Stephan Wolbeck, ROSEN Technology & Research Center, Germany, explains flexible and danger-free inline inspection based on an ATEX-compliant safety concept.

SAFETY FIRST

The need for explosion protection first emerged in the mining, chemical and manufacturing industries of nineteenth-century Europe. Today, the most important requirements on explosion protection are laid down in two ATEX directives: device directive ATEX 95 (94/9/EC) and occupational safety directive ATEX 137 (1992/92/EC). ATEX classifies precautionary measures into primary, secondary and tertiary explosion protection respectively involving the complete avoidance of explosive atmospheres, specific avoidance of ignition sources, and mitigation of the effects of an explosion. Within this classification, explosion-proof devices, including inspection tools and their equipment, are assigned to secondary explosion protection (ATEX 95), because such devices are used in conditions where primary explosion prevention is not feasible. As part of secondary explosion protection, devices are selected on the basis of the defined Ex zone (see below) and the gas composition within the explosive atmosphere.

Classification of explosive atmospheres

Measures to safeguard against explosions are classified as primary, secondary and tertiary. If the primary measure does not prevent the formation of a hazardous and explosive atmosphere, the zones with an explosive atmosphere are divided into Ex zones 0, 1 and 2 respectively. This subdivision is based on the duration of the presence of a potentially explosive atmosphere and the typical situations in which ignition sources must be avoided. Thus, Zone 2 designates an area where ignition sources must be avoided merely under conditions of trouble-free (i.e., normal) operation. Zone 1 refers to a more dangerous section where, in addition to normal operation, ignition prevention must also cover foreseeable malfunctions. Aiming at preventing explosions in the most dangerous scenario, Zone 0 is defined as an area in which preventive measures against ignition of any type must be effective under normal operating conditions, in case of foreseeable malfunctions and even in the event of rarely occurring malfunctions.

Due to its strict requirements, it is difficult to obtain devices and protective equipment for Zone 0 – which as a general rule only exists within pipes and containers such as tanks – and to take and document the appropriate explosion prevention measures for this zone. In general, defining the zones in actual applications can be a very complex task, despite their clearly defined classification. It is therefore imperative that in demarcating zones operators never lose sight of the overall objective of classification, which is to reduce to the greatest possible extent and with the most efficient means available the probability that a potential ignition source becomes active.

In the UK and Germany, for example, operators of tool launchers and receivers must follow especially strict rules, as areas close to tool openings are considered to pose increased explosion risks.[2, 4] Since regulations such as Germany's technical rule for pipelines (Technische Regel für Rohrfernleitungen, TRFL) may, under certain circumstances, be too specific in laying down what devices and protection systems must be used, operators may, in justified cases, be exempt from such specifications and even use devices that do not comply with the ATEX 95 directive, provided that "suitable organisational measures ensure safe operation for the whole period in which the mobile equipment is used in a hazardous place."[1] Such safe operation cannot be achieved without specialised personnel, nor without meticulous documentation of all implemented measures. So-called zone shifting, whereby explosive atmospheres are neutralised temporarily by means of suitable measures such as inertisation or ventilation, provides an alternative method for dealing with potential ignition sources.

An innovative safety concept

The task of inspecting explosive assets makes conflicting demands on operators. On the one hand, they must comply with the universal yet strict requirements laid down in the ATEX regulations and national laws. On the other hand, each concrete application makes different demands in terms of the required measurement technologies and the environmental conditions (transport medium, pressure, temperature, run duration, and wall thickness etc.) of the asset to be inspected. Thus, the ATEX 95 device directive, for example, requires manufacturers to be extremely careful in the development and production process and to document all aspects of it. The ATEX quality standard EN 13980 lays down additional detailed requirements and standards to ensure that the products match the certified types. At the same time, the great variety of different asset conditions means that specific requirements can only be met on the basis of customised technical solutions, to the extent where it is not uncommon for a tool to be used in a specific configuration only once before being altered again.

ROSEN has developed an ATEX-compliant safety concept, which overcomes the tension between the rigid universal standards and the operational flexibility needed for successful and safe inspection. Covering the entire tool fleet from 6 to 56 in. and permitting individual configurations, this solution accommodates a very wide variety of different pipelines and containers. The concept is based on the separation of a tool into two parts: its constantly active and temporarily inactive electronic components (Figure 1).

