APPLIKATIONER MED SIKKERHEDSFUNKTIONER

Dr. Jörg Isenberg, 2016-06-16
Buncefield wasn’t the only major industrial incident:
- Grangemouth Refinery, UK (1987)
- Jaipur Refinery, India (2009)
- Texaco Refinery Milford Haven, UK (1994)
- Deepwater Horizon, Golf von Mexico (2010)
- Piper Alpha, Northsea (1988)
- ...

What can be done to prevent such incidents?
COMPREHENSIVE SAFETY CONCEPT

Avoidance of major industrial incidents:
- Comprehensive concept for components in safety applications
- ...

Comprehensive safety concept for components:
- Explosion protection

Il 2 G Ex de IIC T4
Avoidance of major industrial incidents:
- Comprehensive concept for components in safety applications
- ...

Comprehensive safety concept for components:
- Explosion protection
- Fire-proof components

30 min @ 1100°C
Avoidance of major industrial incidents:
- Comprehensive concept for components in safety applications
- ...

Comprehensive safety concept for components:
- Explosion protection
- Fire-proof components
- Functional safety

SIL 3 capable (1oo2) according to IEC 61508 ed.2
COMPREHENSIVE SAFETY CONCEPT

Avoidance of major industrial incidents:
- Comprehensive concept for components in safety applications
- ...

Comprehensive safety concept for components:
- Explosion protection
- Fire-proof components
- Functional safety
- Fail-Safe

Performance an operation into a safety / fail-safe position without external energy supply
They are both reactions with oxygen
<table>
<thead>
<tr>
<th></th>
<th>Rate of combustion</th>
<th>Pressure rise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion</td>
<td>can hardly be measured</td>
<td>none</td>
</tr>
<tr>
<td>Combustion</td>
<td>0.001 m/s</td>
<td>none</td>
</tr>
<tr>
<td>Explosion:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deflagration</td>
<td>&lt; 330 m/s</td>
<td>1-10 bar</td>
</tr>
<tr>
<td>Detonation</td>
<td>&gt; 1000 m/s</td>
<td>&gt; 20 bar</td>
</tr>
</tbody>
</table>
How can we achieve explosion protection?

Eliminating one of the three components needed for an explosion:

- Fuel
- Oxygen
- Ignition source

Avoiding an ignitable mixture of fuel and oxygen

⇒ primary explosion protection

Avoidance of ignition sources

⇒ secondary explosion protection

Oxygen in the air
Oxygen in chemical compounds

Flammable gases
Flammable vapours
Flammable dusts

Ignition sparks
Hot surfaces
Electrostatic discharges
Chemical reactions
Explosions-proof equipment is inspected and approved according to its use for the following classifications:

- Zone
- Explosion groups
- Temperature class
**Explosion Protection**

Classifications according to zone system and division system:

<table>
<thead>
<tr>
<th>Explosion protection</th>
<th>Flammable substance</th>
<th>Presence of a potentially explosive atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Continuously or for a long period</td>
</tr>
<tr>
<td>Zone system ATEX/IECEEx</td>
<td>Gases</td>
<td>Zone 0</td>
</tr>
<tr>
<td>ATEX/IECEEx</td>
<td>Dusts</td>
<td>Zone 20</td>
</tr>
</tbody>
</table>
### Classification of flammable substances (zone system):

<table>
<thead>
<tr>
<th>Explosion group</th>
<th>Temperature class (maximum permissible surface temperature)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1 (450 °C)</td>
</tr>
<tr>
<td>Zone system</td>
<td></td>
</tr>
<tr>
<td>I (Mining)</td>
<td>Methane</td>
</tr>
<tr>
<td>II A</td>
<td>Acetone, Ethane, Ammonia, Ethyl acetate, Benzol, Acetic acid, Methanol, Carbon monoxide, Naphtelene, Phenole, Propane, Toluene</td>
</tr>
<tr>
<td>II B</td>
<td>Town gas</td>
</tr>
<tr>
<td>II C</td>
<td>Hydrogen</td>
</tr>
</tbody>
</table>
Almost all AUMA products are also available in an explosion-proof version
Products for class IIB T3, IIB T4 and IIC T4 available
Products available with worldwide Ex-certifications (ATEX, FM, CSA, IECEx, …)
Simple and uniform integration into DCS by combination with AMExC and ACExC control units

