TECHNICAL RISK ASSESSMENT

Analysis and Evaluation
of risks according to ISO12100

Equipment:

Electrical Enclosure for Control of Heating Setup

Gauting, Bayern
MAY/2024

Summary

1. DEFINITIONS AND ACRONYMS

1.1. DEFINITIONS OF TERMS

	Definition
Hazard	Potential source of harm
Residual risk	Risk remaining after protective measures have been implemented
Risk	Combination of the probability of occurrence of harm and the severity of that harm
Risk analysis	Combination of the specification of the limits of the machine, hazard identification and risk estimation
Risk Evaluation	Judgment, on the basis of risk analysis, of whether the risk reduction objectives have been achieved
Risk Assessment	Overall process comprising a risk analysis and a risk evaluation

1.2. ACRONYMS

Acronym	**Description**
ATP	Acceptance Test Procedure
DUT	Device Under Test
EFK	Elektrofachkraft (Qualified Electrician)
EuP	Elektrotechnisch unterwiesene Person (Electrotechnically trained person)
HSO	Health & Safety Officer
I/O	Input Output
PID	Proportional Integral Derivative
PPE	Personal Protective Equipment
VEFK	Verantwortliche Elektrofachkraft (Responsible competent Electrician)

Bellow Acronyms for this Document specific only:

Acronym	**Description**
IESU	Integrated Energy Storage Units
PID	Proportional Integral Derivative

1.3. REFERENCES TO OTHER DOCUMENTS

Doc.Ref.	**Document full name**
LD-00-1020	Test Rig Development Method

2. INTRODUCTION

This technical documentation is intended to present the Risk Assessment of the Control for Heating Setup that has two Safety outputs; AC with 400VAC and 230VAC, and DC with 120VDC. The Enclosure of the Control Heating Setup will be located in a control room of the Bunker building. The interfaces (heating fans, heating mat, etc..) will be installed inside the Test Chamber/Bunker for explosive/fire tests.

2.1. GOAL

The purpose of this document is to assess, inform, and expose the possible risks of accidents that may harm its users in any way, making the user aware of the critical items of the equipment.

The safety systems & technical protocols of the equipment are intended to reduce the risks of accidents that may cause damage to the work capacity, physical integrity, health, and consequently to the quality of life of the workers.

2.2. EQUIPMENT FUNCTION

The equipment has been specially developed to assist the tests of the Battery cells that are part of the final product (Lilium Jet).

3. OVERVIEW

3.1. COMPANY

Establishment title:	Lilium eAircraft GmbH
Commercial register:	Amtsgericht München HRB: 257325
District:	Starnberg, Municipality in Bavaria
Address:	Galileistraße 335, Gauting
Zip Code:	82131
Contact:	info@lilium-aviation.com
Phone:	+49 81 0577 277 87

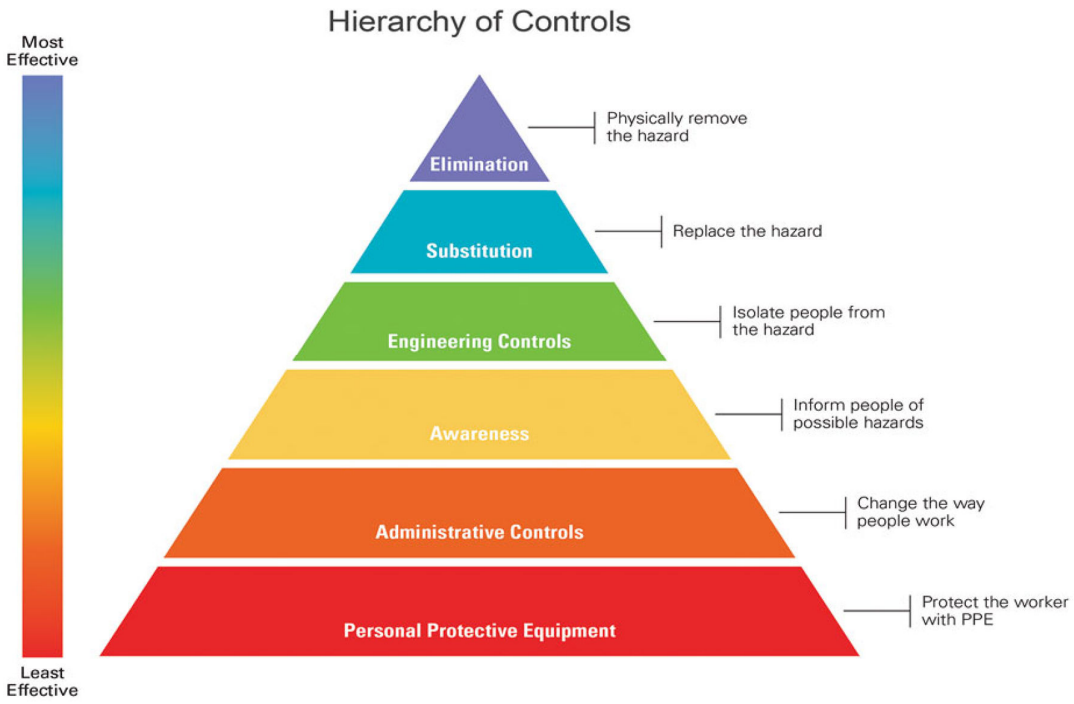
3.2. TECHNICAL CHARACTERISTICS OF THE EQUIPMENT

Title:	Electrical Enclosure for Control of Heating Setup
Type:	Control for Heating Setup
Serial Number:	1
Year Of Manufacture:	2024
Power Supply (Control):	23KVA (3~400V+N+PE)
Fuse Protection (External Supply):	32A
Ac Input:	400V, 230V
Ac Outputs:	400V, 230V
AC Input Cable Cross Section:	6mm²
AC Outputs Cable Cross Section:	4mm² for 400V, 2,5mm² for 230V
Power DC Input:	700W, (120V)
Power DC Output:	700W, (120V)
Voltage DC Input:	120V
Current (max.) DC Output:	8A
DC Input Cable Cross Section:	1.5 mm²
DC Outputs Cable Cross Section:	1.5 mm²
Control Voltage:	24 VDC
Safety Performance level (PL):	D
Maximum Pneumatic Working Pressure:	N/A
Maximum Pneumatic Working Pressure: **Maximum Operating Temperatures:**	N/A -10°C – 55°C
Maximum Pneumatic Working Pressure: **Maximum Operating Temperatures:** **Maximum Storage Temperatures:**	N/A -10°C – 55°C -5°C - 85°C
Air Humidity:	Dry, non-condensing
Operating Location:	Indoor use only
Total Approximate Enclosure Weight:	26.2 Kg
Dimensions Main Cabinet:	500x500x210mm (WxHxD)

4. GENERAL CONSIDERATIONS

4.1. DIAGRAM PRIORITIZATION OF CONTROL MEASURES

Elimination, Substitution and Engineering Controls are always the priority for reducing accident risks, but all control measures must be observed and considered for the safety of users.