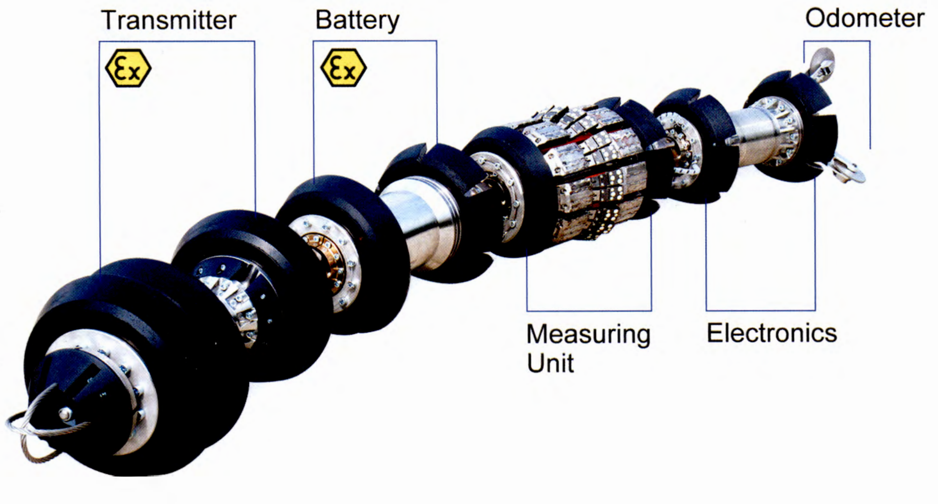

Figure 1. Ex-protected segments of a multi-part inspection tool.

When the tool is in an Ex zone during launching and/or receiving, the entire electronic inspection measurement technology is turned off. Since the power supply from the batteries and the tool status transmitter continue to be electronically active, they are Ex-protected by a type of ignition prevention, which complies with ATEX standards. Because this solution does not require any change in measurement technology, there are virtually no functional constraints, i.e., the usual standards of inspection quality can be maintained. Within the Ex zone, the status of the tool is permanently monitored by means of an intrinsically safe electronic status monitor to ensure ignition protection at all times for both the tool itself and all required supporting equipment.

Despite the fact that tool launching and receiving clearly poses greater dangers, neither of the two ATEX directives specifically address this issue. They only refer to atmospheric conditions with a pressure of between 0.8 and 1.1 bar and an ambient temperature range between -20 °C and 60 °C.[5] However, immediately after the launcher has been closed after tool launch and the flammable medium has been let in, an explosive mixture is likely created, notably if the launcher was not rinsed with nitrogen or another inert gas beforehand. In such a situation, the pressure quickly rises above the atmospheric pressure, so that the conditions are outside of the application range specified in the ATEX directives.

Since this increase in pressure absolves neither the facility operator nor the inspection tool manufacturer of their responsibility for safe inspection, a comprehensive safety concept must assess all known risks. The phase of pressure increase during launching must therefore form an explicit part of a safety concept to guarantee Ex protection for the tools. Interpreting the safety concept accordingly, ROSEN's solution ensures that the measurement technology of the tool is switched on only once the atmospheric oxygen concentration in the launcher has dropped to a degree where the gas/air mixture is no longer flammable. For additional safety, the switch-on pressure for gas of Gas Group IIB (the most common types of gas found in pipelines) is calculated on the basis of the most unfavourable ratio between the medium and oxygen, which is still capable of ignition.

Devices to be used in Zone 1 must never constitute an ignition source, even in case of foreseeable and unforeseeable malfunctions. This aspect too is taken into account by the ROSEN safety concept for higher pressure levels: it allows, for example, for the possibility of an explosive gas mixture entering the tool enclosure through holes or gaps. A specially developed status monitor provides reliable information on maintaining ignition protection and on safe turning on and off of the tool during the launching and receiving process. If the status monitor indicates that ignition protection is no longer guaranteed, this calls for a joint decision by the asset and tool operator.

Key inline inspection success factors

As the description of the complex task of explosion protection in potentially explosive atmosphere shows, effective protection is possible only on the basis of careful co-ordination of activities and effective communication between all parties involved in tool operation. It also follows that ensuring the safety of personnel and assets is a task that goes far beyond zone classification and device category. Because careful co-ordination between the operator, the service provider and other independent task forces is indispensable in preventing potentially dangerous situations and information on specific forms of conduct, the use of work tools, and wearing personal protective equipment is essential, exchange of information and co-ordination of activities form an explicit requirement of ATEX 137.

The process of drawing up an explosion protection document in compliance with ATEX 137 provides operators with an important template for tasks and duties aimed at ensuring the safety of explosive areas within their assets. This document should contain the following information: first, a detailed description of the workplace and work areas; second, a clear outline of the various procedural steps and/or activities to be taken; third, an overview of the substances used (including gas and temperature class); fourth, a summary of the results of any risk assessment conducted; and, finally, a list of technical and organisational explosion protection measures and their implementation.[1] This information allows the service provider to select trained personnel with the required skills and to have suitable work tools and protection equipment ready. If the required work tools are not available, it is possible to determine, on the basis of joint risk assessment, whether additional safety measures such as inertisation need to be taken.

Conclusion

As outlined in this article, effective explosion protection is by no means limited to mere compliance with ATEX and other directives. Over and above ensuring such compliance, ROSEN's innovative safety concept guarantees safe and efficient inline pipeline inspection by taking into account different asset environments and inspection tasks, by making allowance for high-risk zones such as pipeline opening fixtures, and by providing suitable devices even for highly unusual applications. However, the successful implementation of this safety concept also calls for adequate personnel training, co-ordinated activities and transparent communication between all parties involved in in-line inspection. Given the complex nature of the task, then, a holistic view of asset integrity management is essential for effective protection in explosive atmospheres. **WP**

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