

# Risk Assessment Guidance

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# Administration Page

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# 1. Introduction

Risk assessments are an essential tool for any business. Applicable to a wide range of situations, from office-based environments to large scale manufacturing processes. Risk assessments allow hazards associated with a process or environment to be identified and quantified. This aids the selection of appropriate control measures to mitigate or reduce the risk to as low a level as is reasonably practicable. As well as being a legal requirement for employers under the Health and Safety at Work Act 1974<sup>[1]</sup>, a completed risk assessment can provide a valuable overview of the risks for all involved in the process or environment that has been assessed.

Risk assessments are also often the best place to start when building a technical file for product compliance; such as CE marking. Here, the risk assessment can help to demonstrate how essential health and safety requirements (e.g. from European directives) have been satisfied and whether there are any deficiencies in the design. They can also help determine the level of risk reduction required, for example when determining the level of functional safety required.

Automata's industrial robotic arm, Eva, is supplied within the EU as "partially-completed" machinery under the Machinery Directive<sup>[2]</sup>. This means that although the manufacturer has met all of their mandatory obligations under the directive, it is the responsibility of the integrator to assess and mark the product as a fully-compliant machine. The robot is essentially a component in a larger machine. Internationally recognised standards often provide a useful resource for hazard identification. In the case of robotic integrations, ISO 10218-2<sup>[3]</sup>, Annex A provides a wide range of typical hazards that can be used to form the basis of a risk assessment.

In order to aid customers with the process of safely integrating the robot, a risk assessment template<sup>[4]</sup> has been created based upon the hazards identified in ISO 10218-1, Annex A. This guide has been created to assist the use of the template. This is achieved by walking the assessor through the different elements of the template, providing guidance on how to assess each risk, and how to apply and assess the effectiveness of control measures. Customers with their own risk assessment process may wish to use the hazards and control measures contained within the template to populate their own company template. Other customers are welcome to use the template provided to assess their integration.

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1 "Integrator" in this instance refers to the organisation responsible for authorising the product as compliant, and therefore safe for use.  
2 Note that some integrations may be required to conform to other directives or regulations, thus other standards may need to be taken into account when assessing the completed machine.

## 2. Risk Assessment Walkthrough

Under this heading each element of the risk assessment template<sup>[4]</sup> has been explained, with examples given where appropriate.

### 2.1 Risk Matrix

In order to assess the level of risk for each of the hazards listed within the risk assessment, a risk matrix has been devised. By assessing the severity and likelihood of the hazard occurring, a risk rating can be determined against that hazard. The risk ratings will give an indication as to whether additional control measures are necessary to reduce the risk to as low as is reasonably practicable. The simplicity of the risk matrix method is the primary reason it has been chosen for the risk assessment template<sup>[4]</sup>. However, other - equally valid - methods are also available to determine the level of risk. An excerpt of the risk matrix taken from the risk assessment template has been given in Figure 2-1 below.

		Severity						
		C	Cr	Se	M	N		
Likelihood Of Event	F	U	U	H	M	L	<b>C</b> <b>Catastrophic</b> (Multiple fatalities, severe widespread environmental damage)	<b>F</b> <b>Frequent</b> (Not surprised, will occur several times)
	P	U	U	H	M	L	<b>Cr</b> <b>Critical</b> (Single fatality and/or multiple severe injuries, occupational illness or environmental impact)	<b>P</b> <b>Probable</b> (Occurs repeatedly/an incident to be expected)
	O	H	H	M	L	T	<b>Se</b> <b>Serious</b> (Single severe injury or occupational illness and/or multiple minor injuries or minor occupational illness)	<b>O</b> <b>Occasional</b> (Could occur some time)
	R	M	M	L	T	T	<b>M</b> <b>Minor</b> (Minor injury/short term absence)	<b>R</b> <b>Remote</b> (Unlikely, though conceivable)
	I	L	L	T	T	T	<b>N</b> <b>Negligible</b> (Trivial injury (First aid only)/environmental damage)	<b>I</b> <b>Improbable</b> (Could happen, but probably never will)
							<b>Risk Rating</b> <b>Unacceptable/Very High Risk</b> - Work shall not proceed or facility shall not be used <b>High</b> - Reduce risk through additional controls if practicable, if not, Permit to Work may be required in addition to Safe Method of Work; competency levels appropriate and documented <b>Medium</b> - Reduce risk through additional controls if practicable, if not, add to the Safe Method of Work the levels of competency should be appropriate <b>Low</b> - This work which may be of a routine nature will require a Safe Method of Work <b>Trivial</b> - Additional controls required only if the benefits justify the effort	

