Application: The DRL based robotic system in manufacturing environment, tasked with picking and placing components on an assembly line. The workspace includes object and (probably) human interaction, making safety a critical concern.

Operational Context:

* Human Interaction: Frequent, if operators are present in the workspace for maintenance and oversight.
* Component handling: The robot handles both non-critical and safety critical components, where mishandling could lead to significant production issues or safety hazards.
* Environment: Varied lighting and occasional obstructions in the robot’s operational path.

Safety Req. And Considerations

**Failure Modes:**

* Collison with object
* Collison with workspace
* Dropping Components
* Speed Violations

**Failures Consequences (Severity)**

* Injury to operator
* Damage to critical component or robot itself
* Operational delays

Safety Functions/Mitigations

* Safety Rated Monitored Stop
* Speed reduction
* Emergency Stop

The DRL outcomes:

* Unnamed: 0: Seems like an index or identifier for each record.
* episode\_steps: Number of steps in the episode.
* total\_steps: Cumulative number of steps up to this episode.
* collision: Indicator of whether a collision occurred (0 for no, 1 for yes).
* force during collision: The force recorded during a collision.
* speed violation: Indicator of whether a speed violation occurred.
* ik violation: Indicator of an inverse kinematics violation.
* object collision: Indicator of a collision with an object.
* velocity violation: Indicator of a velocity violation.
* velocity during collision: The velocity recorded during a collision.
* collision timestep: The timestep at which a collision occurred.
* velocity: Recorded velocities (appears to be a list).
* force: Recorded forces (also appears to be a list)
* success: Indicates whether the episode was successful (0 for no, 1 for yes).
* return: The return (reward) from the episode.

Based on the performance data from DRL system, I calculated SIL using following key metrices:

* Failure Rate :  the frequency of collisions, speed violations
* Demand Rate: the number of times safety-critical functions were called, estimated from the number of steps or episodes.
* Mean Time to Failure: the average time between failures
* Success Rate:  the reliability of the system to complete incomplete tasks without safety incidents.
* Probability of failure on Demand:
* Risk Reduction Factor:

**Context:** The dataset provided detailed records of numerous operational episodes for a deep reinforcement learning-based robotic system engaged in a manufacturing environment. The system was specifically tasked with picking and placing components. Interactions with objects and potentially humans characterized the system's operational environment, necessitating stringent safety measures.

**SIL Determination: Safety Complaint DRL**

The following step by step process is followed:

**Failure identification (**Failures were identified as any episode featuring a collision, speed violation, or other predefined safety violations.**)**

**MTTF Calculation : Total Operational steps/ Number of failures**

**SIL Determination: Non-Safety Complaint DRL**