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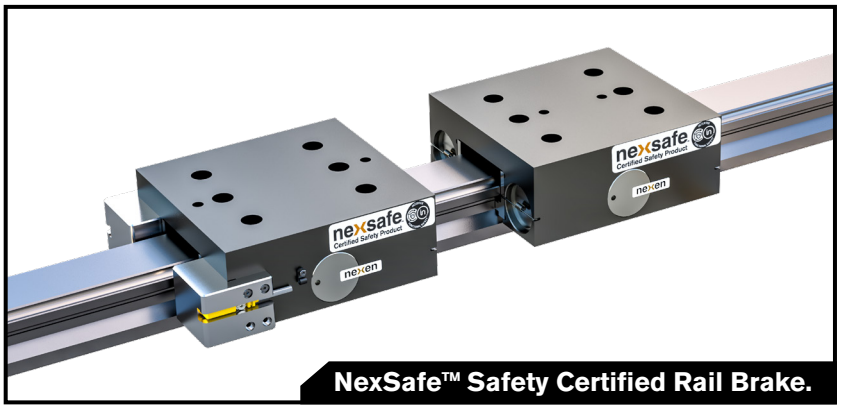
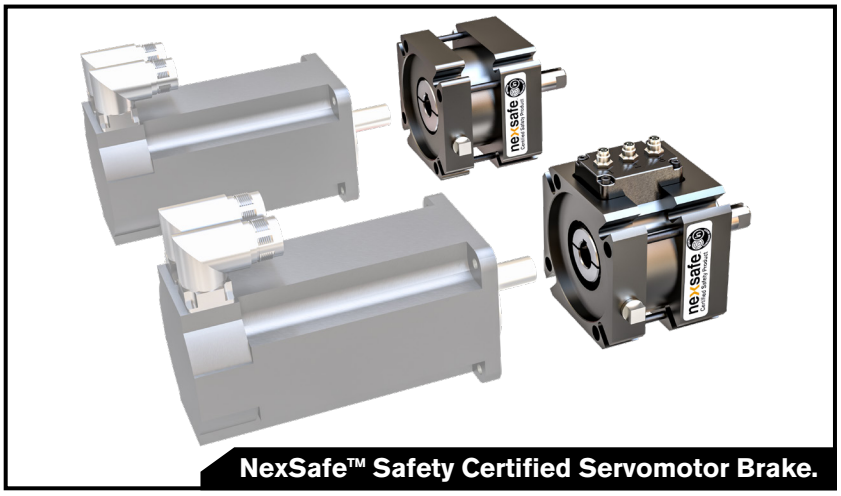
nexsafe™
Certified Safety Products

CERTIFIED SAFETY PRODUCTS

Safety Application Guide

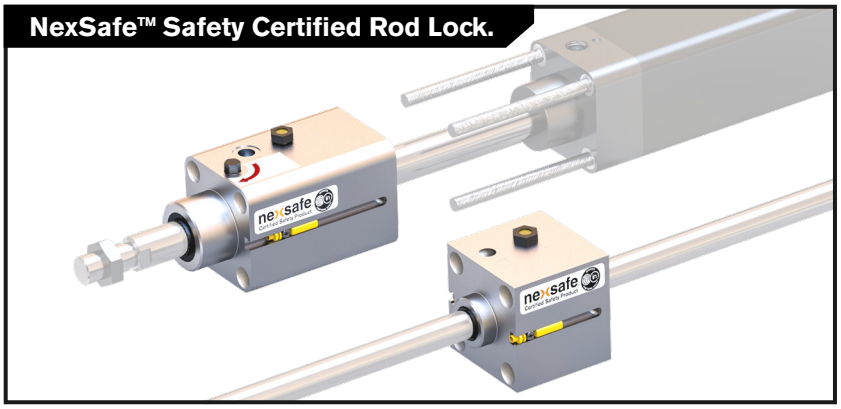


NexSafe™ Safety Certified Rail Brake.



NexSafe™ Safety Certified Servomotor Brake.

NexSafe™ Safety Certified Rod Lock.