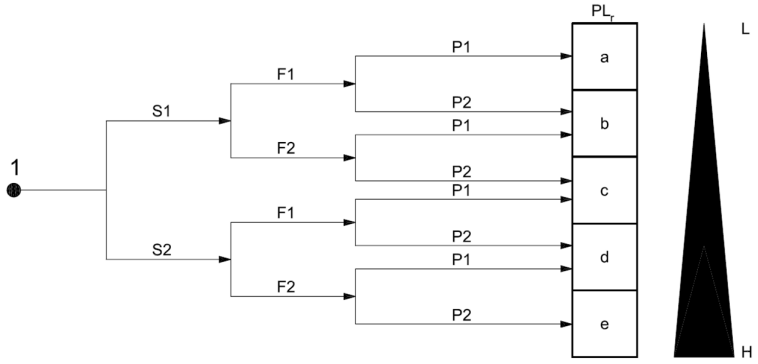
Risk Controls Priority Diagram

4.2. NORMATIVE REFERENCES FOR THE RISK EVALUATION

- Electromagnetic Compatibility (EMC) Directive (2014/30/EU)
- Low voltage directive (LVD) (2014/35/EU)
- EN 60204-1 Safety of machinery – Electrical equipment of machines
  PART 1: GENERAL REQUIREMENTS
- EN 61000-6-4 Electromagnetic compatibility (EMC) - Part 6-4: Generic standards
  Emission standard for industrial environments
- EN ISO 12100 – Safety of machinery – General principles for design — Risk assessment and risk reduction
- EN ISO 13849-1 – Safety-related parts of control systems – Part 1: General principles for design
- IEC 61439-1 - Low-voltage switchgear and controlgear assemblies – Part 1: General rules

3.3 PERFORMANCE LEVEL REQUIRED

The required performance level of functional safety functionalities is concerned with the contribution to the reduction in risk made by the safety-related parts of the control system being considered.



Key

1	starting point for evaluation of safety function's contribution to risk reduction
L	low contribution to risk reduction
H	high contribution to risk reduction
PL_r	required performance level

Risk parameters:

S	severity of injury
S1	slight (normally reversible injury)
S2	serious (normally irreversible injury or death)
F	frequency and/or exposure to hazard
F1	seldom-to-less-often and/or exposure time is short
F2	frequent-to-continuous and/or exposure time is long
P	possibility of avoiding hazard or limiting harm
P1	possible under specific conditions
P2	scarcely possible

Performance Level ISO 13849-1

4.3. GENERAL CONSIDERATIONS FOR THE TECHNICAL REPORT

4.3.1. RISK ANALYSIS

Risk analyses comprises of the following:

1) determination of the limits of the machine.
2) identification of hazards.
3) risk estimation.
4) risk evaluation.

Risk analysis provides information necessary for risk evaluation, which allows judgments to be made as to whether or not to reduce them.

These judgments shall be supported by a qualitative or, where appropriate, quantitative risk estimation, associated with the hazards present in the machine/equipment.

Risk evaluation shall be documented which happens with this document.

(ISO 12100:2013)

4.3.2. HAZARD IDENTIFICATION

After determining the limits of the machine/equipment, the essential step in any risk evaluation of a system is the systematic identification of reasonably foreseeable hazards (permanent hazards and hazards that may arise unexpectedly), dangerous situations and dangerous events that may occur throughout the life cycle of the machine/equipment.

Only when hazards are identified, the steps for elimination or reduction of these can be taken. To complete this identification of hazards, it is necessary to identify the operation situations on the machine/equipment and the tasks that will be performed by the people who will interact with it, taking into account the different parts, mechanisms and functions of the machine/equipment, the materials to be processed and the environment in which it will be used.

(ISO 12100:2013)

4.3.3. RISK REDUCTION

The objective of risk reduction can be achieved by applying the following sequence, defined as the three-step method:

Step 1: Safety measures inherent to the project:

Safety measures inherent to the design eliminate or reduce the associated risks through an appropriate choice of the design characteristics of the machine/equipment itself, and/or the interaction between exposed persons and the machine/equipment.

NOTE 1 – This phase is the only one in which hazards can be eliminated, thus avoiding the need for additional protective measures such as safety protections and complementary protection measures.

Step 2: Safety protections or complementary protection measures

Considering the reasonably foreseeable intended use and misuse, adequately selected additional protections and protective measures should be used to reduce the risks.

This is applied when it is not possible to eliminate the hazard or reduce its associated risk sufficiently through safety measures inherent in the project.

Step 3: Information for use

Where risks remain, although safety measures inherent in the project have been considered, or additional safety measures have been adopted, residual risks should be identified in the usage information. Usage information should include, but is not limited to, the following:

- Operational procedures for the use of the machine compatible with the training of users of the machine or other persons who may be exposed to the hazards related to it.
- Recommendations of safe working practices for the use of machine / equipment and the necessary training requirements, adequately described.
- Sufficient information, including residual risk warnings, for the different stages of machine/equipment life.

- Description of any recommended personal protective equipment, including details about it's need, as well as the training required for it's use.
- Usage information may not be considered as a replacement for a safety measure inherent in the design, safety protections, or other complementary safety measures.

