

Collision Risk Analysis Report

(Power and force limit)

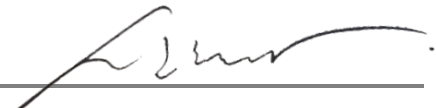
Related to

ISO 10218-2:2011 and ISO/TS 15066

Report Reference No	: SFT_PFL_191104
Report Date	: 25. Nov. 2019
Requested Company	: Sample Inc.
Project Manager	S. John, Sample Inc.
Model Reference	: Indy7
Manufacturer	: Neuromeka
Robot Installation Location	: 1732, Deogyong-daero, Giheung-gu, Yongin-si, Gyeonggi-do 17104, Republic of Korea
Test Terms	: Dynamic Collision Test (Power and Force Limit)
Tested by	Junsuk Choi, Safetics Inc.



Approved by Heonseop Shin, Safetics Inc.



Summary of Test Results

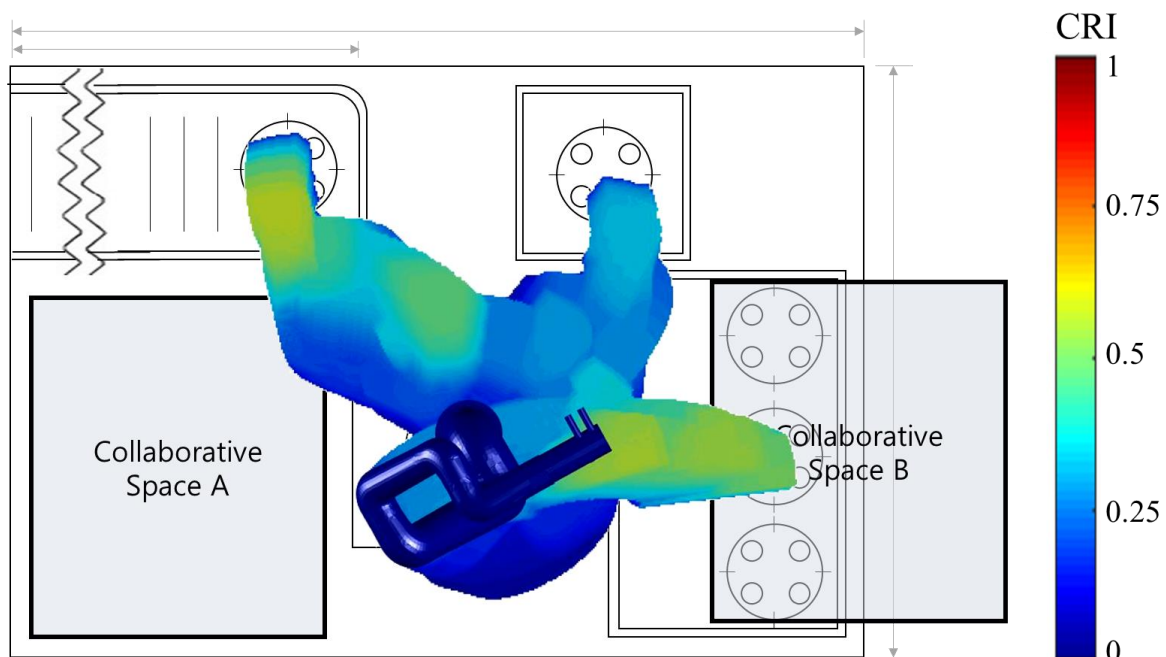
Collision Type	Collaborative Space	Collision Scenario	Robot Part	Human Body part	Result
Unconstraint Dynamic Collision	A	C1	5 th Link	Chest	Pass
				Lower arm & wrist	Pass
				Hand	Pass
Unconstraint Dynamic Collision	A	C2	5 th Link	Chest	Pass
				Lower arm & wrist	Pass
				Hand	Pass
Unconstraint Dynamic Collision	B	C3	5 th Link	Hand	Pass
Constraint Dynamic Collision	B	C4	5 th Link	Hand	Pass

The human body parts are chosen by the request with the consideration of that the parts have potential risk to collision.