Nexen Functional Safety Certified Products: SAFETY APPLICATION GUIDE

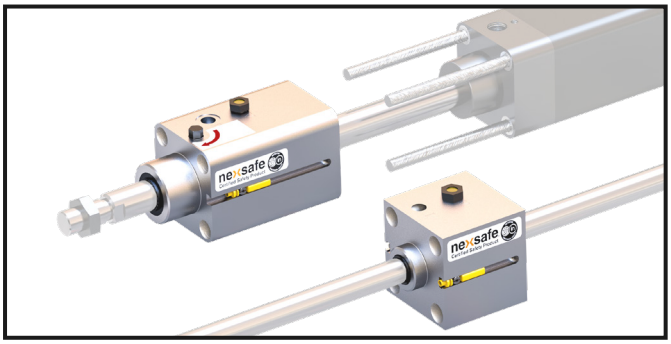
SAFETY RATED TECHNOLOGY

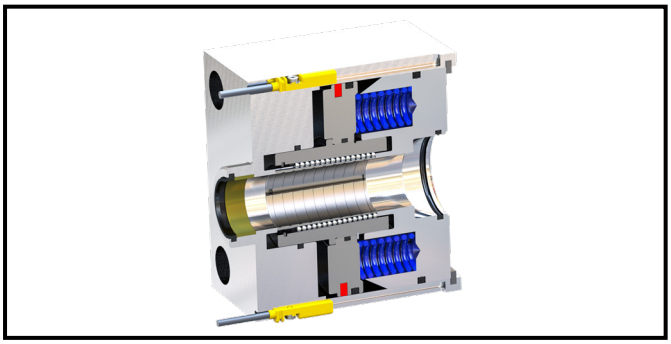
The nexsafe™ Advantage

NexSafe™ Functional Safety certified Rod Locks, Rail Brakes and Servomotor Brakes provide a verified, reliable solution that machine builders can depend on. With ISO 13849-1 Functional Safety Certification by Intertek©, these products can be used on a machine for operations such as holding, emergency stopping or positioning. NexSafe™ products are an ideal fit for applications where safety is a priority.

With spring engaged air released functionality, these products are default to lock, ideal for emergency stopping and holding applications. Optional operating mode sensors further ensure NexSafe™ products are an ideal fit for safety channels designed for ISO 13849-1 Categories B through 4 and Performance Levels PLa through PLe.

ISO 13849-1 is a safety of machinery standard that assists in the design and integration of safety related parts of control systems or machines. This safety standard includes a system of categorizing the risk a machine poses, and the safety functions to mitigate that risk. By selecting NexSafe™ certified safety components, machine builders can rely on the provided reliability data while achieving a safety performance level.





Safety Rated Rod Lock

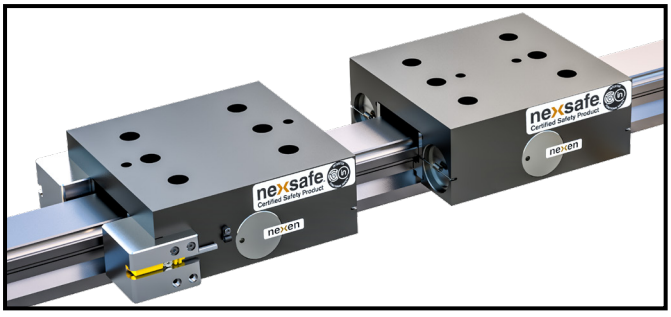
Precision holding with guide rod systems and NFPA or ISO cylinders.

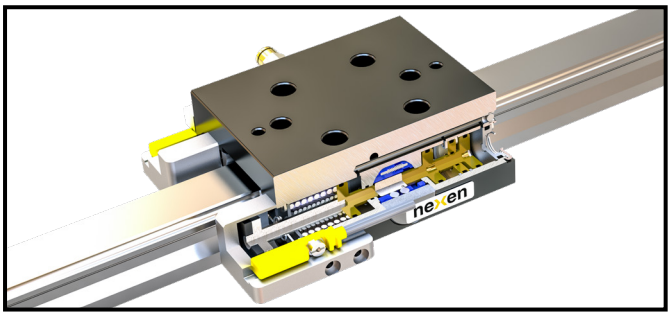
Safety Features:

- Spring-engaged, air-released
- Multiple springs
- Engagement and Disengagement sensors available
- B_{10D} of 2 million cycles

Features:

- Extremely low backlash
- Can be used in all orientations
- Cylinder mount or stand alone
- No rod wear; due to large clamping area
- Can be stacked for additional force
- Meets IP67 standards
- Emergency stopping and holding





Safety Rated Rail Brake

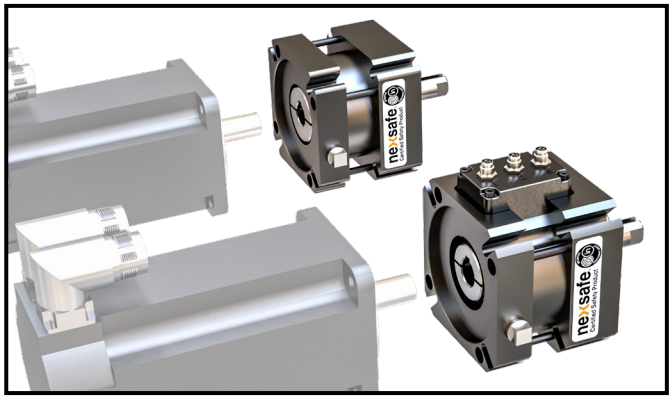
Compact and powerful brakes compatible with most profile guide rails and carriages.