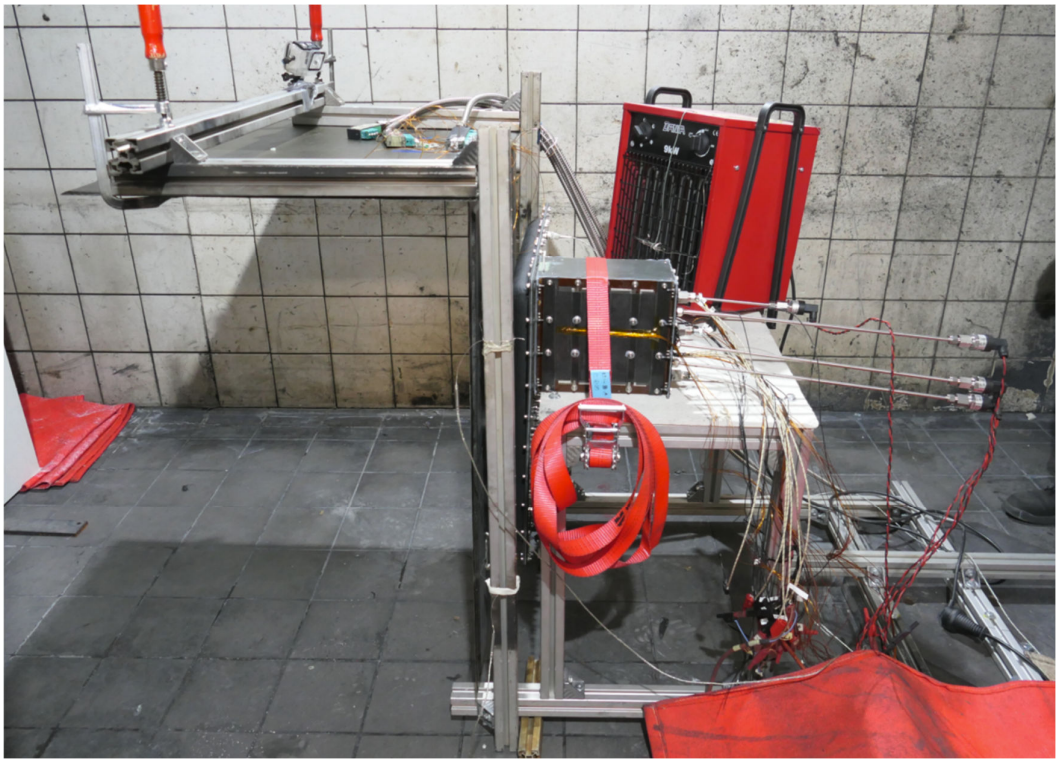
Note 2 – Appropriate protection measures associated with each of the modes of operation and intervention procedures reduce the possibility of operators being induced to use dangerous intervention techniques in the event of difficulties.

(ISO 12100:2013)

5. DETERMINATION OF THE EQUIPMENT LIMITS & EQUIPMENT OVERVIEW

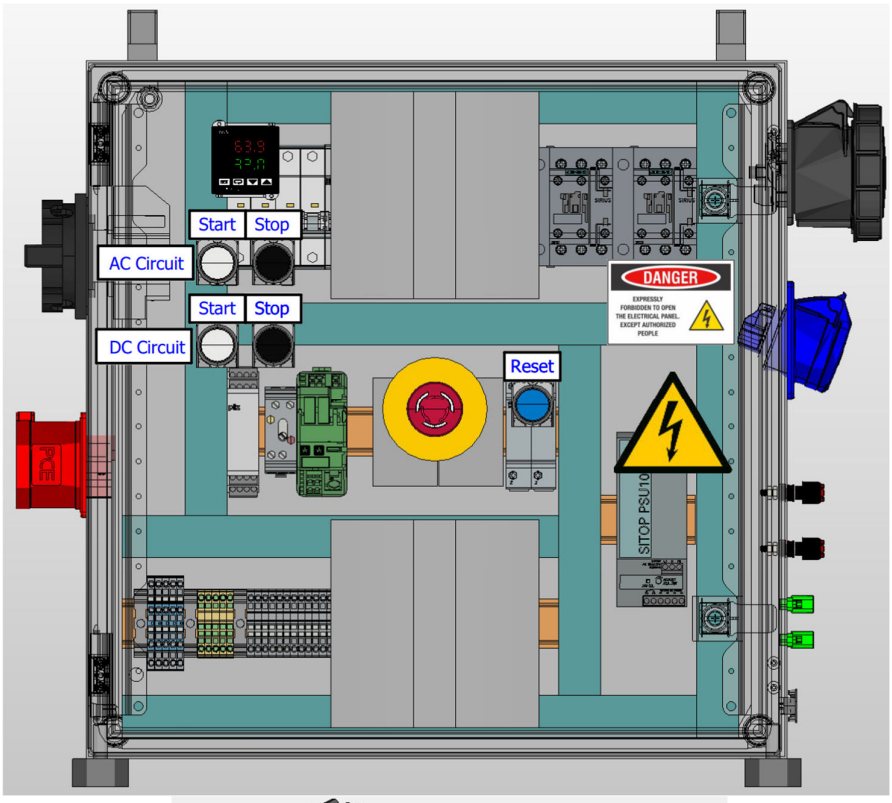
The Control for Heating Setup Enclosure was designed to be used **Outside** the Test Chamber, at the safe control room of the building. The control system will control the temperature inside the Chamber to achieve up to 60° Celsius. It also will control the heating of the Battery cells to force the thermal runaway from it.

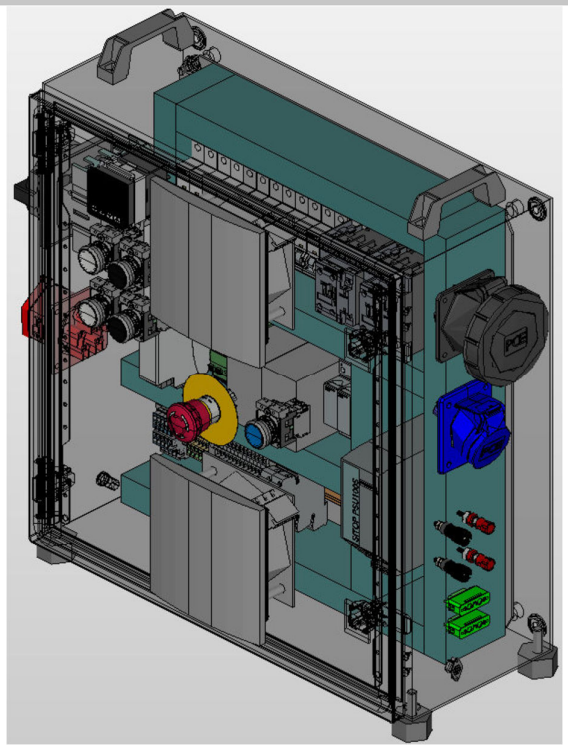
The interfaces; heating fans and heating mat will be installed inside the Test Chamber/Bunker for explosive/fire tests, below are images of the Test Chamber.



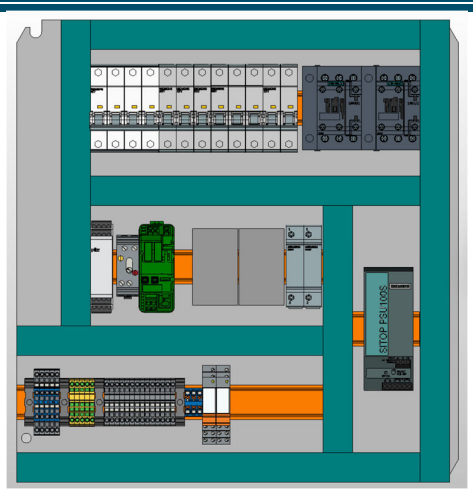
Chamber

The Control for Heating Setup Enclosure will be placed in a control room of the building (outside the chamber). The enclosure has four rubber foot to place it directly on the floor.





