Safety Level 3

Collaboratieve Robot Safety System

Battery charging

* Charging connection only activated when robot is connected
* Charging status must be displayed
* Correct charging is automatically supervised, overloading or charging of deeply discharged.

Energy storing and supply

* Safe extra low voltage -> lower than 25 AC or 60 DC
* Low pressure for pneumatic of hydraulic

Uncontrolled release of stored energy

* Minimize risk of release energy
* Prevent overheating of overcurrent’s caused by overloads short circuits clothes with encompassed the heat source or device small function.

Power failure and shut down

* Risk due to manipulator movement or dropt loads in the event of failure of shut down of power to the manipulator must be acceptable.
* Robots equipped with mobile platforms shall be designed to insure that the risk due to robot travel following failure or robot shutdown of power are acceptable.
* Use of the de-energised to apply principle for breaking mechanisms.
* Internal storage of sufficient energy to allow recovery to a safe state following power failure/shutdown.

Robot start-up and restart of regular operation

* During start-up the robot shall conform internal control test to insure that al safety related functions are available.
* If the robot safety related functions cannot be performed correctly after start-up is shall immediately perform a protected stop.
* The robot shall start-up in a state of restricted speed/force/etc. and shall only return to normal levels of control by means of a mode change.
* The robot shall always start-up in manual mode and it shall only continue operation in autonomous mode after a mode change.

Electrostatic potential

* Use conductive materials
* Earth outer surfaces

Hazards due to robot shape

* Sharp edges and points shall be avoided in the design
* Holes or gaps in the assemble part of the robot shall be designed so that the insertion of any part of the human body is prevented.
* The robot’s joints shall be designed in a way that the human body cannot be crushed when the joint is moved.
* Limit the load being carried to objects with are not sharp or pointed

Hazards due to emissions

* Noise
  + No noise components
  + Actions and or motions shall be designed to be as quiet as practicable.
* Non-ionising radiation
  + The laser equipment used shall not be exceed class 1 according to IEC60825-1

Hazards due to electromagnetic interference

* The functions of the control system shall be designed to meet the electromagnetic immunity requirements.

Mental stress and usage hazards

* User interfaces such as controls, signalling or data display elements, shall be designed to be easily understood so that clear an unambiguous interaction between the human and the robot is possible.

Hazards due to robot motion

* Mechanical instability
  + Designed the ground support area to be as large as reasonably practicable.
  + Designed the centre of gravity of the robot to be as low as reasonably practicable.
  + Designed the robot to ensure that mechanical resonance effects cannot lead to instability.
  + Designed the mass of moving parts, especially the manipulator, to be as low as reasonably practicable.
* In case of collision
  + Design of the mass distribution and shape of the robot so that unintended collisions within the maximum expected limits do not result in overturning.
  + Use of soft materials to absorb forces which lead to hazardous instability.
* Collision with safety related obstacles.
  + Physical limitation of the ravel speed of the robot to an inherently safe maximum.
  + Moving parts shall be designed so that acceptable impact energy cannot be exceeded.
  + Use of materials or structures to reduce impact forces to levels that do not cause harm.

Hazards due to contact with moving components

* The robot shall be designed with moving parts in which components such as motor shafts, gears, drive belts, wheels, tracks or linkages are not exposed.

Hazards due to lack of awareness of robots by humans

* Acoustic emitters shall be provided to warn users of potential hazardous situations.
* Warning lights or other optical devices shall be provided to alert users and third parties to the presence of het robot.
* The robot shall stop while a safety-related object is in its protective stop space, and shall continue to perform its tasks when it has left.