the data transmission rates and functionality to allow the diagnostic tools integrated into the field units to fully display what they are capable of doing. It seems that this cannot be achieved unless manufacturers and operators cooperate closely in selected pilot projects.

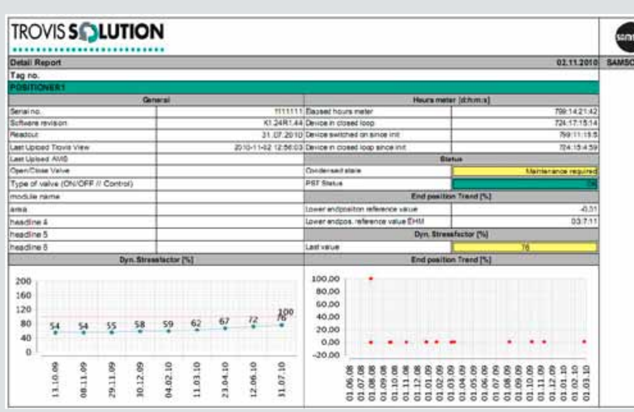

Fig. 9: Zero point trend

Bibliography

1. Rogiers, I.: Using a "Smart" Partial Stroke Test Device on SIS Loop On/Off Valves: Adding Value or Adding Cost? P4039, Valve World 2004. KCI Publishing BV
2. Börcsök, J., Schrörs, B., Holub, P.: Reduzierung der Ausfallwahrscheinlichkeit und Verlängerung des Proof-Test-Intervalls durch Einsatz von Partial-Stroke-Tests am Beispiel von Stellgeräten (German only: reducing the probability of failure and extending the proof test interval using partial stroke testing exemplified on control valves). atp – Automatisierungstechnische Praxis 11/2008
3. McCrea-Steele, R.: Partial Stroke Testing: The Good, the Bad and the Ugly. Seventh International TÜV Symposium on Safety 2006
4. Götz, A., Hildebrandt, A., Karte, T., Schäfer, B., Ströbl, J.: Implementation of Safety-instrumented Systems in the Process Industry – SIL in Practice, special print by SAMSON AG of article "Realisierung von Schutzeinrichtungen in der Prozessindustrie – SIL in der Praxis", atp – Automatisierungstechnische Praxis 8/2008
5. SAMSON AG: Competence in Functional Safety – Functional safety of globe valves, rotary plug valves, ball valves and butterfly valves, WA 236
6. IEC 61511-1 and IEC 61511-2: Functional safety – Safety instrumented systems for the process industry sector, parts 1 and 2. May 2005
7. VDI 2180-3: Safeguarding of industrial process plants by means of process control engineering - Plant engineering, realisation and operation. April 2007
8. VDI 2180-5: Safeguarding of industrial process plants by means of process control engineering (PCE) - Recommendations for practical use. May 2010
9. Hildebrandt, A.: SIL-Bewertung von Mechanik – Versagenswahrscheinlichkeit mechanischer Komponenten (German only: SIL assessment of mechanics – failure probability of mechanical components). atp – Automatisierungstechnische Praxis 1-2/2011
10. Smith, D.: Reliability, Maintainability and Risk. Elsevier Butterworth-Heinemann, Burlington, MA 01803, Sixth Edition 2001
11. Karte, T., Kiesbauer, J.: Smart Valve Positioners and Their Use in Safety-instrumented Systems, Industrial Valves 2009
12. SAMSON AG: Competence in Functional Safety – Application notes for safety-instrumented systems, WA 239
13. Pepperl + Fuchs specification sheet: Solenoid Driver KFD2-RI-Ex1. Edition 2010-04-13. Document 216568_GER.xml
14. Pepperl + Fuchs specification sheet: HART Loop Converter KFD2-HLC-Ex1.D. Edition 2011-01-26. Document 198804_GER.xml
15. SAMSON AG: Type 3755 Volume Booster, Data Sheet T 8393, September 2009
16. Gabriel, T., Litz, L., Schrörs, B.: Nutzung von SIS-Armaturen für Leitsystemfunktionen – Rahmenbedingungen für die Ausführung von BPCS-Funktionen (German only: use of SIS valves for BPCS functions – conditions for executing BPCS functions). atp – Automatisierungstechnische Praxis 3/2010
17. Karte, T., Kiesbauer, J.: Smart Limit Switch for On/off Valves in Process Engineering. Special print by SAMSON AG of the German article published in atp – Automatisierungstechnische Praxis 5/2009
18. Hablawetz, D., Matalla, N., Adam, G.: IEC 61511 in der Praxis – Erfahrungen eines Anlagenbetreibers (German only: application of IEC 61511 – experiences of an operational company). atp – Automatisierungstechnische Praxis 10/2007
19. SAMSON AG: Type 3730-3 Electropneumatic Positioner, Data Sheet T 8384-2, February 2012

Appendix

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