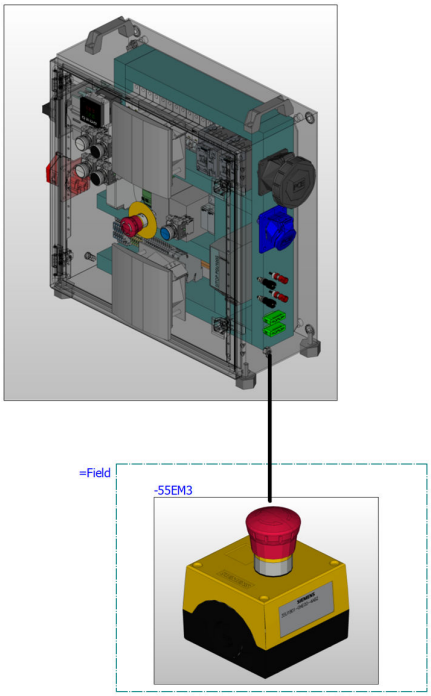
Outside View of the Enclosure



Mounting Panel View

This **Risk Evaluation** (this document) is limited to **Enclosure and E-stop as seen on the images below**, all the interfaces (e.g. external cables, heat fan, heat mat, etc..) are **NOT** covered by this Risk Evaluation.

A final user **Risk Assessment** must be developed by the final user considering all information related to the entire process (e.g. Connections, Machine/Equipment Operation, Procedures and Manual of the Chamber/Bunker, Device Under Test "Battery Cells", Environment, Heat equipment, etc..).



Entire System of this Risk Evaluation

<u>Exclusions: It is excluded from this Risk Evaluation the Laboratory DC Power Supply, Heat Equipment, and any other interfaces or risks generated from any other factors not mentioned inhere (e.g. battery, infrastructure, environment, etc..).</u>

5.1.1. INTENDED USE OF THE EQUIPMENT

The **Control for Heating Setup Enclosure** has been specially developed to assist the **Tests of the Battery Cells** that are going to be used by Lilium eAircraft GmbH. This Enclosure has four (4x) contactors that are part of two (2x) safety circuits; one is the AC safety circuit that feeds the Heater Fans, and the other is the DC safety circuit that feeds the Heater Mat.

The control enclosure has a **PID Temperature Controller, and a Thermocouple** that controls the temperature at the output, turning on/off the contactors (Output AC and DC).

5.1.2. INTENDED USER (USE LIMITS)

This equipment is for **industrial use**, and can only be operated by **qualified, trained, and authorized** professional.

Adequate training is required for predictable (normal) use, basic knowledge of safety concepts and operational procedures related to safety system are necessary.

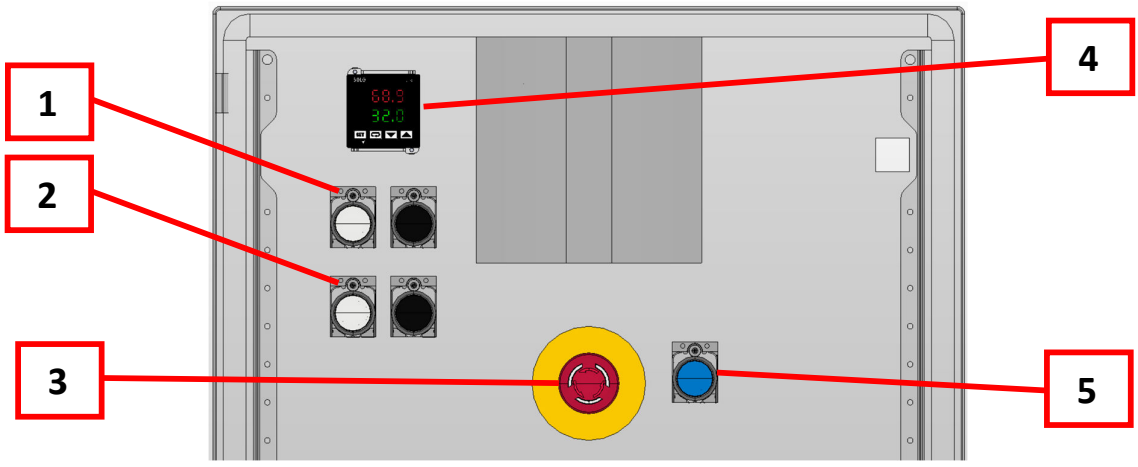
5.1.3. OPERATING CONDITIONS

The **Control for Heating Setup Enclosure** will be operated in the safety control room of the Bunker building.

Equipment cycle type: **Automatic (Set up of the cables are manually done by the operator).**

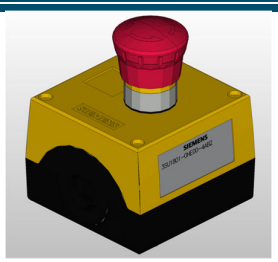
Bellow the operating interface of the Control for Heating Setup Enclosure:

1 – Start and Stop for the AC Circuit.
2 – Start and Stop for the DC Circuit.
3 – E-Stop.
4 – PID Controller.
5 – Reset the safety System (Safety Relay).



Operating Interface

The system also has an external E-Stop to be installed at the operation table, with easy reach for the operator.



External E-Stop

5.1.4. OPERATING ENVIRONMENT

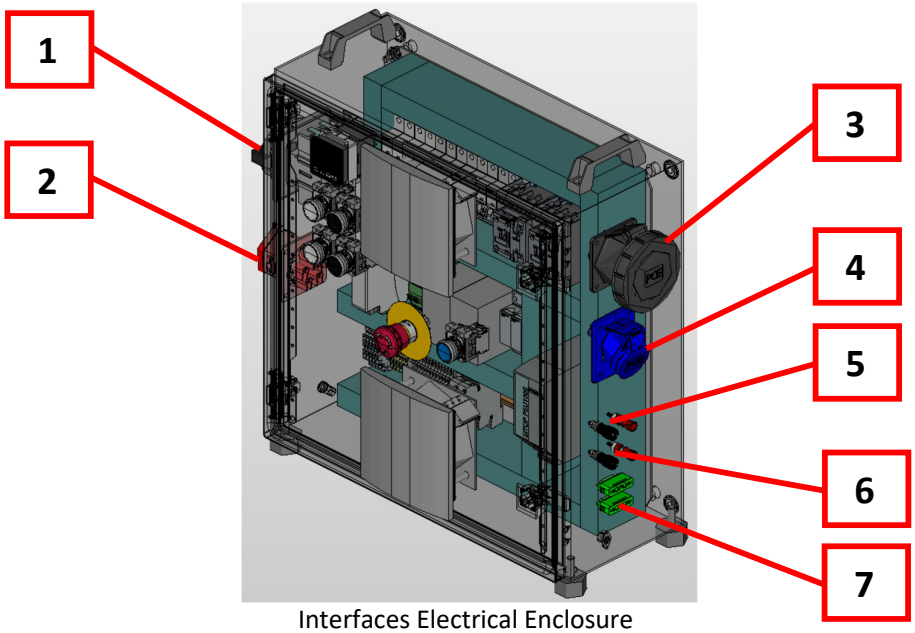
Indoors, clean and dry area.