ISO 10218-2									
Clause	Requirement Test	Result-Remark						Verdict	
5.11.5.5	If using power and force limiting technology, robots in collaborative space meet the requirements of ISO 10218-1.	The test model is manufactured in accordance with ISO 10281-1						Pass	
	Parameters have been determined by risk assessment and guidance provided by ISO/TS 15066.	Body	Eff. Mass	K1	K2	Thick ness	Threshold (Force [N])	Threshold (Pressure [MPa])	Pass
		Chest	40kg	70	25	7	280N	2.4MPa	
		Lower arm & wrist	2kg	70	40	7	320N	3.8MPa	
		Hand	0.6	70	75	7	280N	6MPa	
		Hand (Constraint)	1000	70	75	7	280N	6MPa	

The test is conducted with guidance of collision safety standard (ISO/TS 15066:2016 ISO/TC 299 USA-RIA-TR-R15-806).

Description of Operating Space and Collaborative Space on Layout

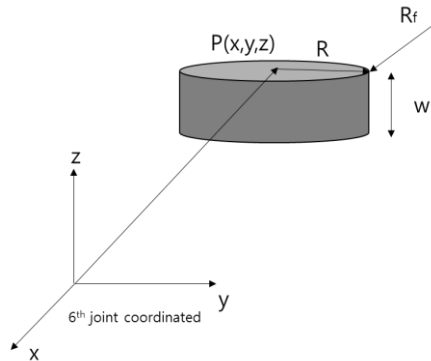


Collision Risk Index (CRI) states the maximum value of Permissible pressure violation rate and Permissible force violation rate

$$CRI = \text{MAX} \left(\frac{Pressure_{result}}{Pressure_{threshold}}, \frac{Force_{result}}{Force_{threshold}} \right)$$

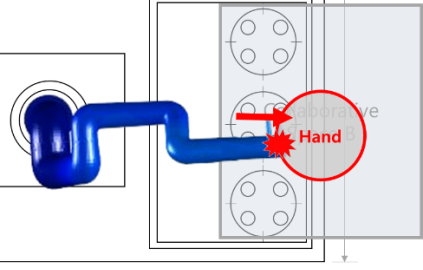
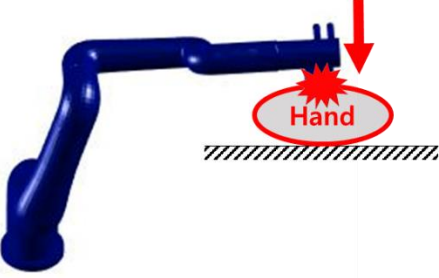
Shape of 5th link of robot : Sphere Type, R 80

