**FSS5**

**Attachment 4 – CoBot Applications**

(Human Robot Collaboration)

**Introduction**

The target to introduce CoBot is to combine the repeatability and the endurance of a robot with the individual skills and creativity of a human.

To guarantee a safe operation a human access to the working area is restricted during the robot activities. Therefor a variety of tasks making human interaction necessary can nor be automized with robot applications.

Human-Robot-Collaboration (following called CoBot) enable interaction between robot and humans in a defined *collaboration space*.

As CoBots are machines, the requirements of the FSS5 are in force unmodified.

What is new about the application of CoBot applications is the changed view of risk. CoBots can and should interact with operators, with the result that operators intervene directly in a collaboration space where movements of the CoBot take place. This requires a changed view of the possible safety concepts:

Principally, according to ISO TS 15066 (5.5.1), various safety concepts are conceivable:

* Safety-rated monitored stop – In this case, the collaborating robotic system can work non-collaboratively if there is no human in the collaboration space. Before an operator is allowed to enter the collaboration room, the robot system is found in a safety-assessed monitored stop (stop category 2). Then the operator is allowed to enter the collaboration room and perform his work task (for example, remove a part and insert a new one). Only when the operator has left the collaboration room is the robot system allowed to resume operation.
* Speed and separation monitoring – Here, the operator and the collaborating robot system are allowed to move simultaneously in the collaboration room. Sufficient risk mitigation shall be ensured by the continuous maintenance of at least the safety distance. If the distance is reduced to a value below the safety distance, the robot system stops. If the operator moves away from the robot, the robot system can resume movement if at least the safety distance is maintained. When the robotic system reduces its speed, the safety distance decreases accordingly. The robotic system must be equipped with a function for safety-assessed monitored stop and safety-assessed monitored speed.
* Hand Guiding (Manual-control) – Using a hand-operated device, an operator can control the movement of the robot system. Before the operator is allowed to enter the collaboration room, the robot system performs a safety-assessed monitored hold. By manual confirmation ([permission](#_Zustimmungseinrichtung) switch / enabling device) the operator can start operation manual. The hand-operated device can be located either directly at or near the end effector.
* Power and force limiting – The robot system and operator are allowed to move in the collaboration room at the same time. Physical contact between the operator and the robot system may occur intentionally or unintentionally. Risk reduction is achieved by complying with biomechanical exposure limits.

New developments in the future can lead to safety concepts that are not yet taken into account in the ISO standard.

**Organizational Requirements**

Risk Assessment

A risk assessment is required to apply a CoBot application. This includes the selection of a suitable safety concept (e.g. according to ISO TS 15066).

The risk assessment shall contain an appropriate statement of the possible harmful contacts between CoBot and the operator and the measures taken against it.

**Selection of the Safety Concept acc. ISO TS 15066**

The selection of the safety concept is based on the process requirements and a risk assessment.

**Acting Persons and responsibilities**

Purchasing/Design/Project:

* Definition of the task/process of the CoBot.
* Definition of the security concept based on process requirements and risk assessment.
* Responsible for technical safety according to the legal requirements in the country of use (e.g. in Europe declaration of conformity and CE marking of concatenated systems)

Operation (Machine Owner):

* Verification of the requirements of the applicable specifications (ISO TS 15066)
* Sufficient information for the machine operators, e.g. as part of a regular instruction.

System-integrator:

* Risk Assessment (e.g. acc. ISO 12100)
* Documentation according to the extended requirements of ISO TS 15066.

Supplier:

* Compliance with legal requirements (e.g. declaration of conformity or Declaration of Incorporation, user information,...)
* Compliance with legal requirements in the country of use

**Documentation acc. Legal Standards / Declaration of Conformity (Europe only)**

Approvals or similar must be drawn up for the (concatenated) machines in accordance with applicable national law (e.g. overall conformity for the concatenated machines according to the Machinery Directive for applications in the EU).

The entire machine must comply with at least the applicable national law.

The Extended requirements for the Operation Manual – “Users Information” according ISO TS 15066 Chapter 7 must imperatively be observed, e.g. Information about safely reduced speed and/or forces during the different operational modes.

**Technical requirements**

* Minimum requirements according ISO TS 15066 (e.g. Chapter 5) and ISO 10218 1/2 are mandatory.
* Mandatory minimum Requirements for functional safety aspects according ISO TS 15066 (e.g. Category 3, PLd, dual channel/redundant structure, sufficient diagnosis coverage). The PL evaluation must be based on a comprehensive Risk Assessment.
* The lifecycle/intended duration of use of the used components must be considered (e.g. MTDF for the used components). Exchange intervals must be included in the operating manual.

**Skills / Knowledge**

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| ***Affected*** | ***Skill / Knowledge*** |
| Purchasing | * Placing on the market of machinery in the user country * Basic knowledge of machine safety |
| Project / Design | * Advanced knowledge of machine safety (incl. FSS 5) (incl. standards for CoBot/robot safety ISO TS 15066 and ISO 10218 1/2 "Industrial robots – safety requirements" as well as specific rules in the user country) * Advanced knowledge of functional safety (ISO 13849-1) * Knowledge of safety-rated software |
| System-Administrator | * Advanced knowledge of machine safety (incl. FSS 5) (incl. standards for CoBot/robot safety ISO TS 15066 and ISO 10218 1/2 "Industrial robots – safety requirements" as well as specific rules in the user country) * Advanced knowledge of functional safety (ISO 13849-1) * Advanced knowledge of safety-rated software, programming skills |
| Machine Owner | * Basic knowledge of machine safety (FSS5 + user country) * Knowledge risk assessment (FSS10 + user country) |
| Operator | * Annual safety briefing on hazards, risks and protective measures to be applied. |
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**Verification of Requirements**

Mandatory use of the FSS5 Checklist.

Supporting Checks according the ISO TS 15066 contain at a minimum:

* Technical Specification (e.g. verification of safely reduced speed and forces)
* Documentation (e.g. Declaration of Conformity in the EU or other applicable certificates elsewhere; labelling, etc.)
* Information in the Operating Manual (acc. ISO TS 15066)

**Supporting Documents:**

* FST Handlungsanweisung (Stand 05/2018) Mensch-Roboter Kollaboration
* FST TA HSE 000 0126 CoBot- Systeme (Checkliste)