5.1.5. TEST ARTICLE

The test article are the **Battery Cells**.

5.1.6. SYSTEMIC INTERFACES

1- **Disconnect Switch:** Used to turn on and off the system. It has resources to Lock-out and Tag-out the system when required (e.g. maintenance).
2- **AC Power Input (3~400VAC+N+PE):** Incoming of AC power for the system (Male Outlet).
3- **AC Power Outlet (400VAC):** Output for the controlled 400VAC for the 9KW Heater Fan.
4- **AC Power Outlet (230VAC):** Output for the controlled 230VAC for the 3KW Heater Fan.
5- **DC Power Input (120VDC):** Incoming of safety DC power from the DC laboratory power supply.
6- **DC Power Output (120VDC):** Output of the controlled DC power supply for the Heater Mat.
7- **Thermocouple:** Input of signal, reading of temperature.

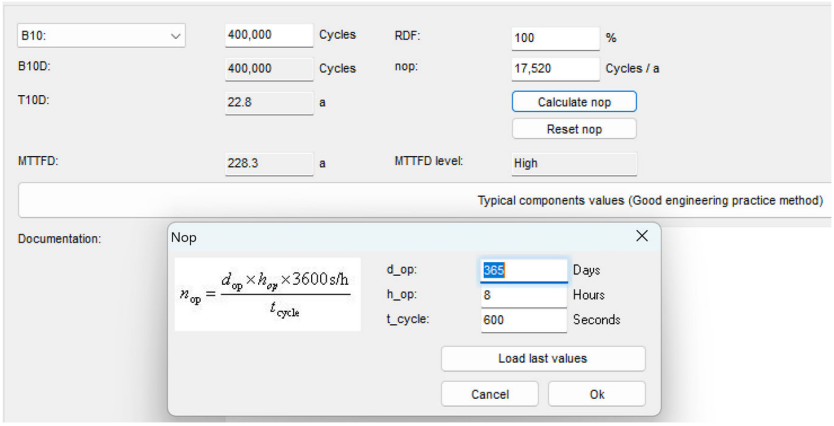


Interfaces Electrical Enclosure

5.1.7. LIFETIME / OPERATION CYCLES (TIME LIMITS)

The Electrical Enclosure was designed to achieve a lifetime of **10 years**, or up to **400.000 cycles** with load for the **DC Circuit**, and **1.000.000 cycles** with load for the **AC circuit**.

The predictable usage of this equipment for Lilium`s process/test is 8 Hours with a Cycle of 600 Seconds, used daily, which is completely acceptable.



MTTF Calculation

6. RISK EVALUATION & PERFORMANCE LEVEL (PL)

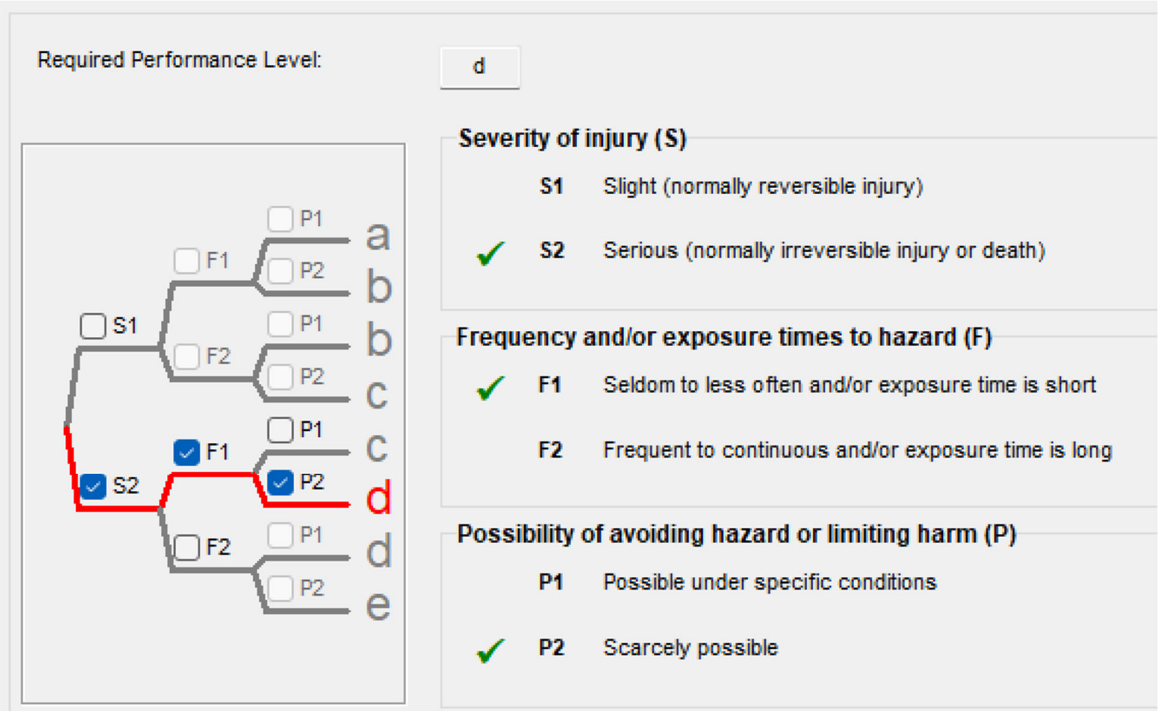
For the calculation of the electrical safety circuit (safety-related parts), was used the software; SISTEMA (Safety Integrity Software Tool for the Evaluation of Machine Applications) of the IFA (Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung; "Institute for Occupational Safety and Health of the German Statutory Accident Insurance").

The full report is attached as part of the technical file of this equipment.

6.1. PERFORMANCE LEVEL REQUIRED VS. PERFORMANCE LEVEL

6.1.1. PERFORMANCE LEVEL REQUIRED (PLr)

- The Performance Level required for the **E-Stop Circuit** is (PLr) = **D**



Performance Level Required Definition

6.1.2. PERFORMANCE LEVEL (PL)

- The performance level reached by the **E-Stop Circuit** is (PL)= **e**

Contained safety functions

SF Name: Emergency Stop

Required: PLr d	Reached: PL e	PFHD [1/h]: 7.6E-8	Status: green

Conclusion: The performance level reached and safety-related parts achieve the design required performance level.

