Application Report

Top priority: no injuries!

Safety engineering for a crash simulation system at Continental

Risk assessments for machine safety and occupational safety in the spirit of the applicable machinery directive are complex processes that require extensive specialist knowledge. Just the range of standards and directives with constant changes keeps machine and system construction companies and operators on the go. Continental Safety Engineering International in Alzenau obtained the support of the safety experts from Leuze electronic for the implementation of a suitable safety concept for a crash simulation system and the required CE certification.

Alzenau, Continental Safety Engineering, crash simulation system: the hall that houses the catapult system, referred to in industry jargon as a sled system, is empty of people. With concentration, the employees look out upon the test system from the control room protected by a pane of bullet-proof glass. Ready for release, the system operator begins his countdown: 5 – 4 – 3 – 2 – 1 – fire!
Barely has he uttered command, and already everything is over. This applies both to the recording of test-relevant data, which is completed after just 100 to 150 milliseconds, as well as to the high hazard potential with respect to machine safety and occupational safety. Depending on acceleration and mass, everything stands still after no more than 1 to 1.5 seconds.

"That is precisely the reason for the high classification according to Performance Level d, namely the short exposure time to the hazard during which serious, but usually irreversible, injuries including death can occur. In the classification, the possibility for avoiding the hazard under certain conditions is taken into account," explains Martin Kahlert, the team leader responsible for the sled system.

Accident- and injury-free operation as a goal

The crash simulation system is part of a complete test infrastructure based on the state of the art with which Continental Safety Engineering International – a subsidiary of the international automotive supplier, Continental – has committed itself to the development of systems for active and passive vehicle safety (figure 1). The vision of one of the leading system-development and test-service providers is accident- and injury-free operation. In addition to the test track – the Continental Safety Park – a vehicle crash system and the crash simulation system mentioned at the start of the article are at the center of the facilities.

While the vehicle crash system accelerates or drives vehicles or vehicle prototypes against a crash block, moving barriers or other vehicles (figure 2), the crash simulation system, in the form of a servo-hydraulic, controlled sled system, is used to perform tests without destroying expensive vehicles. Typical applications of the sled system include the development and testing of frontal, side and head air bags, vehicle and child seats, belt systems and other interior components (figure 3). Furthermore, the system is also used for realistic testing of components such as high-voltage batteries, locks, hinges and mounting brackets for load restraint.

"In the sled system, we realistically recreate deceleration processes from complete vehicle tests, basically as an inversion function by accelerating a sled with the appropriate test setup," explains Kahlert. The data from deceleration processes acquired during crash tests are used as acceleration definitions for the sled with the test object, which is accelerated from a standstill by a pneumatic working cylinder. Explained in simple terms, this is as if one would catapult a crash block against the car body instead of a car body against a crash block. In this way, frontal, side and rear-end crashes can be simulated with reproducible parameters. Kahlert speaks here of pulse reproducibility – with values better than ±1 g and 0.1 m/s , complex acceleration processes are recreated and implemented with a servo-hydraulic plunger brake unit. During a test, the acceleration of the sled is measured constantly. These signals serve as control variables for controlling the system in order to achieve optimum agreement with the specification.

Life-threatening danger with no time to respond

An acceleration distance of 1,700 mm suffices in the sled system. This path represents the maximum distance on which in a real crash vehicle deformation results from the impact with the bumper until standstill. At this distance, a nominal force of 2,500 kN is available which is used to catapult a maximum test weight of 3,000 kg plus the weight of the sled and piston - 1500 kg, - at 60 times the acceleration due to gravity. In this short time, sled speeds of up to 90 km/h are reached. The accelerations of the enormous masses for the simulation tests occur in just milliseconds, from zero to a maximum value. If an employee were to be present in this area, he would not have time to realize the impending danger to life. Even in the area near the tracks at the end of the system, on which the sleds are braked within 1.0 to 1.5 seconds, he would not have time to respond. *"Aside from the fact that the actual danger zone is highly variable over its entire width, e.g., due to attachments for mounted high-speed video cameras, parts of test objects could separate and, in the worst case, be projected like bullets,"* adds Kahlert. For this reason, all employees must exit the hall prior to every crash simulation and it must be ensured that absolutely no one can enter for the duration of the test.

Well-advised with Safety Consulting

Due to the size of the hall (figure 4), which includes some difficult-to-see areas, and the various doors and gates, a sophisticated safety concept is necessary. This was realized with support as well as safety components from Leuze electronic. At its center is a precisely defined routine, according to which the system operator in charge personally locks all entrances from the inside in sequence and within specific time windows. As he covers this route, which takes him through all parts of the hall, he must also ensure that all employees leave the hall. After the hall has been cleared, he exits it as well through the door in the control room. The pending test can only be triggered after this routine has been successfully and correctly performed with explicit confirmation at all control points.
Focus of the Safety Consulting project was on the development and implementation of a suitable safety concept. This also involved the implementation of a safety controller, including the necessary components, such as safety locking devices for the doors, additional magnetically coded sensors and safety relays – everything from Leuze electronic.
Here, the SISTEMA and Safexpert software programs were used to efficiently perform the CE certification with the objective of producing the Declaration of Conformity.
The SISTEMA software wizard for evaluating safety-related machine controls offers extensive support during the evaluation of safety within the framework of
DIN EN ISO 13849-1. The tool can be used to reproduce the structure of safety-related control parts and permits the automated calculation of permissible values on various detail levels, including of the achieved Performance Level.