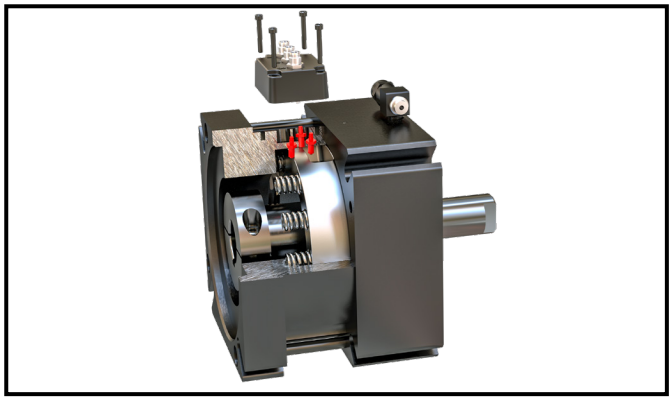
Safety Features:

- Spring-engaged, air-released
- Multiple springs
- Multiple actuators
- Engagement and Disengagement sensors available
- B_{10D} of 4 million cycles

Features:

- High clamping force
- Low backlash
- Holds in all orientations
- Emergency stopping and holding
- Brake geometry matches rail system





Safety Rated Servomotor Brake

Powerful, high-torque brake installed between the servo motor and gearhead/load.

Safety Features:

- Spring-engaged, air-released
- Multiple springs
- Integral clamp collar with backup keyway
- Engagement, Disengagement and Wear sensors available
- B_{10D} of 2 million cycles

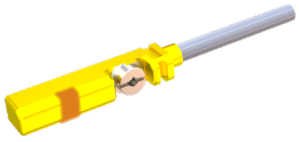
Features:

- Zero backlash
- Long facing life
- Can be used in all orientations
- Low inertia
- Sizes to fit most servo motors
- Meets IP67 standards
- Emergency stopping and holding
- Enough torque to stall servo motor

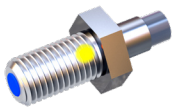
Operating Feedback

OPTIONAL OPERATING MODE SENSORS

Optional operating mode sensor(s) are available for all three Nexsafe™ product lines and can be used to signal Engagement, Disengagement or Wear. By using the Operating Mode Sensors, system manufacturer's are able to gain higher safety category ratings per ISO 13849-1. Rating of the overall safety channel is the responsibility of the system manufacturer. Nexen's sensors are also Industry 4.0 compatible and can provide information to maximize machine efficiency.



Disengagement and Engagement Sensors on Rod Lock and Rail Brake Product Lines	
Operating Principal	Magneto-Resistive
Sensor Output	Normally Open
	Normally Closed



Disengagement, Engagement and Wear Sensors on Servomotor Brake Product Line	
Operating Principal	Inductive Proximity Sensor
Sensor Output	Normally Open
Fieldbus Connectivity	IO-Link v1.0 (See Tech Data Sheet)

Safety Design Considerations

ISO 13849-1 "Safety of Machinery – Safety-Related Parts of Control Systems, Part 1: General Principles for Design" is an international standard intended to help incorporate safety systems into machinery with sufficient reliability.

If initial machinery risk assessments identify a risk to safety, then a proper safety function per ISO 13849-1 is required to mitigate the risk. The standard specifies a Performance Level based on reliability data that is required for carrying out safety functions. Each Performance Level is defined by four specific requirements: Category, Mean Time to Dangerous Failure ($MTTF_D$), Diagnostic Coverage (DC) and Common Cause Failure (CCF). The Performance Level can then be used in risk assessments to ensure the proper safety devices have been implemented and the risk is reduced.

The following safety design steps are from ISO 13849-1 safety standard. It is the manufacturer's responsibility to follow the applicable standards to ensure machine safety.