6.2. RISK EVALUATION

														Risk Rating to be asheived					
Hazard Group / Origin	Appicab Not Appilcable	Hazard zone / Life cycle phase	Possible consequence hazard / Affected body part(s)	Description of hazard Exposed persons	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number	Protection objective / Protective measures (D: design, T: technical, C: control-related, U: User Information) ***Note*** : Following the 3-Step method - If D or T/C are not possible, then justify or mark as Not Applicable and describe measures for U (e.g. warning sign, wear special PPE, ...).	PLr / SIL	Applied Standards	Residual Risk	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number
Electrical Hazards																			
Arc Electric;	Applicable	Electrical Enclosure / Operation (Always that the system is running)	Electrical Shock, Burns, Blindness	> Might occur during commutation of the contactors under loads (hot switch). (≥1 person)	**S1 = Slight**	**F1 = Seldom**	**O2 = Medium**	**A1 = Possible**	1	- Commutation by contactors that intrinsically have features to control and suppress the arcing. - (T) - Properly wired circuit breakers and fuses. - (T)		ISO 60204-1 Low Voltage Directive 2014/35/EU	Lack of training or procedures to be followed.	**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1
Electromagnetic phenomena;	Applicable	Electrical Enclosure / Operation (Always if the system is running)	Could lead to death for pacemaker holders.	> Pacemaker might be effected if in the vicinity of the cabinet. (≥1 person)	**S2 = Serious**	**F1 = Seldom**	**O2 = Medium**	**A1 = Possible**	2	> Electrical Enclosure in Carbon steel contributing to the insulation of the electrical magnetic field. - (T) > Warning signs at the enclosure. - (U) > Only autorized personel alowed. - (C,U)		ISO 60204-1 EN 61000-6-4 Electromagnetic Compatibility (EMC) Directive (2014/30/EU)	Lack of training or procedures to be followed.	**S2 = Serious**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	2
Electrostatic phenomena;	Not Applicable																		
Live parts;	Applicable	Electrical Enclosure / Operation & Maintenance (1/day)	Electrical Shock, Burns, Blindness, Death	> Might occur when personnel have access inside the electrical enclosure or through connectors. (≥1 person)	**S2 = Serious**	**F1 = Seldom**	**O2 = Medium**	**A1 = Possible**	2	> Electrical connections with IP2x (finger safe), no electrical live parts exposed. - (T) > Labels, signs to identify the DC connection poles, danger, etc. - (U) > Warning in the user information that all energy sources must be locked out, tagout before opening the cabinet or performing any maintenance work. - (U) > Only female plugs (finger safe) at the outlets that carry voltage - (T) > Cabinet with Disconnect Switch and Lockout/Tagout resource to isolate energy source for maintenance. - (T) > Only autorized personel alowed to carry on maintenance. - (C,U)		ISO 60204-1 Low Voltage Directive 2014/35/EU	Lack of training or procedures to be followed.	**S2 = Serious**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	2
Not enough distance to live parts under high voltage;	Not Applicable																		
Overload;	Applicable	Electrical Enclosure, Wires, Connector / Operation (Always when the system is live or powered)	Fire, Burns, Death	> Might occur if passing more current/ power that the connector/wires were dimentioned, or if there is improper usage/connection. (≥1 person)	**S2 = Serious**	**F1 = Seldom**	**O2 = Medium**	**A1 = Possible**	2	> Fuses and Circuit breakers properly dimentioned and installed in the Cabinet - (T) > Proper dimensioning of cables/wires and electrical devices for the electrical circuits. - (T) > Plugs with "Poka-Yoke" system, to void wrong connection. - (T) > E-Stop to safely stop driven power/current to external circuits that are smoking. - (T)	**d: S2, F1, P2**	ISO 60204-1 ISO 13849-1& 2 Low Voltage Directive 2014/35/EU	Lack of training or procedures to be followed.	**S2 = Serious**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	2
Parts which have become live under fault conditions;	Applicable	Electrical Enclosure, Wires, Connector / Operation (Always if the system is live)	Electrical Shock, Burns, Blindness, Death, Fire	> Might occur if a Loose connector wire is inside the enclosure. > Wires or devices with insulation fault. (≥1 person)	**S2 = Serious**	**F1 = Seldom**	**O2 = Medium**	**A1 = Possible**	2	> Fuses and Circuit breakers properly dimensioned and installed in the Cabinet - (T) > Protective grounding systems installed on conductive part (e.g plate, door, enclosure body, etc..). > Connector properly dimensioned for cable relief and to avoid pulling/pushing cables and wires. - (T)		ISO 60204-1 Low Voltage Directive 2014/35/EU	Lack of training or procedures to be followed.	**S2 = Serious**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	2
Short-circuit;	Applicable	Electrical Enclosure, Wires, Connector / Operation (Always that the system is running)	Fire, Burns, Death	> Might occur if a Loose connector wire is inside the enclosure. > Wires or devices with insulation fault. > Fault on the load (s) (≥1 person)	**S2 = Serious**	**F1 = Seldom**	**O2 = Medium**	**A2 = Impossible**	3	> Fuses and Circuit breakers properly dimensioned and installed in the Cabinet - (T) > Wire and cables selected in accordance to norm IEC 61439-1. - (T) > Heating limits and expected short-circuit currents and short-circuit breaking capacity according to IEC 61439-1. - (T) > Electrical enclosure used only indoor and dry/clean areas - (C/U) > E-Stop to safely stop driven power/current to external circuits that are in short circuit. - (T)	**d: S2, F1, P2**	ISO 60204-1 ISO 13849-1& 2 IEC 61439-1 Low Voltage Directive 2014/35/EU	Short Circuit output circuits (e.g.heating mat during the tests). Lack of training or procedures to be followed.	**S2 = Serious**	**F1 = Seldom**	**O1 = Low**	**A2 = Impossible**	2
Loss of power or return of power after an interruption.	Applicable	Electrical Enclosure, Wires, Connector / Operation (Always if the system is live)	Electrical Shock, Burns, Blindness, Death, Fire	> Might occur when the equipment is powered after an energy drop on the system. (≥1 person)	**S2 = Serious**	**F1 = Seldom**	**O2 = Medium**	**A2 = Impossible**	3	> Safety relay to monitor the E-stop (safety system). In case of an energy drop the safety relay be disabled and will require a new Reset. - (T)	**d: S2, F1, P2**	ISO 60204-1 ISO 13849-1& 2 Low Voltage Directive 2014/35/EU	Lack of training or procedures to be followed.	**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1
Thermal radiation.	Applicable	Electrical Enclosure / Operation (Always that the system is running)	Burns	>Might occur when driving of current on the loads. (≥1 person)	**S1 = Slight**	**F1 = Seldom**	**O2 = Medium**	**A1 = Possible**	1	> Fuses and Circuit breakers properly dimensioned and installed in the Cabinet - (T) > Proper dimensioning of cables/wires and electrical devices for the electrical circuits. - (T) > Cooling Fans with filters - (T)		ISO 60204-1 Low Voltage Directive 2014/35/EU	Lack of training or procedures to be followed.	**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1

