Industrial Robots Safety & Compliance Game Plan

5 things to do to prevent robot injuries and OHS penalties.

Once relegated to the realm of fantasy and science fiction, industrial robots have become a fixture in a wide range of workplaces. They're used to move materials, perform repetitive tasks and carry out operations that would pose dangers to humans, such as enter confined spaces with hazardous atmospheres. But like any other mechanical device, industrial robots create their own hazards, especially to workers who operate or work within a robot's "working envelope." Common hazards include:

- Impact, collision or other struck-by or caught-between hazards due to robot malfunction or unexpected movement;
- Crushing and other injuries that can occur if parts of a worker's body are trapped within or between the components of a robotic system;
- Being struck by projectiles that a robot system releases;
- Hydraulic and pneumatic hazards created by ruptures, leaks or pressure changes in robotic lines or hoses;
- Electric shock, arc flash, fire and other electrical hazards; and
- Slips, trips and falls caused by cables, hoses, spills or leaks.

Failing to protect workers against these hazards can result in not only serious and even fatal injuries but also significant OHS penalties. **Example:** An Ontario company was fined $100,000 after a robot that was supposed to be put into manual mode automatically restarted and hit a worker, breaking his arm [*Linamar Holdings Inc*., Ontario Govt. News Release, March 24, 2010].

Unfortunately, OHS laws haven't kept pace with technology in many parts of Canada. Only 6 provinces and territories specifically address industrial robots in their OHS regulations—AB, BC, MB, NT, NU, SK. The other 8 jurisdictions regulate robotics hazards indirectly under the all-purpose general duty clause of their OHS acts requiring employers to protect workers from reasonably foreseeable hazards not mentioned in the OHS regulations. Regardless of where you operate, if your company uses robotic systems, it must implement appropriate safety measures. Here's a Game Plan outlining the 5 things you must do.

Defining Our Terms

For purposes of OHS compliance, industrial robots are multifunctional mechanical devices designed to perform a variety of tasks through programmed motions. An industrial robot system also includes any devices, sensors, control panels, safeguards, etc., required for the robot to perform its tasks. Industrial robot safety encompasses 3 broad areas:

- Safety in the manufacturing, remanufacturing and rebuilding of robots;
- Safe installation of robots; and
- Safeguarding workers exposed to the workplace hazards associated with robots.

Step 1. Perform a Hazard Assessment

The starting point for controlling robotic systems hazards is to have a competent person identify and assess the hazards. That assessment should be carried out in accordance with CSA standard CSA Z434, *Industrial Robots and Robot Systems – General Safety Requirements*, which calls for considering the following factors:

- The robot's size, capability and speed;
- Its applications and processes;
- The tasks that it's expected to perform and the hazards associated with each of those tasks;
- Foreseeable jobs associated with the robot, such as teaching, maintenance and repair, and the hazards associated with each of those jobs;
- Anticipated failures;
- The likelihood of failure occurring and the probable severity of any resulting injuries; and
- The level of expertise of workers exposed to the robot's hazards and the frequency of their exposure.

Hazard identification and assessment should be performed for each stage of the robot process, including integration, operation and maintenance.

Step 2. Bar Access to Restricted Work Envelope

Use the hierarchy of controls to eliminate or manage the robot systems hazards you identify, starting with engineering controls. Think of robots as a piece of machinery and install the necessary safeguards to prevent injury. The first thing you need are controls to keep unauthorized workers out of the so called "restricted work envelope." **Explanation:** Every robot is surrounded by a "work envelope" defined by the robot's maximum reach. The portion of the work envelope to which a robot is restricted by devices that establish limits that can't be exceeded if the robot's control fails is called the "restrictive work envelope" and entering into it can be very dangerous.

In addition to marking the boundaries by a clearly visible line on the floor, install fences, interlocked gates or other fixed physical barriers, to keep workers out of the restricted work envelope. As with other machine guards, ensure that when safeguard must be removed or made ineffective for performing maintenance, repair, testing, teaching or adjustment, they're replaced or made

effective before a worker uses the robot or robot system again.

Robot controls should also be located outside the restricted work envelope.

Step 3. Implement Shutdown Devices or Mechanisms

You also need safeguards that will shut down the robot in case unauthorized workers do cross into the danger zone. Potential solutions may include one or more of the following:

- Signs, flashing lights or alarms to alert workers when they've strayed into the danger zone;
- Safety light curtains or screens;
- Devices that scan the area;
- Safety mat systems;
- Single and multiple safety beams; and
- Radiofrequency/capacitance-sensing safety systems.

Step 4. Implement Safe Work Practices

The next level down in the hierarchy of controls is administrative or work controls that control the hazards by managing how the dangerous work is carried. At a minimum, you'll need to create and implement safe work procedures for the installation, operation, teaching and maintenance of industrial robots and robot systems. For example, require robots to be locked out and moving parts blocked or pinned before maintenance or repair work is done on them. And bar workers from entering the restricted work envelope while the robot is turned on or in motion.

There also need to be safe work procedures for "teaching," the process in which workers train robots on how to do their tasks. They can teach the robot by physically guiding its arm through the pattern of motions or using a "pendant"—that is, a device like a remote control that the worker uses to walk the robot through the steps slowly, recording each step. Either approach may be hazardous because it requires the worker to be in the restricted work envelope while the robot is in operation. That's why several provinces and CSA Z434 require employers to use special safe work procedures for workers teaching robots, including ensuring that:

- Only the worker teaching the robot is allowed in the restricted work envelope;
- The robot system is under the sole control of the worker doing the teaching;
- When the robot is under drive power, it operates at slow speed only or at a speed deliberately selected and maintained by the teaching worker;
- The robot won't respond to a remote interlock or signal that would activate it; and
- The teaching worker leaves the restricted work envelope before returning the robot to automatic operation.

Step 5. Provide Proper Robot Safety Training

Train workers on your robot safe work procedures and how to implement them.

According to CSA Z434, any worker who programs, teaches, operates or maintains a robot or robot system should be trained on the associated hazards and safe work procedures. Basic training should include:

- Applicable industry standards;
- The robot manufacturer’s safety recommendations;
- Safe work procedures, including lockout and emergency procedures; and
- Safeguards, including their types, functions and limits.

Some workers may need additional safety training, depending on their jobs. For example, a worker who operates a robot must be trained on the robot’s tasks, the hazards associated with each task and responding to abnormal or unexpected events. Also be sure to document workers’ training and verify that workers understood the material and are actually applying their training on the job. Furnish retraining as necessary, including after safety incidents, significant changes to work conditions and/or indications that workers aren’t following their training or need a refresher.