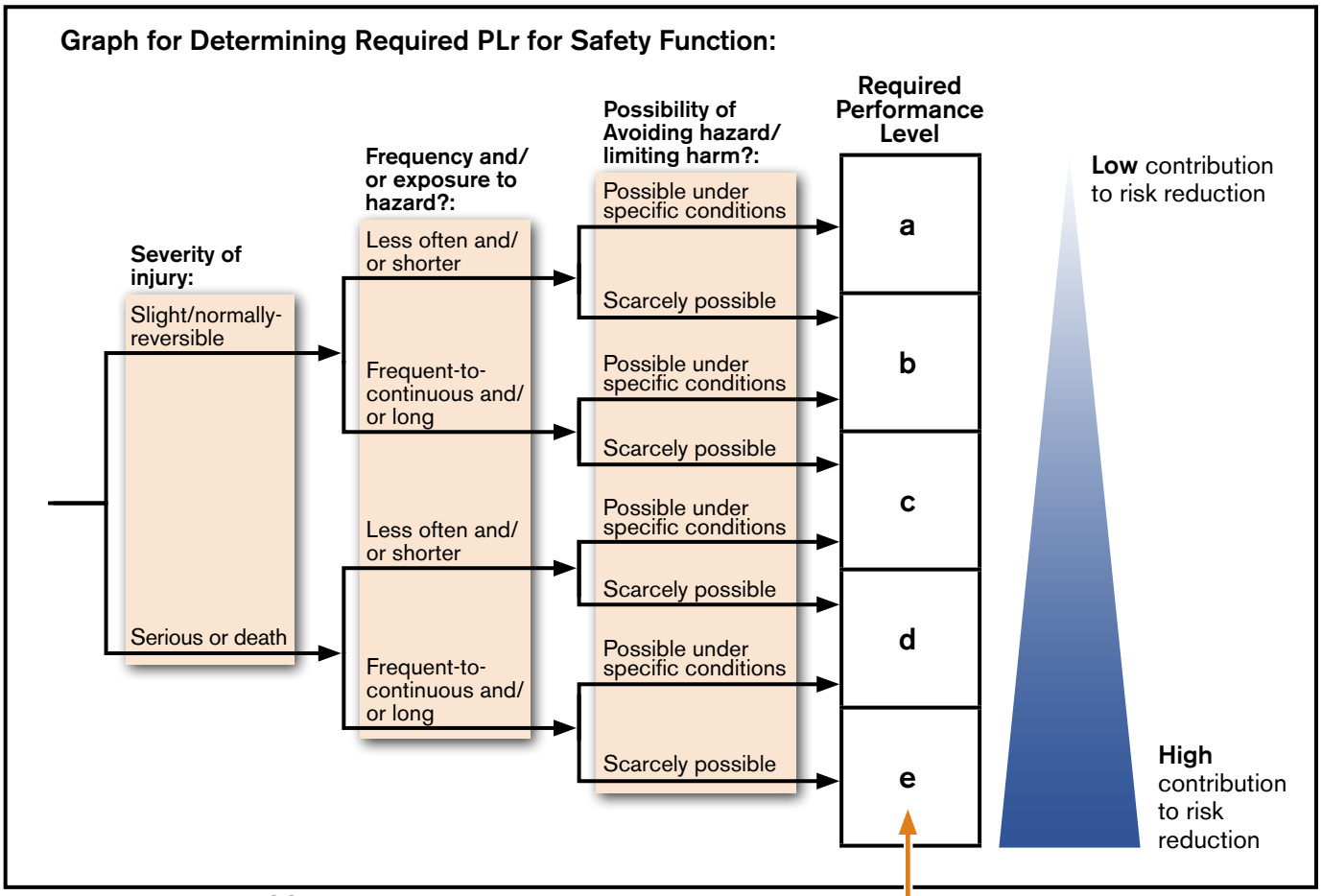
››› Specify Required Performance Level (PLr) Based on Risk Estimation.

Performance Level (PL) is the value used to specify the ability of safety-related parts of a control system to perform a safety function.

Required Performance Level (PLr) is the required Performance Level (PL) to achieve the required risk reduction for each safety function.

The Performance Level (PL) of safety related parts of a control system must be equal to or higher than the Required Performance Level (PLr).

Graph for Determining Required PLr for Safety Function:



Paraphrased excerpt from ISO 13849-1

NexSafe™ products are capable of achieving all Performance Levels (PL a through PL e).

››› Select System Category Level Requirements.

Category Level is the structure of the safety related parts of the control system and how their behavior in a fault condition affects the safety performance of the safety control system.

Category Level Definitions:

Category	Summary of Requirements	System Behavior	Principal Used to Achieve Safety
B	Safety Related Parts of Controls Systems and/or their protective equipment, as well as their components, shall be designed, constructed, selected, assembled and combined in accordance with relevant standards so that they can withstand the expected influence. Basic safety principals shall be used.	The occurrence of a fault can lead to the loss of the safety function	Mainly characterized by selection of components
1	Requirements of Category **B** shall apply. Well-tried components and well-tried safety principles shall be used.	The occurrence of a fault can lead to the loss of the safety function but the probability of occurrence is lower than for category B.	Mainly characterized by selection of components
2	Requirements of Category **B** and the use of well-tried safety principles shall apply. Safety function shall be checked at suitable intervals by the machine control system.	The occurrence of a fault can lead to the loss of the safety function between the checks. The loss of safety function is detected by the check.	Mainly characterized by structure, generally a single channel with monitoring.
3	Requirements of Category **B** and the use of well-tried safety principles shall apply. Safety-related parts shall be designed, so that: • A single fault in any of these parts does not lead to the loss of the safety function, and • Whenever reasonably practicable, the single fault is detected.	When a single fault occurs, the safety function is always performed. Some, but not all, faults will be detected. Accumulation of undetected faults can lead to the loss of the safety function.	Mainly characterized by structure, generally a dual channel with monitoring.
4	Requirements of Category **B** and the use of well-tried safety principles shall apply. Safety-related parts shall be designed, so that: • A single fault in any of these parts does not lead to the loss of the safety function, and • The single fault is detected at or before the next demand upon the safety function, but that if this detection is not possible, an accumulation of undetected faults shall not lead to the loss of the safety function.	When a single fault occurs, the safety function is always performed. Detection of accumulated faults reduces the probability of the loss of the safety function (high DC). The faults will be detected in time to prevent the loss of the safety function.	Mainly characterized by structure, generally dual channel with dual monitoring.