Reaching the goal with software and training

In addition, the "sensor people" from Leuze electronic used the proven Safexpert software for the CE certification in accordance with Machinery Directive 2006/42/EC and for the risk assessment. The software contains a hazards list that enables a methodical procedure in accordance with EN ISO 12100. The basis for the entire safety concept was an on-site, joint assessment of the current, individual safety situation.

"For us, one of the main components was the training for programming the MSI safety controller with the MSIsafesoft programming software. The safety experts from Leuze electronic could give helpful tips here that are necessary for a project of this magnitude," adds Kahlert. On the hardware side, it is mainly the MSI safety relays which contribute to a simple implementation of the safety application through a combination of innovative connection technology, compact and space-saving designs and well-arranged housing design. They function as monitoring and integration components for the L200 safety locking devices (figure 5) used on the doors and gates to securely lock all safety doors and thereby prevent the unauthorized entry of persons during a crash simulation.

Additional safeguarding in accordance with the required Performance Level

In addition to this, all doors are also monitored by MC 300 magnetically coded sensors as specified due to the high Performance Level (figure 6). *"Moreover, the particularly rugged construction of the safety locking devices from Leuze electronic - designed for rough industrial use - was the decisive factor for also using these to safeguard the doors and gates near the sled system. These products have proven their reliability in continuous use for us in various projects over many years,"* recalls Kahlert, who sums up: *"With Leuze electronic, we have found a partner who has accompanied us with a great deal of application experience over the entire CE certification and risk assessment process in the integration of a best-possible safety concept that offers optimum safety taking into account the relevant standards and regulations."*

Figures and captions

Figure 1. Continental Safety Engineering International – a subsidiary of the international automotive supplier, Continental – has committed itself to the development of systems for active and passive vehicle safety.

Figure 2. The crash simulation system is part of a complete test infrastructure based on the state of the art at Continental Safety Engineering International.

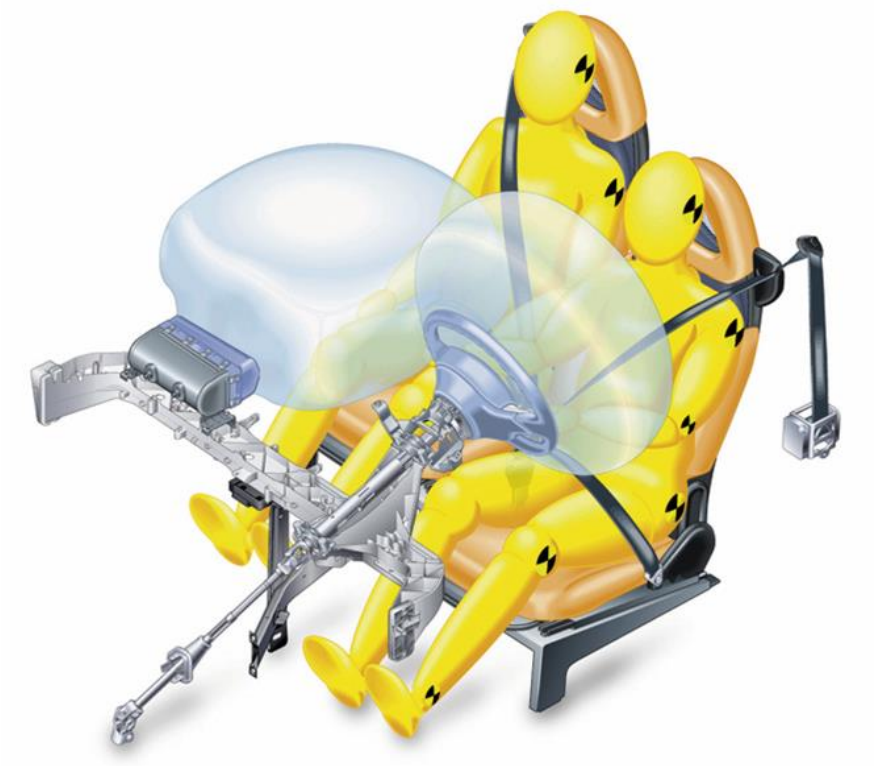

Figure 3. In the crash simulation system, developments and testing of frontal, side and head air bags, vehicle and child seats, belt systems and other interior equipment take place.

Figure 4. Due to the size of the hall that houses the crash simulation system at Continental Safety Engineering International in Alzenau, a sophisticated safety concept is necessary. This was realized with support and safety components from Leuze electronic.

Figure 5. Heavy-duty L200 locking devices were mounted in front of the doors to ensure that no one can enter during the dangerous test.

Figure 6. Behind the doors, MC300 magnetically coded sensor perform position monitoring and thereby ensure the required Performance Level.

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