Figure 2-1: Risk matrix

As well as assessing the initial risk rating, the risk matrix can also be used to determine appropriate control measures and can be reapplied to determine the effectiveness of these measures on the hazards. This process has been described in more detail under Heading 2.3, Risk Assessment.

For low to high levels of risk, the concept of "Safe Method of Work" and "Permit to Work" processes have been introduced. If the risk rating cannot be reduced through appropriate control measures, the use of these processes is highly recommended.

A “Safe Method of Work” - otherwise known as a “Work Method Statement” - is a document giving specific guidance on how to safely perform a particular task, such as operating a piece of machinery. It will typically outline the hazards likely to be encountered and the methods to be employed in order to safely operate around these hazards. This document should be released to all those involved in the hazardous task/process, or given as training as part of a safety induction.

A “Permit to Work” is generally reserved for high-risk activities where tighter controls are necessary. Similar to a Safe Method of Work, it documents the hazards involved and instructions for safe working practises. A Permit to Work, however, restricts those conducting the hazardous activities to a pre-approved list of personnel over a specified time limit.

## 2.2 Document Control

The “Info” tab in the risk assessment template is concerned with document control, as shown in the completed example in Figure 2-2 below.

<b>Document Reference:</b>	AUTO/RA/190049	<b>Number of Operatives:</b>	1-5
<b>Name of Installation:</b>	Eva With Camera and Stylus Payload	<b>Access by Untrained Visitors:</b>	No
<b>Installation Description:</b>	Single Eva robot fitted with custom payload for holding a touchscreen stylus and machine vision camera (<1 kg). Tabletop mounted with no guarding or barriers.	<b>Usage (hours per day):</b>	7.5
<b>Purpose of Installation:</b>	Used for testing touchscreen equipment.	<b>Location of Installation:</b>	Automata, London
<b>Machine Model/Serial Number:</b>	Eva V4	<b>Name of Risk Assessor(s):</b>	Mike Grout
<b>Modifications to Machine:</b>	None	<b>Date of Risk Assessment:</b>	07/08/2019

Record of Changes		
Issue	Date	Detail of Changes
1.0	07/08/2019	Initial Issue

Figure 2-2: Example completed document control form

Document control ensures that the relevance between the risk assessment and the physical installation is clear. It also provides a method of tracking changes, allowing the reader to determine whether they are in possession of the most up to date revision or if any significant changes have been made which may affect the way they interact with the installation.

An explanation of each field within the document control form has been given below:

- **Document Reference:** A unique reference to identify the risk assessment and distinguish it from other documents. In the example, a unique reference number has been generated from a company database. This reference has also been given in the footer of each page to ensure any loose pages can be identified if printed.
- **Name of Installation:** A unique title or name given to the installation.
- **Installation Description:** A brief overview of the installation. E.g. main components, description of environment, etc.
- **Purpose of Installation:** A brief overview of the main purpose(s) of the installation.
- **Machine Model / Serial Number:** This could refer to the model of the main components (e.g. the robot) or the completed machine under assessment; whichever is appropriate. It may also be appropriate to list the serial number, for example where several similar machines require different risk assessments owing to the different risks involved.
- **Number of Operatives:** The estimated number of people with access to the robot (i.e. people authorised to use the robot). In the example a numerical value is given. It may also be appropriate to provide a more detailed description to support the risk assessment; e.g. "5 operators trained for use. 2-3 operators typically working in tandem" This can help when determining the severity or likelihood of risk against some hazards.
- **Access by Untrained Visitors:** In the example a simple "No" is given. In some cases it may be appropriate to expand on this answer; for example, "robot kept in a locked room with limited access. Cleaners also have access and are untrained". This can help when determining the severity or likelihood of risk against some hazards.
- **Usage (hours per day):** An estimation of usage per day. This can help to determine the likelihood of risk.
- **Location of Installation:** Address, room name, or similar to help identify the equipment and its environment.
- **Name of Risk Assessor(s):** Name of the person responsible for completing the risk assessment.
- **Date of Risk Assessment:** Date the risk assessment was issued (latest issue).
- **Record of Changes:** Any changes made to the risk assessment between issues should be recorded here. When a change has been made, a new line will be populated with the issue number, date of issue and detail of changes. The detail of changes should give a brief overview of what changes have been made.

## 2.3. Risk Assessment

The risk assessment template<sup>[4]</sup> contains a list of typical hazards associated with robotic installations, based upon ISO 10218-2<sup>[3]</sup>, Annex A. An example produced using the template is given in Figure 2-3 below.

ID	Risk / Hazard	Who Might be Harmed and How	Rating with Minimal or No Control Measures in Place			Control Measures	Rating with All Control Measures in Place		
			Severity	Likelihood	Rating		Severity	Likelihood	Rating
<b>1 MECHANICAL HAZARDS</b>									
1.1	Movements (normal or unexpected) of any part of the robot arm or end effector: <ul style="list-style-type: none"> <li>• Impact</li> <li>• Crushing</li> <li>• Trapping</li> <li>• Cutting</li> <li>• Stabbing or puncturing</li> <li>• Friction or abrasion</li> <li>• Entanglement</li> </ul>	Injury to operator within operating space of the robot. Consequence of machine fault, operator error, or insufficient control methods, e.g: <ul style="list-style-type: none"> <li>• Brake failure causes robot to fall under its own weight and weight of payload</li> <li>• Operator approaches robot when running a toolpath (e.g. robot paused)</li> <li>• Secondary operator demands the robot to move whilst the primary operator is within the operating space of the robot (e.g. over a shared network)</li> </ul>	Se	O	M	C1, C2, C4, C5, C7, C9, C11, C12, C14, C15, C16, C17, C25, C26	M	R	T
1.2	Sharp edges or angular parts of the end effector when stationary: <ul style="list-style-type: none"> <li>• Cuts</li> <li>• Friction or abrasion</li> </ul>	Injury to the operator when working in close proximity to the robot end effector during installation, maintenance, setting up or decommissioning activities.	N	O	T	C1, C2, C5, C6, C7, C12, C13, C15, C17	N	I	T
1.3	End-effector failure (separation): <ul style="list-style-type: none"> <li>• Impact</li> <li>• Cutting or severing</li> <li>• Stabbing or puncturing</li> <li>• Friction or abrasion</li> </ul>	Injury to the operator or bystander within or just outside the operating space of the robot. Some examples of potential failures could be: <ul style="list-style-type: none"> <li>• Failure (stripping) of the aluminium threads in the toolplate or shearing of the end effector fixings</li> <li>• Loosening of the end effector fixings</li> <li>• Failure of the end effector housing</li> </ul>	M	R	T	C1, C2, C3, C5, C7, C12, C14, C17, C18, C19	M	I	T

Figure 2-3: Example risk assessment

Within the template, each hazard has been grouped into a category - such as “mechanical hazards”, “vibration hazards” and so on - to aid the risk assessment process. Against each hazard, a list of typical effects have been given (e.g. impact, crushing, etc.). A separate column also provides guidance on “who might be harmed and how” for each specific hazard. When completing the template the risk assessor may determine that certain risks or effects are not applicable. In such cases, it may be pertinent to remove some rows from the template or edit some of the pre-existing text to better reflect the integration under assessment and reduce clutter.