Paraphrased excerpt from ISO 13849-1

NexSafe™ products are capable of achieving all Category Levels (Cat B through Cat 4).

Safety Design Considerations

Specify Mean Time to Dangerous Failure ($MTTF_D$)

B_{10D} is the mean number of cycles until 10% of the components fail dangerously.

NexSafe™ B10D: Refer to product specifications.

Mean Time to Dangerous Failure ($MTTF_D$) is given in three levels (see Table) and shall be taken into account for each channel individually.

NexSafe™ $MTTF_D$: Perform calculation using intended application cycle rate, operating usage and Nexen supplied B_{10D} cycle life specification.

Denotation of each channel	Range of each channel
Low	3 years ≤ $MTTF_D$ < 10 years
Medium	10 years ≤ $MTTF_D$ < 30 years
High	30 years ≤ $MTTF_D$ ≤ 100 years

$$MTTF_D = \frac{\left(10 * B_{10D} * t_{cycle(sec)}\right)}{\left(\frac{\text{Days}}{\text{per Year}} * \frac{\text{Hours}}{\text{per Day}} * \frac{\text{3600 Seconds}}{\text{per Hour}}\right)}$$

Paraphrased excerpt from ISO 13849-1

Useful Life (T_{10D}) is the mean time until 10% of the components fail dangerously. **B_{10D}** can be converted to **T_{10D}** by using the mean number of annual operations.

NexSafe T10D: Perform calculation using MTTFD calculated above.

$$T_{10D} = \frac{MTTF_D}{10}$$

Specify Diagnostic Coverage

Diagnostic Coverage (DC) is the ratio between the failure rate of detected dangerous failures and the failure rate of total dangerous failures. Diagnostic coverage can exist for the whole or parts of a safety-related system.

NexSafe™ Diagnostic Coverage (DC): Dependent on brake redundancy and sensor setup, refer to product safety ratings.

None	Low	Medium	High
If DC is < 60%	**If DC is 60 to 90%**	**If DC is 90 to 99%**	**If DC is ≥ 99%**
No sensor feedback necessary.	Feedback sensor shall be used to monitor the operating mode of brake.	Feedback sensor shall be used to monitor the operating mode of brake. The brake must be cycled engaged and disengaged at least this often to check for brake functionality:	
		every 3 months	once every day