**Multi-turn actuator**
SA(R)Ex 07.2 – 16.2

**Multi-turn actuator**
SA(R)Ex 25.1 – 40.1

**Part-turn actuator**
SQEx 05.2 – 14.2

**Gearboxes**
GS 50.3 – 630.3, etc.
ACTUATORS IN FIRE-PROOF VERSION
Plants and processes with potentially flammable substances ⇒ fire can cause severe damage (Casualties, Environmental disaster, financial loss)

Event of fire ⇒ immediately stop discharge of flammable substances

Actuators must be reliable during and after fire (high temperatures and pressures) ⇒ Tested e.g. according to UL 1709 (30 min. at 1,100 °C)
Fireproof version

- Special fireproof coating
- Available for all explosion-proof AUMA actuators
In case of fire, the coating protects both actuator and actuator controls

- In case of fire, the fire resistant coating K-MASS coating expands
- The foam reacts and protects the device against high temperatures.
- Heat is reflected
- The internal temperature is max. 70 °C (external: up to 30 minutes at 1,100 °C)
- After the fire, the coating has to be renewed
FIREPROOF AUMA ACTUATORS: K-MASS

K-MASS
direct coating to each single part
FIREPROOF AUMA ACTUATORS

Result after 30 min. at 1,100 °C:

- Actuator and actuator controls fully functional in spite of fire
- After the fire, the fire protection is no longer effective and the device must be replaced

Logic board AM controls

Local controls board AM
FUNCTIONAL SAFETY
Functional Safety (FS)

- Process facilities and machinery represent a danger for humans and the environment if the basic process control system (BPCS) fails.
  - Power stations
  - Chemical industry
  - Oil and gas production and distribution
  - Car

⇒ Safety system desirable that **automatically** recognizes dangerous conditions and **automatically** sets the facility in a safe state

⇒ **Functional Safety**
WHY CARE ABOUT FUNCTIONAL SAFETY?

History:
- Industrial accidents in 20th century:
  - Automatic safety systems desirable
- IEC 61508 (1998):
  First international standard
- Process industry: IEC 61511

Today:
- Often required by authorities
- Often required by insurance companies
- State-of-the-art
A Safety Instrumented System (SIS) always contains the components sensor – logic – actor
Safety instrumented systems are classified in 4 different safety levels (SIL 1 to SIL 4) with SIL 4 being the highest and SIL 1 the poorest.

- **Basic idea:** The lower the probability that the safety system fails when required the higher the safety (level).
- **Main (not only!) criteria:** Probability of Failure on Demand (PFD).

<table>
<thead>
<tr>
<th>SIL</th>
<th>Probability of Failure on Demand of safety function (Type of duty: Low demand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIL 4</td>
<td>&lt; 10^{-4}</td>
</tr>
<tr>
<td>SIL 3</td>
<td>&lt; 10^{-3}</td>
</tr>
<tr>
<td>SIL 2</td>
<td>&lt; 10^{-2}</td>
</tr>
<tr>
<td>SIL 1</td>
<td>&lt; 10^{-1}</td>
</tr>
</tbody>
</table>
Safety instrumented systems are classified in 4 different safety levels (SIL 1 to SIL 4) with SIL 4 being the highest and SIL 1 the poorest.

**Basic idea:** The lower the probability that the safety system fails when required the higher the safety (level).

**Main (not only!) criteria:** Probability of Failure on Demand (PFD).

<table>
<thead>
<tr>
<th>SIL</th>
<th>Risk reduction factor (Type of duty: Low demand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIL 4</td>
<td>&gt; 10,000</td>
</tr>
<tr>
<td>SIL 3</td>
<td>&gt; 1,000</td>
</tr>
<tr>
<td>SIL 2</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>SIL 1</td>
<td>&gt; 10</td>
</tr>
</tbody>
</table>
SIL of a SIF always depends on 3 criteria:

- Probability of failure on demand (PFD)
- Systematic capability (avoidance of systematic errors)
- Architectural constraints (robustness of system)

The SIL achieved is the **lowest** SIL achieved by any of these 3 criteria!