Shape of End-effector of robot : P = (100,0,180) R = 150mm, R_f = 0.5mm



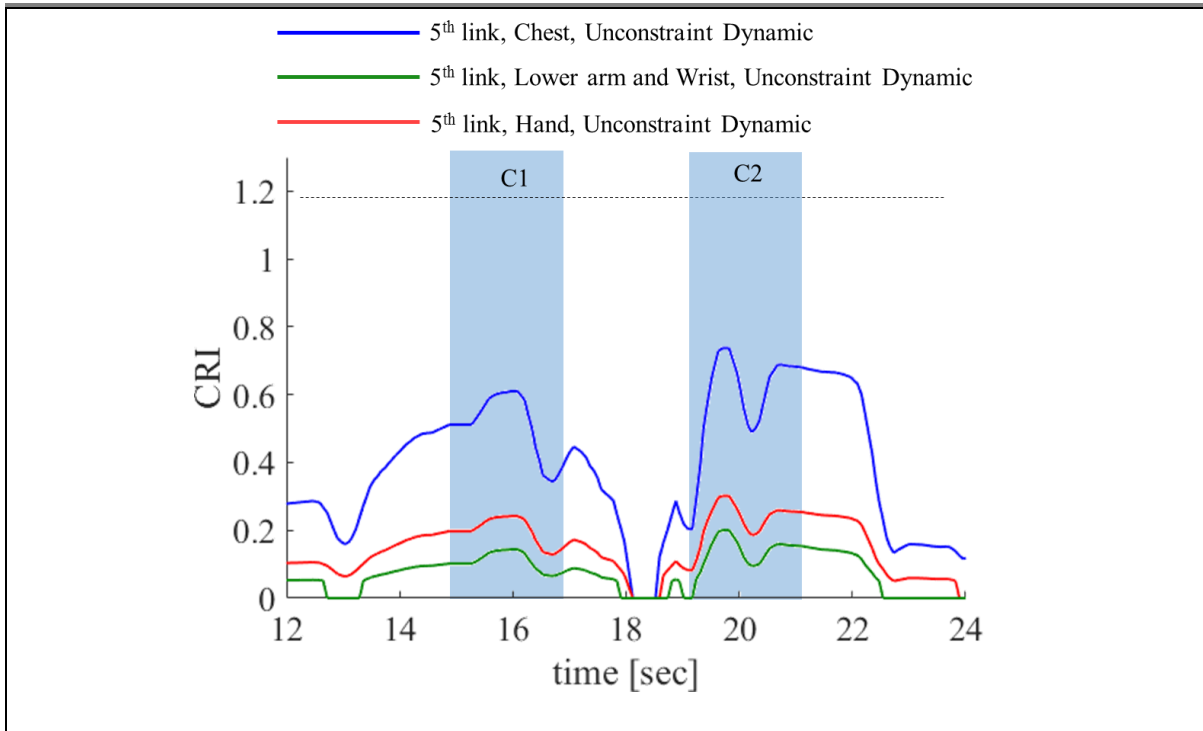
Collision Risk Assessment

Collision Type	Collaborative Space	Collision Scenario	Robot Part	Human Body part	Description
Unconstraint Dynamic Collision	A	C1	5 th Link	<ol style="list-style-type: none"> 1. Hand 2. Lower arm and wrist 3. Chest 	
Unconstraint Dynamic Collision	A	C2	5 th Link	<ol style="list-style-type: none"> 1. Hand 2. Lower arm and wrist 3. Chest 	

<p>Unconstraint Dynamic Collision</p>	<p>B</p>	<p>C3</p>	<p>End- Effector</p>	<p>1. Hand</p>	
<p>Constraint Dynamic Collision</p>	<p>B</p>	<p>C4</p>	<p>End- Effector</p>	<p>1. Hand</p>	

Collision Test Results

Collision Scenario	Robot Part	Collision Velocity (V)	Human Body part	ISO Threshold	Result	CRI	Verdict	Maximum Safe Velocity *CRI=1
C1	5 th Link	259mm/s	Chest	280N	123N	0.61	Pass	2.26 × V
				2.4MPa	1.46MPa			
			Lower arm and wrist	320N	54.9N	0.24	Pass	> 3 × V
				3.8MPa	0.92MPa			
			Hand	280N	40.3N	0.14	Pass	> 3 × V
				6Mpa	0.76MPa			
C2	5 th Link	354mm/s	Chest	280N	169N	0.73	Pass	1.65 × V
				2.4MPa	1.76MPa			
			Lower arm and wrist	320N	75.6N	0.30	Pass	> 3 × V
				3.8MPa	1.14N			
			Hand	280N	56.2N	0.20	Pass	> 3 × V
				6MPa	0.93MPa			



Collision Scenario	Robot Part	Collision Velocity (V)	Human Body part	ISO Threshold	Result	CRI	Verdict	Maximum Safe Velocity *CRI=1
C3	End-Effector	412mm/s	Hand	280N	64.5N	0.53	Pass	2.4 × V
				6MPa	3.21MPa			
C4	End-Effector	260mm/s	Hand	280N	140N	0.50	Pass	1.9 × V
				6MPa	1.38MPa			