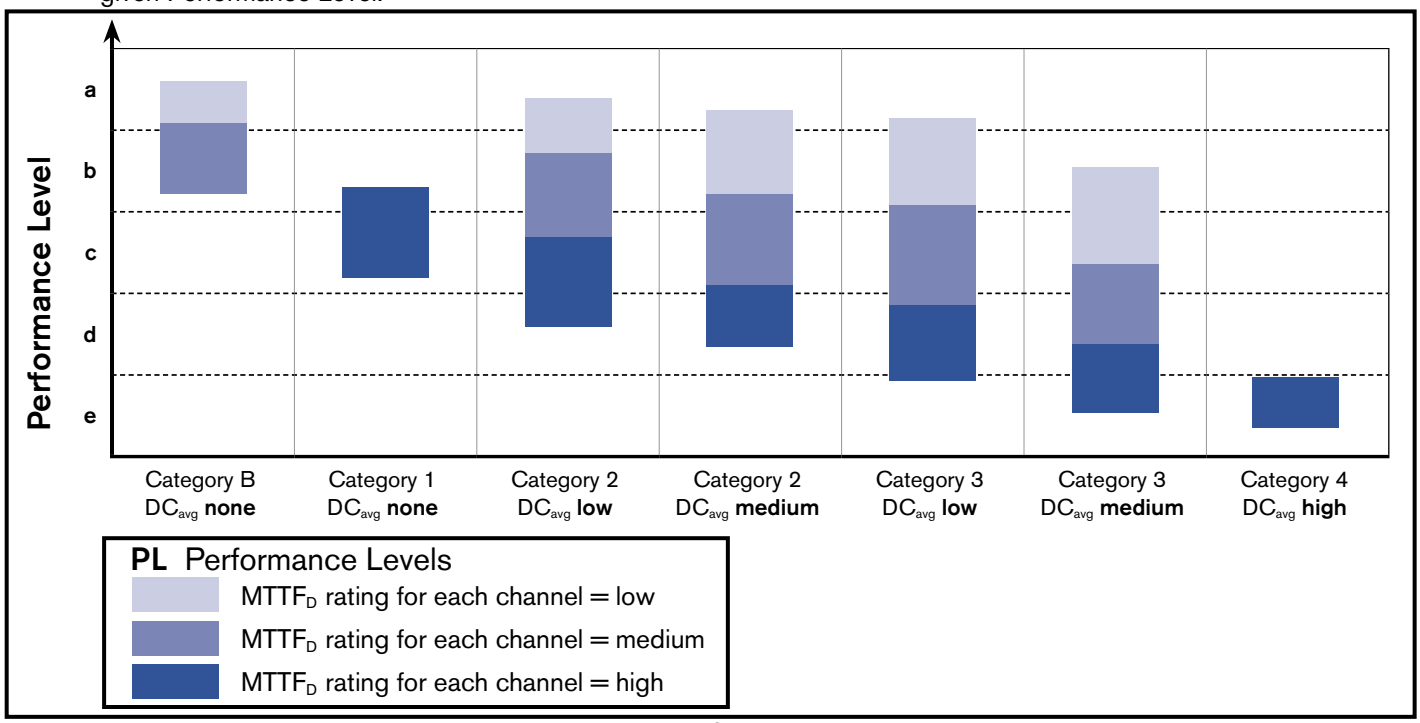
Specify Common Cause Failure

Common Cause Failure (CCF) is the failure of different items, resulting from a single event, where these failures are not consequences of each other. CCF is to be considered at the system level, not the component level.

NexSafe™ Common Cause Failure (CCF): 75% assuming similar technology used in safety channel. Value may be higher if diversity of technology is used. Refer to product safety ratings.

Reliability Data Relationships

The following graph shows the relationship between Category, Diagnostic Coverage, and $MTTF_D$ to the Performance Level. Use this graph to determine if the capabilities of the safety related parts of the control system can achieve a given Performance Level.



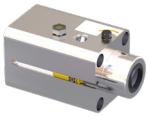
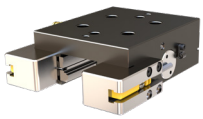
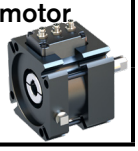
Paraphrased excerpt from ISO 13849-1

NexSafe™ Compliance Capabilities

Choose Required Performance Level (PLr) and Safety Category

ISO 13849-1 steps through to determine the Performance Level and Category required. Use the following table to identify the Performance Level and Category that are possible for a given NexSafe™ product's technology. The Category structure is further defined by any redundancies that are required with the number of sensors and products.

NexSafe™ Product Capabilities

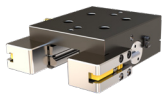
Rod Lock 	Category **B** (PL**a**, PL**b**) Category **1** (PL**b**, PL**c**)	Category **2** (PL**a**, PL**b**, PL**c**, PL**d**)			Category **3** (PL**a**, PL**b**, PL**c**, PL**d**)	Category **4** (PL**e**)
Rail Brake 	Category **B** (PL**a**, PL**b**) Category **1** (PL**b**, PL**c**)		Category **2** (PL**a**, PL**b**, PL**c**, PL**d**)			Category **3** (PL**a**, PL**b**, PL**c**, PL**d**) Category **4** (PL**e**)
Servomotor Brake 	Category **B** (PL**a**, PL**b**) Category **1** (PL**b**, PL**c**)	Category **2** (PL**a**, PL**b**, PL**c**, PL**d**)			Category **3** (PL**a**, PL**b**, PL**c**, PL**d**)	Category **4** (PL**e**)
	No Sensors Required	**1** Sensor Required	**2** Sensors Required	**No** Sensors Required	**1** Sensor Required	**2** Sensors Required
	1 Safety Product Required			**2 Safety Products Required***		

*Products may differ in technology.

Example: Finding a NexSafe™ Product Configuration Capable of Meeting an Application's Safety Needs.

Safety Function: Holding or emergency stopping a potentially hazardous movement.
Proposed Product: Nexen Servomotor Brake.
System Structure: Category 3.

Possible Performance Levels: Capable of PL a, PL b, PL c and PL d. (Category 3 systems cannot achieve PL e.)
Sensor Requirement: One sensor required.
Product Requirements: Redundancy with two safety products required. Both products do not have to be NexSafe™ Servomotor Brakes, but must perform intended risk reduction on the safety function.

