

Safety in Robotic Operations

A robotic welding system consists of a manipulator; a power source; an arc welding torch and accessories; an electrode feed system; a dereeling system, welding circuit, shielding and communication control; and grounding system.

Potential Hazards

Potential hazards to personnel from robotic welding units shall be eliminated by design through protection such as safeguarding and work procedures. If a hazard cannot be eliminated by either design or protection, a warning against the specific hazard shall be provided.

The operational characteristics of robots can be significantly different from other machines and equipment. Robots are capable of high-energy movements through a large volume of space, even beyond the base dimensions of the robot. Any change to the object being worked or the environment can affect the programmed movements.

Some maintenance and programming personnel may be required to be within the restricted envelope while power is available to actuators. The restricted envelope of the robot can overlap a portion of the restricted envelope of other robots or work zones of other industrial machines and related equipment. Therefore, a worker can be hit by one robot while working on another, trapped between them or peripheral equipment, or hit by flying objects released by the gripper.

A robot with two or more resident programs can find the current operating program erroneously calling another existing program with different operating parameters, such as velocity, acceleration, deceleration, or position within the robot's restricted envelope. This might not be predictable by maintenance or programming personnel working with the robot. A component malfunction could also cause unpredictable movement and/or robot arm velocity.

Additional hazards can also result from the malfunction of, or errors in, interfacing or programming of other processes or peripheral equipment. The operating changes with the process being performed or the breakdown of conveyors, clamping mechanisms, or process sensors could cause the robot to react differently.

Risk Assessment

Before work with robotic welding systems can begin, the employer is required to perform a risk assessment on the arc welding robot system and ancillary equipment to

determine and select the safeguarding necessary to achieve and maintain a safe work environment. The risk assessment shall comply with AWS D16.1, *Specification for Robotic Arc Welding Safety*. It shall consist of an application description, robotic operating characteristics, robot classification, categories of hazards, risk analysis, documentation, and training required. The risk assessment process shall be performed and maintained by qualified individuals who have been trained in understanding robotic arc welding application design, methodology of classifying arc welding robots, methodology of identifying operating characteristics, and information concerning the proper use of minimum safeguarding protocols. The risk assessment should be reviewed and revised, if necessary, at least annually and any time changes take place in equipment or processes. The risk assessment should be available for review by anyone at any time. A sample risk assessment form may be found in AWS D16.3:2009, *Risk Assessment Guide for Robotic Arc Welding*, Annex C.

Training

Once the risk assessment is complete, training on the overall system, component safety, and safe operation must take place. All operators, maintenance personnel, welding inspectors, welding supervisors, and safety personnel should receive the training, and it should include a review of the risk assessment as well as the manufacturer's operation manual and safety information. Management and engineering personnel may also receive the training as required. Should a risk assessment be revised, all applicable personnel should receive refresher training on the new risk assessment.

Robots or robotic systems must comply with the following regulations: Occupational Safety and Health Administration, OSHA 29 CFR 1910.333, *Selection and Use of Work Practices*, and OSHA 29 CFR 1910.147, *The Control of Hazardous Energy (Lockout/Tagout)*, and personnel should be trained to these standards.

Personnel who program, operate, maintain, or repair robots or robot systems should receive adequate safety training, and they should be able to demonstrate their competence to perform their jobs safely. Employers can refer to OSHA's publication 2254 (Revised), *Training Requirements in OSHA Standards*.

Additionally, employers should provide training for operators, programmers, and maintenance personnel to help them attain and maintain certifications such as the AWS Certified Robotic Arc Welding Technician/Operator Program. **WJ**