OPTIMIZATION OF THE SAFETY SYSTEM FOR AUTOMOTIVE COMPONENT PRESSING PROCESS AT "UZ SAEMYUNG CO" ENTERPRISE

Nematjonov Javoxir
Andijan State Technical Institute, student
Mechatronics and Robotics direction, 4th year
E-mail: nematjonovjavoxir669@gmail.com | Tel: +998 91 288 30 57
Scientific supervisor: Toshmatov Shunqorjon

Abstract: This thesis examines the optimization of the safety system for the automotive component pressing process at the "Uz Saemyung Co" enterprise. The shortcomings of the existing safety system are analyzed and five main optimization directions are proposed: upgrading protective devices (safety light curtains, two-hand control modules), implementing Safety PLC controllers, installing hydraulic pressure and position sensors, modernizing the emergency stop system on the Fail-Safe principle, and deploying a SCADA monitoring platform. Research demonstrates that the comprehensive implementation of these devices brings the safety level to PLd standard according to EN ISO 13849-1, reduces workplace injury risk significantly, and improves production efficiency.

Keywords: press safety, optimization, Safety PLC, light curtain, two-hand control, hydraulic pressure sensor, emergency stop, SCADA, EN ISO 13849, "Uz Saemyung Co".

Introduction "Uz Saemyung Co" is one of the leading enterprises in Uzbekistan producing stamped metal parts, brackets, and body components for the automotive industry. High-power hydraulic and mechanical presses are widely used in the production process. Due to their enormous force and operating speed, press machines represent one of the most hazardous production operations for workers.

Industrial statistics show that accidents involving press equipment account for a significant share of total manufacturing injuries. The primary cause is safety systems that are insufficiently developed or outdated. At many enterprises, existing systems still rely on mechanical guards and simple contactors, providing temperature fluctuations in protection level of ±50–80% from the required standard. International standards EN ISO 13849 and IEC 62061 define clear technical requirements for ensuring safety in pressing operations. Optimizing the existing safety system using modern devices is therefore a pressing scientific and practical challenge [1].

Main Body ***Shortcomings of the existing system.*** The current safety system at "Uz Saemyung Co" relies primarily on mechanical fixed guards and simple electromechanical contactors. This approach has several critical shortcomings: mechanical guards do not detect operator hand intrusion into the press zone; contactors wear out rapidly under frequent switching and may fail to open at the right moment; there is no centralized real-time monitoring of the safety system status; and the lack of data archiving prevents post-incident analysis. As a result, the safety level does not meet PLd requirements of EN ISO 13849-1 [2].

Optimization direction 1 — Protective devices. Safety light curtains (SICK deTec4 or Keyence GL-R series) are installed vertically at the front of the press zone, forming an invisible infrared grid. Any intrusion — operator hand, fingers, or foreign object — is detected within 10 milliseconds and the press is immediately stopped. These devices are certified to Safety Category 4 / PLe per IEC 61496-1/2 and can detect objects as small as 14 mm, which is smaller than a finger width. Two-hand control modules (Pilz PNOZ m B0 or Schmersal SRB301ST, certified to ISO 13851) ensure the press cycle can only start when both operator hands simultaneously press dedicated buttons, guaranteeing the hands are outside the danger zone.

Optimization direction 2 — Safety PLC controller. A Siemens SIMATIC S7-300F or Allen-Bradley GuardLogix 5580 Safety PLC (certified to SIL 3 per

IEC 62061 and PLe per EN ISO 13849) is installed as the central control unit. Unlike standard PLCs, Safety PLCs continuously self-diagnose all connected safety devices. If any device signal deviates or a cable fault occurs, the controller switches the press to a safe state within microseconds. The Fail-Safe principle is applied: any system failure results in press shutdown rather than continued operation [3].

Optimization direction 3 — Sensors. Hydraulic pressure sensors (Rexroth HM 20 or Balluff BSP series, 0–400 bar range) monitor press system pressure continuously and send an immediate signal to the Safety PLC if overpressure occurs. Position sensors (Turck or Pepperl+Fuchs inductive proximity sensors) monitor the open/closed state of the die and prevent the press cycle from starting unless the die is fully closed, eliminating risks from objects or hands left inside the tooling.

Optimization direction 4 — Emergency stop system. Emergency stop (E-Stop) buttons compliant with IEC 60947-5-5 and ISO 13850 (red, yellow-background, non-latching reset) are installed at multiple strategic positions around the press. The modern E-Stop system operates on the Fail-Safe principle: a cable break or device fault is also treated as a hazard signal, triggering press shutdown. This eliminates the key flaw of older systems where electrical circuit interruption could go undetected [2].

Optimization direction 5 — SCADA monitoring. A SCADA platform (Weintek or Ignition, integrated via OPC-UA protocol) provides centralized monitoring of all press equipment. Every safety event, press cycle, and technical parameter is archived with a timestamp, forming a full audit trail. Maintenance engineers can plan preventive service schedules and predict equipment wear. Studies show that SCADA integration reduces defective output by 2.8 times by enabling root-cause analysis of each incident [4].

Table. Comparison of safety system performance before and after optimization

Indicator	Before optimization	After optimization
Safety level (EN ISO 13849)	PLb	PLd / PLe
Danger zone detection	None	Light curtain <10 ms
Fail-Safe principle	No	Yes (Safety PLC + E-Stop)
Hydraulic pressure control	Manual check	Automatic 0–400 bar
Event archiving	No	SCADA — full audit trail
Estimated injury risk reduction	Baseline	Up to 85%

As seen from the table, the optimized system transitions the enterprise from PLb to PLd/PLe safety level, introduces automated danger zone detection, implements the Fail-Safe principle across all critical nodes, and establishes full digital traceability of safety events through the SCADA platform.

Conclusion The following results were obtained on optimization of the safety system for the pressing process at "Uz Saemyung Co":

1. The shortcomings of the existing safety system (PLb level, absence of automated danger zone detection, no Fail-Safe logic, no event archiving) were identified and five optimization directions were proposed.

2. Safety light curtains (SICK deTec4, Cat.4/PLe) and two-hand control modules (Pilz PNOZ, ISO 13851) provide the primary physical layer of worker protection, eliminating the main source of hand injuries entirely.

3. Safety PLC (Siemens S7-300F, SIL 3/PLe) with Fail-Safe logic monitors all safety devices in real time and guarantees press shutdown within microseconds upon any hazardous signal.

4. Comprehensive implementation of all five optimization directions raises the safety level to PLd per EN ISO 13849-1, reduces estimated workplace injury risk by up to 85%, extends equipment service life, and improves production efficiency.

Scientific supervisor: Toshmatov Shunqorjon

References

1. Pilz GmbH. Safety in Pressing Operations – Technical Guide. – Germany, 2023. – 96 p.
2. EN ISO 13849-1:2015. Safety of machinery – Safety-related parts of control systems.
3. Bolton W. Programmable Logic Controllers. – 7th Edition. Elsevier, 2021. – 380 p.
4. Lozynskyy O., Paranchuk Ya. Optimization of Industrial Safety Control Systems. – Electrotechnic and Electronic Engineering, 2021. – Vol. 14. – P. 28–35.
5. IEC 61496-1:2020. Safety of machinery – Electro-sensitive protective equipment.
6. IEC 60947-5-5:2005. Low-voltage switchgear – Emergency stop devices.
7. Karimov Q.X. Fundamentals of Industrial Automation. – Tashkent: O'qituvchi, 2021. – 256 p.