**Example:**

- Probability of failure on demand (PFD) ⇒ SIL 2
- Systematic capability ⇒ SIL 3
- Architectural constraints ⇒ SIL 1
- i.e. achieved SIL for this SIF ⇒ SIL 1
Electric actuators by AUMA can be used in safety-related systems up to SIL 3 (depending on device, version and configuration)

Safety parameters and SIL capability were determined by internationally renowned test institutes (TÜV, exida)

Comprehensive documentation

Technical support in choosing the right actuator and controls configuration for the specific safety application
Overview of AUMA products with SIL capability:

<table>
<thead>
<tr>
<th>Product</th>
<th>SIL 1</th>
<th>SIL 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA.2 (NORM)</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>SA.2 with AM(^1)</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>SA.2 with AC .2-SIL</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>SA.2 with AC .2(^1)</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>SQ.2 (NORM)</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>SQ.2 with AM(^1)</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>SQ.2 with AC .2-SIL</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>SQ.2 with AC .2(^1)</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>End position feedback (SA.2 &amp; SQ.2)</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>GS(^1), GST, GK 10.2 – GK 25.2</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)in assessed configurations only

(for AC .2 controls (standard) and AM, safety parameters and Declarations of Incorporation are wiring diagram specific. Not all wiring diagrams are released.)
Two different categories of AUMA products for Functional Safety:

⇒ Safety figure calculated products (SFC)
  - For comparably low functional safety requirements
  - Calculation of safety figures verified by exida
  - Economically priced & high flexibility (functions, WDs)

⇒ AC .2-SIL: TÜV certified High End Products
  - For highest functional safety requirements
  - With external certificate
  - But: higher price, lower flexibility
AC01.2/ACEXC01.2 IN SIL VERSION

Certificate
No. SEBS-A.1044A14 V1.0
TÜV NORD Systems GmbH & Co. KG hereby certifies
AUMA Riester GmbH & Co. KG
Aumastraße 1
72379 Mühlacker, Germany
that the electric actuator system with the actuators SA(R)07.1 – SA(R)16.2/SAR/E07.1 – SAR/E16.1/SAR(R)/E07.2 – SAR(R)/E16.2/SARM/E07.2 – SAR(R)/E16.2 and SQ/R05.3/SQ/R14.2/SQ/R05.3/SQ/R14.2/SQ/R05.3/SQ/R14.2/SQ/R05.3/SQ/R14.2 with the actuators AC01.2/ACEXC01.2 is capable for safety related applications up to SIL 3 and meets the requirements listed in the following standards:

- DIN EN 61508: 2011 part 1 and part 2

SIL 3 can be reached in a four-channel and SIL 2 in a two-channel architecture.

Base of certification is the report SEBS-A.1044A14V02 in the valid version.

This certificate entitles the holder to use the pictorial safety approved mark.

Valid until: 2020-01-23
File referenced: 0118327650

Hamburg, 2015-11-21

Bianca Pfaff

TÜV NORD Systems GmbH & Co. KG
Ogle-Broadhead, 21, 30539 Hannover, Germany

Please note that this certificate is valid only under the following conditions:

AC01.2/ACEXC01.2 IN SIL VERSION

AUMA Solutions for a world in motion
FAIL-SAFE
FAIL-SAFE ACTUATORS

Conventional solution:

- Spring based, actuated / loaded by hydraulic or pneumatic system
  ⇒ high maintenance demand particularly with hydraulic systems
- Usually round wired springs are used
  ⇒ non-constant force
  ⇒ Oversizing of spring necessary
- Spring is always loaded / unloaded during standard operation
  ⇒ mechanical wear / reduction of lifetime
  ⇒ Oversizing of actuator
What do we consider important for a mechanical fail-safe actuator?

- Constant torque
  ⇒ reduced stress for actuator & valve
- No loading / unloading of spring during standard operation
  ⇒ reduced oversizing
  ⇒ reduced wear
- Flexible operation time to avoid water hammer

⇒ The spring is the critical element!!!
AUMA FAIL-SAFE UNIT

AUMA Fail-Safe Quarterturn Mechanical
FQM 05.1 – FQM 12.1 und
FQMEEx 05.1 – FQMEEx 12.1
AUMA FQM – DESIGN PRINCIPLE

- Constant force spring motor
- Differential gear
- Mechanical end stop
- Power supply unit
- Solenoid and toggle lever
- Solenoid switch
- Motor for spring loading
- Limit switches
KRAFT-/HUB DIAGRAMM FÜR FEDERTYPEN

Spring washer / round wired spring

- Loss of spring strength ≈ factor 2
- Safety margin
- Spring sizing value
- Required valve torque

OPEN

CLOSE

90°
Special constant force spring (patent pending)

Loss of spring strength \( \approx 10\% \)

Safety margin

Required valve torque

Spring sizing value
Comprehensive safety concept for components in safety applications:

- Explosion protection
- Fire proof components
- Functional safety
- Fail-Safe – but with the “right” spring 😊
Functional Safety Conference
Marienlyst Beach Hotel, (DK-Helsingør)
May 3-4, 2017
SIGN UP NOW
www.fscph.com
Understanding risk - your responsibility