Rod Lock 	Category **B** (PL**a**, PL**b**) Category **1** (PL**b**, PL**c**)	Category **2** (PL**a**, PL**b**, PL**c**, PL**d**)			Category **3** (PL**a**, PL**b**, PL**c**, PL**d**)	Category **4** (PL**e**)
Rail Brake 	Category **B** (PL**a**, PL**b**) Category **1** (PL**b**, PL**c**)		Category **2** (PL**a**, PL**b**, PL**c**, PL**d**)			Category **3** (PL**a**, PL**b**, PL**c**, PL**d**) Category **4** (PL**e**)
Servomotor Brake 	Category **B** (PL**a**, PL**b**) Category **1** (PL**b**, PL**c**)	Category **2** (PL**a**, PL**b**, PL**c**, PL**d**)			Category **3** (PL**a**, PL**b**, PL**c**, PL**d**)	Category **4** (PL**e**)
	No Sensors Required	**1** Sensor Required	**2** Sensors Required	**No** Sensors Required	**1** Sensor Required	**2** Sensors Required
	1 Safety Product Required			**2 Safety Products Required***		

*Products may differ in technology.

Safety Example: Category B

Safety Function: Holding or emergency stopping a potentially hazardous movement.

Required Performance Level (PLr): b

System Structure: Category B

Proposed Product: Nexen NexSafe™ Rail Brake

Calculate Mean Time to Dangerous Failure ($MTTF_D$):

Inputs:	
Average Cycle Time	5 seconds per cycle
Operating Hours per Day	16 hours per day
Operating Days per Year	260 days per year
Nexen Rail Brake B_{10D}	4 million cycles

$$MTTF_D = \frac{(10 * B_{10D} * t_{cycle(sec)})}{(\text{Days per Year} * \text{Hours per Day} * \text{3600 Seconds per Hour})}$$

$$MTTF_D \ 13 \text{ years, "medium"} = \frac{(10 * B_{10D} \ 4{,}000{,}000 \text{ cycles} * t_{cycle(sec)} \ 5 \text{ sec per cycle})}{(260 \text{ Days per Year} * 16 \text{ Hours per Day} * \text{3600 Seconds per Hour})}$$

Denotation of each channel	Range of each channel
Low	3 years ≤ $MTTF_D$ < 10 years
Medium	10 years ≤ $MTTF_D$ < 30 years
High	30 years ≤ $MTTF_D$ ≤ 100 years

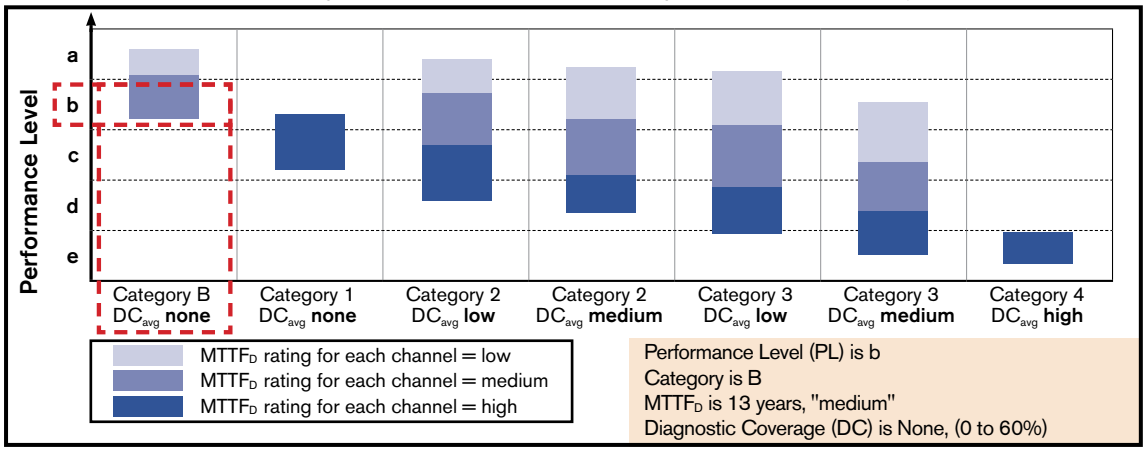
Calculate Useful Life (T_{10D}):

$$T_{10D} = \frac{MTTF_D}{10} \qquad T_{10D} \ 1.3 \text{ years} = \frac{MTTF_D \ 13 \text{ years}}{10}$$

In this example the brake must be replaced after usage reaches B_{10D} life of 4,000,000 cycles or 1.3 years.