														Risk Rating to be asheived					
Hazard Group / Origin	Appicab Not Appilcable	Hazard zone / Life cycle phase	Possible consequence hazard / Affected body part(s)	Description of hazard Exposed persons	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number	Protection objective / Protective measures (D: design, T: technical, C: control-related, U: User Information) *Note* : Following the 3-Step method - If D or T/C are not possible, then justify or mark as Not Applicable and describe measures for U (e.g. warning sign, wear special PPE, ...).	PLr / SIL	Applied Standards	Residual Risk	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number
Mechanical Hazards																			
- Loss of power or return of power after an interruption.	Not Applicable																		
- acceleration, deceleration;	Not Applicable																		
- angular parts;	Not Applicable																		
- approach of a moving element to a fixed part;	Not Applicable																		
- cutting parts;	Applicable	Outside Enclosure / Commissioning & Dismantling (1 per week)	Cutting / mutilation, impact, and perforation of limbs	> Might occur when Handling the enclosure (e.g. Assembling or Disassembling the system). (≥1 person)	**S1 = Slight**	**F1 = Seldom**	**O2 = Medium**	**A1 = Possible**	1	> Handles on the top of the enclosure to move/carry it/transportation. - (T, C, U) > No sharp / cutting parts at the enclosure. - (T) > Personal protection equipment (PPE): Gloves clothes, boots - (U)		ISO12100	Lack of training or procedures to be followed.	**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1
- elastic elements;	Not Applicable																		
- falling objects;	Not Applicable																		
- gravity;	Not Applicable																		
- height from the ground;	Not Applicable																		
- high pressure;	Not Applicable																		
- instability;	Applicable	After the setup / Operation. (Daily)	Falling, tripping, pressing / crushing impact, cutting / perforation of limbs	> Might occur after setting up the system. (≥1 person)	**S1 = Slight**	**F1 = Seldom**	**O3 = Hight**	**A1 = Possible**	2	> Anti Vibration Foot to improve stability - (T) > To be installed by the user only on even/solid and floor surfaces - (U) > Lay of the cables properly, and use of Floor, use of Cable Bridge when needed - (T, C). > Use Hazard Chain Barrier and Signals when needed - (T, C, U). > Not install the cabinet in aisle/hallway or any walking paths - (T, C, U).		ISO12100	Lack of training or procedures to be followed.	**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1
- kinetic energy;	Not Applicable																		
- machinery mobility;	Not Applicable																		
- moving elements;	Not Applicable	Electrical Enclosure ; Commissioning & Dismantling, Maintnance (1 per week)	Pressing / crushing impact, cutting / perforation of limbs	> Might occur when providing maintenance due to open door instability, or (de)commissioning the equipment due to plug/socket cover spring.	**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1	> No sharp / cutting parts at the enclosure. - (T) > Personal protection equipment (PPE): Gloves clothes, boots - (U) > Only autorized personel alowed to provide maintenance and (de)commissioning the equipment. - (C,U)		ISO12100	Lack of training or procedures to be followed.	**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1
- rotating elements;	Not Applicable																		
- rough, slippery surface;	Not Applicable																		
- sharp edges;	Applicable	Outside Enclosure / Commissioning & Dismantling (1 per week)	Cutting / mutilation, impact, and perforation of limbs	> Might occur when Handling the enclosure (e.g. Assembling or Disassembling the system). (≥1 person)	**S1 = Slight**	**F1 = Seldom**	**O2 = Medium**	**A1 = Possible**	1	> Handles on the top of the enclosure to manipulate or carry it. - (T, C, U) > No sharp / cutting parts at the enclosure. - (T) > Personal protection equipment (PPE): Gloves clothes, boots - (U)		ISO12100	Lack of training or procedures to be followed.	**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1
- stored energy;																			
- vacuum.																			

														Risk Rating to be asheived					
Hazard Group / Origin	Applicab Not Appilcable	Hazard zone / Life cycle phase	Possible consequence hazard / Affected body part(s)	Description of hazard Exposed persons	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number	Protection objective / Protective measures (D: design, T: technical, C: control-related, U: User Information) *Note* : Following the 3-Step method - If D or T/C are not possible, then justify or mark as Not Applicable and describe measures for U (e.g. warning sign, wear special PPE, ...).	PLr / SIL	Applied Standards	Residual Risk	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number
Thermal Hazards																			
- explosion;	Not Applicable																		
- sparks;	Not Applicable																		
- flame;	Applicable	Electrical Enclosure / Operation (Always that the system is running)	Fire, Burns, Death	> Might occur if overheating of electrical / electronic components, or wires. (≥1 person)	S2 = Serious	F1 = Seldom	O1 = Low	A1 = Possible	2	> Fuses and Circuit breakers properly dimensioned and installed in the Cabinet - (T) > Proper dimensioning of wires and electrical devices for the electrical circuits. - (T) > E-Stop to safely stop driven power/current to circuits that has initiated fire. - (T)	d: S2, F1, P2	ISO 60204-1 ISO 13849-1,-2 ISO 12100 Low Voltage Directive 2014/35/EU	Lack of training or procedures to be followed.	S1 = Slight	F1 = Seldom	O1 = Low	A1 = Possible	1
- objects or materials with a high or low temperature;	Not Applicable																		
- radiation from heat sources.	Not Applicable	Electrical Enclosure / Operation (Always that the system is running)	Fire, Burns, Death	> Might occur if the Cooling system (intake and exhaust) is blocked. (≥1 person)	S2 = Serious	F1 = Seldom	O1 = Low	A1 = Possible	2	> Air intake and exhaust cooling system to be kept free. (U) > Only autorized personel alowed to commissioning and operate the equipment. - (C,U)		ISO 12100	Lack of training or procedures to be followed.	S1 = Slight	F1 = Seldom	O1 = Low	A1 = Possible	1
Noise Hazards																			
- cavitation phenomena;	Not Applicable																		
- exhausting system;	Applicable	Electrical Enclosure / Operation (Always that the system is running)	Stress, hearing loss	- Noise from the cooling fans (intake and exhaust). (≥1 person)	S1 = Slight	F1 = Seldom	O1 = Low	A1 = Possible	1	> Low noise from the fan, under the limit daily permissible - (T)		ISO 12100		S1 = Slight	F1 = Seldom	O1 = Low	A1 = Possible	1
- gas leaking at high speed;	Not Applicable																		
- manufacturing process (stamping, cutting, etc.);	Applicable	Electrical Enclosure / Operation (Always that the system is running)	Stress, hearing loss	- Switching of the power contactors. (≥1 person)	S1 = Slight	F1 = Seldom	O1 = Low	A1 = Possible	1	> Contactors are located inside the enclosure attenuating the noise emission. - (T) > Low commuting frequency of the contractors. - (T/C)		ISO 12100		S1 = Slight	F1 = Seldom	O1 = Low	A1 = Possible	1
- moving parts;	Applicable																		
- scraping surfaces;	Not Applicable																		
- unbalanced rotating parts;	Not Applicable																		
- whistling pneumatics;	Not Applicable																		
- worn parts	Not Applicable																		