For each hazard identified as relevant to the integration, the assessor must consider the severity and likelihood of the hazard occurring using the risk matrix method described under Heading 2.1. This should be completed twice for each hazard, in order to determine the effectiveness of any control measures. First, to obtain a risk rating assuming no control measures are in place. And secondly, to obtain a rating with all control measures in place. You can use the drop down menus to select a severity and likelihood of each risk, this will automatically generate a risk rating. Colour coded risk ratings help to highlight high and low risk hazards more clearly when reviewing the document.



In the example shown in Figure 2-3, Risk ID 1.1 has been marked as “Se” (Serious) under Severity and “O” (Occasional) under Likelihood, giving it a final risk rating of “M” (Medium). Figure 2-4 shows how the risk matrix was used to obtain a risk rating from the severity and likelihood. In order to reduce the risk given in the example from “Medium” to a lower rating, control measures can be selected which either reduce the severity or likelihood of hazard occurrence, or both.

		Severity				
		C	Cr	Se	M	N
Likelihood Of Event	F	U	U	II	M	L
	P	U	U	II	M	L
	O	II	II	M	L	T
	R	M	M	L	T	T
	I	L	L	T	T	T

Figure 2-4: Using the risk matrix to determine the risk rating

A column has been provided to allow specific control measures to be referenced against each hazard in the template. These have been explained in more detailed under Heading 2.4, Control Measures.

## 2.4 Control Measures

When the hazards associated with the integration have been identified and further risk reduction is deemed necessary, appropriate control measures should be employed. Within the risk assessment template<sup>[4]</sup> a number of example control measures have been given; as shown in Figure 2-5. These examples have been compiled from a wide range of typical applications. The risk assessor may wish to use these measures as they are given, edit them to better reflect their application, add new control measures, or delete those which are not applicable to the integration.

Summary of Control Measures	
The control measures listed in the above risk assessment have been summarised below:	
<b>C1</b>	Conduct a risk assessment of the final machine and intended use case
<b>C2</b>	Perform visual checks and/or proof tests upon commissioning the final machine
<b>C3</b>	Perform visual checks and/or proof tests at predefined maintenance intervals
<b>C4</b>	Ensure brake release tool remains with the robot or in a secure, accessible location at all times
<b>C5</b>	Ensure machine operators are outside the operating space of the robot whenever possible, except for maintenance or teaching operations when the robot is placed into teach mode

Figure 2-5: Example control measures taken from the risk assessment template

## 2.5 Register

A register is provided within the risk assessment template[4] in order to record those persons who have read the risk assessment, and therefore have acceptance and understanding of the risks and control measures associated with the integration. An example of how this may be completed is given in Figure 2-6.

Date	Name	Company	Role	Signature
07/08/2019	Mike Grout	Automata	Robot Operator	<i>M Grout</i>
08/08/2019	Joe Clegg	RTT Automation	Machine Builder	<i>J Clegg</i>

Figure 2-6: Example risk assessment register

The register allows an organisation to trace the competency of the individuals who may come into contact with the hazards detailed with the risk assessment. This could include employees of the end user's organisation or third parties, such as machine builders.

### 3. References

The following references have been used throughout this document:

- [1] Legislation.gov.uk. (2019). Health and Safety at Work etc. Act 1974. [online] Available at: <http://www.legislation.gov.uk/ukpga/1974/37/contents> [Accessed 26 Nov. 2019].
- [2] Machinery Directive. (2006). 2006/42/EC. Official Journal of the European Union.
- [3] Robots and robotic devices - Safety requirements for industrial robots. Part 2: Robot systems and integration. (2011). BS EN ISO 10218-2. BSI.
- [4] Automata Technologies Ltd. (2020). Risk Assessment Template.







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