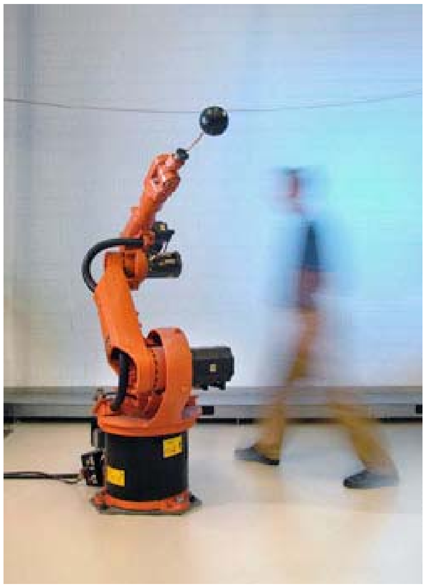
more than automation
safe automation

21 September 2007

TECHNICAL ARTICLE

An introduction to the safeguarding of industrial robots

Many machine builders and system integrators are finding themselves in the position of installing a robot for the first time. Because there are important differences between conventional automation and robotic applications when it comes to safeguarding, this article provides guidance for new users.



Suppliers of industrial robots have been busy launching new products in the past year and, although the take-up in the UK still varies between market sectors (automotive, plastic/rubber and food/beverage are the largest users), many machine builders and system integrators are finding themselves in the position of installing a robot for the first time. Robot suppliers, of course, emphasise the ease of use of modern programming, teaching and simulation tools, but it should not be forgotten that there are important differences between conventional automation and robotic applications when it comes to safeguarding.

Without a doubt, the best place to start is HSG43, 'Industrial Robot Safety', which is published by the HSE (Health and Safety Executive). While it is not compulsory to adhere to this guidance, the HSE says that doing so will normally be enough to comply with the law.

HSG43 covers safety during installation, commissioning, testing and programming, as well as during use and maintenance. Other topics range from the principles of safeguarding robot systems and safety at the design stage, through to hazard identification, risk assessment, training and interfacing with the robot controller. There is also a useful appendix with seven case studies and another that outlines the relevant health and safety laws.

However, while the guide's References section includes a list of relevant standards, it has to be borne in mind that HSG43 (second edition) was published in 2000, so it does not include all of the latest standards - such as EN ISO 13849-1 (Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design), which supersedes EN 954-1, or EN ISO 10218-1:2006 (Robots for industrial environments - Safety requirements - Part 1: Robot), which was recently harmonised to the Machinery Directive to replace EN 775 (Manipulating industrial robots - Safety). Note that a draft for public comment of ISO 10218-2 (Robots for industrial environments - Safety requirements - Part 2: Robot system and integration) is expected to be available by mid-2008, and this is could pave the way for substantial changes in the ways industrial robots are used and safeguarded.

One of the issues raised in the guidance is the way hazardous situations can arise in unpredictable ways when dealing with robots, which can make the selection of appropriate safeguards more difficult than for conventional automation in which the operating envelope, motions and other performance parameters are more clearly defined. Something else to be wary of is that robots used for lifting - such as those in handling or palletising applications - must meet the requirements of LOLER (Lifting Operations and Lifting Equipment Regulations) as well as PUWER (Provision and Use of Work Equipment Regulations). However, the guidance points out that following HSG43 means that the measures needed to comply with LOLER will be minimal.

Today's industrial robots range from lightweight benchtop units to large machines powerful enough to manipulate objects weighing 1000kg. Clearly the risks depend very much on the particular robot and its application, so the starting point for safeguarding a robot will always be a risk assessment. In many robot applications, the potential for serious injury is relatively high, so it is important to design-out the hazards as far as possible. Safety should therefore be considered during the early planning and design stages of a robotic application. Furthermore, HSG43 recommends that hazard identification and risk assessment should be carried out jointly by the user and the robot supplier.

Robot programs are often prepared off-line using software packages, but teaching - typically using a pendant controller - still has a role to play in some programming and position correction tasks. By ensuring good visibility through the guarding - or by using CCTV - most of this teaching should be achievable from outside the enclosure. However, occasionally it is necessary to teach the robot or observe its movements from close quarters, which entails entering the robot enclosure while the robot is powered. Step-by-step guidance is included in HSG43 for this type of situation, as well as for the program verification procedure that is necessary after the programming/teaching has been completed.

HSG43 gives a good overview of the various safeguarding methods appropriate for use with robots, with a note reminding readers that other safeguards can be used so long as they can be demonstrated to provide a similar level of safety (which means that the state-of-the-art Pilz SafetyEYE 3D vision-based safety monitoring system can be used).