														Risk Rating to be asheived					
Hazard Group / Origin	Applicab Not Appilcable	Hazard zone / Life cycle phase	Possible consequence hazard / Affected body part(s)	Description of hazard Exposed persons	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number	Protection objective / Protective measures (D: design, T: technical, C: control-related, U: User Information) *Note* : Following the 3-Step method - If D or T/C are not possible, then justify or mark as Not Applicable and describe measures for U (e.g. warning sign, wear special PPE, ...).	PLr / SIL	Applied Standards	Residual Risk	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number
Vibration Hazards																			
- cavitation phenomena;	Not Applicable																		
- misalignment of moving parts;	Not Applicable																		
- mobile equipment;	Not Applicable																		
- scraping surfaces;	Not Applicable																		
- unbalanced rotating parts;	Not Applicable																		
- vibrating equipment;	Applicable	Electrical Enclosure / Operation (Always that the system is running)	Fire, Burns, Short-circuit	> Vibration from contactors commuting and fans could lead to Loose terminals / screws / wires / electrical devices, or damage to the electril devices inside the electrical enclosure. (≥1 person)	**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1	> All electrical equipment for industrial use with CE marking. - (T) > Electrical equipment firmly installed on the DIN rail, device`s base with spring connection. - (T) > Spring connector on the terminals. - (T)		ISO 60204-1 IEC 61439-1 ISO 12100 Low Voltage Directive 2014/35/EU		**S1 = Slight**	**F1 = Seldom**	**O1 = Low**	**A1 = Possible**	1
- worn parts.	Not Applicable																		
Radiation Hazards																			
- ionizing radiation source;	Not Applicable																		
- low frequency electromagnetic radiation;	Not Applicable																		
- optical radiation (infrared, visible and ultraviolet), including laser;	Not Applicable																		
- radio frequency electromagnetic radiation.	Not Applicable																		

														Risk Rating to be asheived					
Hazard Group / Origin	Appicab Not Appilcable	Hazard zone / Life cycle phase	Possible consequence hazard / Affected body part(s)	Description of hazard Exposed persons	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number	Protection objective / Protective measures (D: design, T: technical, C: control-related, U: User Information) *Note* : Following the 3-Step method - If D or T/C are not possible, then justify or mark as Not Applicable and describe measures for U (e.g. warning sign, wear special PPE, ...).	PLr / SIL	Applied Standards	Residual Risk	Severity	Frequer / Exposure	Probabil of Occurrence	Possibil of avoidance	Risk Rating Number
Ergonomic Hazards																			
- Access	Applicable	Electrical Enclosure / Operation	Back pain. Posture injuries.	> Might occour if the enclosure is located in a difficult access area, cluttered area. High operation frequency.	S1 = Slight	F1 = Seldom	O2 = Medium	A1 = Possible	1	> Enclosure to be operated on a low frequency (up to 4 times per day). - (U) > Electrical enclosure to be placed in a place of easy/free access. (1 meter free space around the enclosure). - (U, C). > Buttons to be easily accessible with free reach. - (U, C). > Area around the enclosure tidy/neat. - (U, C)				S1 = Slight	F1 = Seldom	O1 = Low	A1 = Possible	1
- design or location of indicators and visual displays units;	Not Applicable																	
- design, location or identification of control devices;	Not Applicable																	
- Effort	Not Applicable	Assembling the electrical enclosure. / Assembly (1 per week)	Back pain. Posture injuries	> High effor or Bad/ wrong posture when Assembling. (≥1 person)	S1 = Slight	F1 = Seldom	O2 = Medium	A1 = Possible	1	> Assembly only by qualified, trained, and authorized professionals. - (T, C, U). > Use of the correct techniques, devices and tools for each type of task. Training, guidance and awareness of correct work techniques. - (T, C, U).				S1 = Slight	F1 = Seldom	O1 = Low	A1 = Possible	1
- Flicker, daziling, shadow, stoboscopic effect;	Not Applicable																	
-Local Lighting	Not Applicable																	
- Mental Overload / Underload	Not Applicable																	
- Posture;	Not Applicable																	
- Repetitive activity	Not Applicable																	
- Visibility	Not Applicable																	
Hazards associated with the environment in which the machine is used																			
- dust and fog;	Applicable	Electrical Enclosure / Operation (Always that the system is running)	> Arcs, fire, burns.	> Ingress into the electrical enclosure could lead to damage to electrical devices and potentially cause faults, short circuits, explosions - (≥1 person)	S2 = Serious	F1 = Seldom	O1 = Low	A1 = Possible	2	> Cooling Fans with filters - (T) > Use of the electrical device in an industrial clean environment - (C)			Lack of training or procedures to be followed. Lack of Predictive maintenance to clean the filters.	S2 = Serious	F1 = Seldom	O1 = Low	A1 = Possible	2
- electromagnetic disturbance; - lightning;	Not Applicable																	
- lightning;	Not Applicable																	
- moisture;	Not Applicable																	
- pollution;	Not Applicable																	
- snow;	Not Applicable																	
- temperature;	Not Applicable																	
- Water	Not Applicable																	
-Wind	Not Applicable																	
- Lack of oxygen	Not Applicable																	

7. TRAINING SHEET

Bellow a example of training sheet (training must be documented).

LILIUM	TRAINING FORM	**Data**	____ /____ /_____
Equipment:			
Program content:	- Safety: o Safety system recognition (Safety devices present on the equipment); o Location and operation of the system; o Devices for Blocking Energy Sources (Lockout / Tagout); o Test Procedure at the beginning of the shift; o Use of PPE to operate the equipment (if necessary); - Identification of process errors: o Fault reset. o How to put the equipment in the starting position (home); - Presentation and recognition of the operation of the machine: o Parameterization; o Operations mode (Automatic, Manual, etc..); - Maintenance: o Location of lubrication locations, wear parts, etc; o Maintenance procedure, lockout, etc; o Identification of damaged parts;		

Participants sign below stating that they have received and understood the training, according to the syllabus.

Full name	**Sector / Role**	**Signature**

Instructors:

Sign: _____ *Sign:* _____

Name: *Name:*

Role: *Role:*

8. APPENDIX

8.1. (SISTEMA) - PL Calculation - Control Enclosure for the Heating Set Up

Attached.