The safeguarding methods covered in the guidance include: perimeter fencing; interlocking devices; electro-sensitive safety systems; safety light curtains and light beam devices; laser scanners; capacitance safety devices; pressure-sensitive mats; two-hand controls; trip devices; positive stops; brakes; emergency stop actuators; and enabling devices. Allied to safeguarding are controls for changing operating mode from normal operation to teach/setting, reduced-speed controls for teaching/setting/troubleshooting, and the indication of the robot's swept area.

Control for a multi-axis robot, peripheral devices and associate machinery is highly complex - and further complications arise if multiple robots are synchronised so that they can operate together. It is therefore undesirable for robots to be halted by cutting the power supply to the servo drives, as recovery from the powered-down state can be time-consuming and require human intervention, plus there can be costs associated with damage to work-in-progress. Instead it is preferable to bring the robot and other machinery to rest in a controlled manner. When the robot has been brought to rest, power to the servo drives may be removed, or power can remain connected (known as 'servo hold'), provided the robot controller has adequate built-in safety monitoring functionality or there is a separate safety-related controller to monitor the robot while it is stopped.

HSG43 outlines a number of alternative architectures for integrating a robot controller with a safety-related control system. Note that almost any modern safety-related control system for use with a robot will include some form of programmable electrical/electronic controller, so machine builders and system integrators should avoid the use of BS EN 954-1, as either EN

62061 (Safety of machinery, Functional safety of safety-related electrical, electronic and programmable electronic control systems) or EN ISO 13849-1 would be more appropriate. If there is any reliance on software - or a programmable controller - for robot safeguarding, it would be advisable to work closely with the supplier, especially the first time the system is used.

In all areas of machinery safety, including robot applications, the following hierarchical approach should be used:

- Design out the hazards wherever possible
- Provide safeguards for the hazards that cannot be designed out
- Use safe systems of work, training, personal protective equipment (PPE) and warnings so that residual hazards are as low as reasonably practicable

With robotic installations, there is often a need to rely on safe systems of work during commissioning, programming, teaching, troubleshooting and maintenance, and this is covered in HSG43, together with formal permit-to-work systems.

Pilz has considerable experience with robot safety, having been involved with numerous installations ranging from standalone robots to fully automated robotic production lines. Engineering and consultancy services can therefore be provided to companies that are implementing industrial robots, whether they require assistance with hazard identification and risk assessment, SIL determination, CE marking, ESPE certification, safety system development, PSS (programmable safety system) programming, or other safety-related aspects of the project.

In addition, Pilz has an extensive range of products suitable for robot safeguarding. These include SafetyEYE (the world's first 3D machine vision-based safety monitoring system), PSS, PNOZmulti configurable modular safety controllers, interlock guard switches with solenoid locking, safety light curtains, and high-integrity, coded non-contact guard switches.

Safeguarding of robots - and ISO 10218-2 in particular - will be discussed at the two Functional Safety Seminars being organised for 2008 by the Safety SIG (Special Interest Group) within BARA (British Automation and Robot Association). More information about the Safety SIG is available on the BARA website (http://www.bara.org.uk/sig_safety.htm). Copies of HSG43 'Industrial Robot Safety, Your Guide to the Safeguarding of Industrial

Robots' (ISBN 0717613100), priced at £13.50, can be obtained directly from HSE Books (http://www.hsebooks.co.uk).

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Note to editors

Pilz Automation Technology develops, manufactures and supplies process and automation control products for use wherever there is a requirement to ensure the safety of plant, personnel or the environment. Included in the range are: safety relays; configurable safety controllers; programmable safety systems (safety PLCs) for use with or without the SafetyBUS p safe, open industrial fieldbus network; mechanically actuated and non-contact guard switches; safety light curtains; 3D vision-based safety sensors; emergency stop switches; conventional and touchscreen operator interfaces; plus control and monitoring relays for non-safety applications.

In addition, Pilz provides safety-related services, such as training, engineering and consultancy. For 20 years Pilz has taken a leading role in educating the market with regard to safety legislation. This has been through seminars on legislation, software packages that assist with standards compliance and product selection, and publications. Pilz has produced six editions of the Guide to Machinery Safety, a Guide to Programmable Safety Systems, and publishes a free monthly email newsletter

Pilz Automation Technology is a wholly owned subsidiary of Pilz GmbH & Co KG, a family-owned German company with global operations. Since its foundation in 1948, Pilz has remained at the forefront of safety technology, launching the first safety relay the first programmable safety system, the first safe, open fieldbus system (SafetyBUS p), the first solid-state safety 'relay', the first software-configurable modular safety controller, and the first safe camera system for monitoring three-dimensional zones. Future developments will see safety technology being integrated more closely with standard control, such as in servo drives with safety functionality.

Editors should contact Pilz if they would prefer to receive future press releases electronically or by post.

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