Reliability Data Relationships:

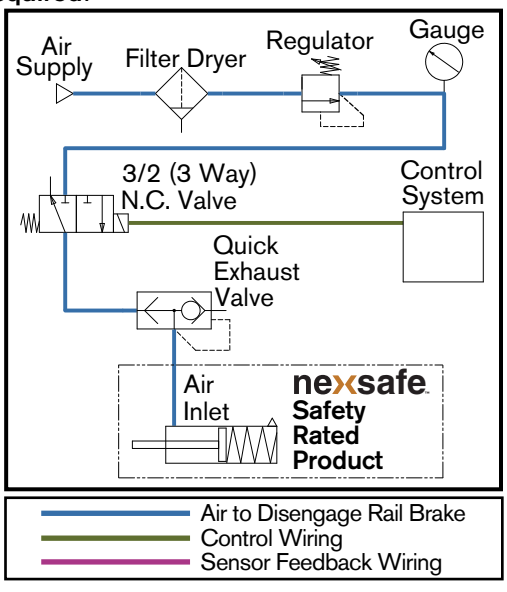
Compare Category, Diagnostic Coverage, and $MTTF_D$ to the Performance Level. Use this graph to determine if the capabilities of the safety related parts of the control system can achieve a given Performance Level.



Category B Control Circuit Example: One Brake, No Sensors Required:

	Category B (PLa, PLb) / Category 1 (PLb, PLc)	Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd)	Category 4 (PLe)
Rod Lock						
Rail Brake	Category B (PLa, PLb) / Category 1 (PLb PLc)		Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd) / Category 4 (PLe)
Servomotor Brake						
	No Sensors Required	1 Sensor Required	2 Sensors Required	No Sensors Required	1 Sensor Required	2 Sensors Required
	1 Safety Product Required			2 Safety Products Required*		

*Products may differ in technology.



Safety Example: Category 1

Safety Function: Holding or emergency stopping a potentially hazardous movement.

Required Performance Level (PLr): c

System Structure: Category 1

Proposed Product: Nexen NexSafe™ Rail Brake

Calculate Mean Time to Dangerous Failure ($MTTF_D$):

Inputs:	
Average Cycle Time	15 seconds per cycle
Operating Hours per Day	16 hours per day
Operating Days per Year	260 days per year
Nexen Rail Brake B_{10D}	4 million cycles

$$MTTF_D = \frac{(10 * B_{10D} * t_{cycle(sec)})}{(\text{Days per Year} * \text{Hours per Day} * \text{3600 Seconds per Hour})}$$

$$MTTF_D \text{ 40 years, "high"} = \frac{(10 * B_{10D} \text{ 4,000,000 cycles} * t_{cycle(sec)} \text{ 15 sec per cycle})}{(\text{260 Days per Year} * \text{16 Hours per Day} * \text{3600 Seconds per Hour})}$$

Denotation of each channel	Range of each channel
Low	3 years ≤ $MTTF_D$ < 10 years
Medium	10 years ≤ $MTTF_D$ < 30 years
High	30 years ≤ $MTTF_D$ ≤ 100 years

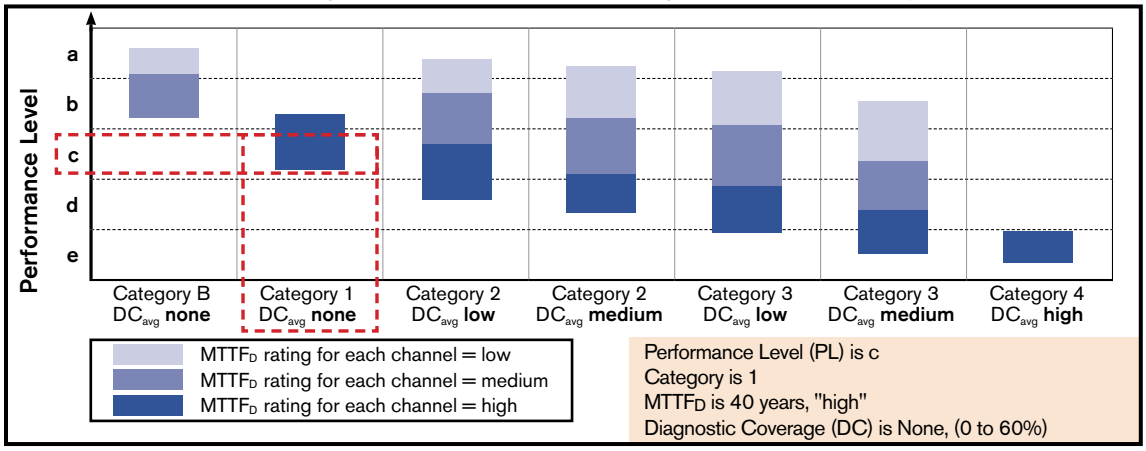
Calculate Useful Life (T_{10D}):

$$T_{10D} = \frac{MTTF_D}{10} \qquad T_{10D} \text{ 4 years} = \frac{MTTF_D \text{ 40 years}}{10}$$

In this example the brake must be replaced after usage reaches B_{10D} life of 4,000,000 cycles or 4 years.

Reliability Data Relationships:

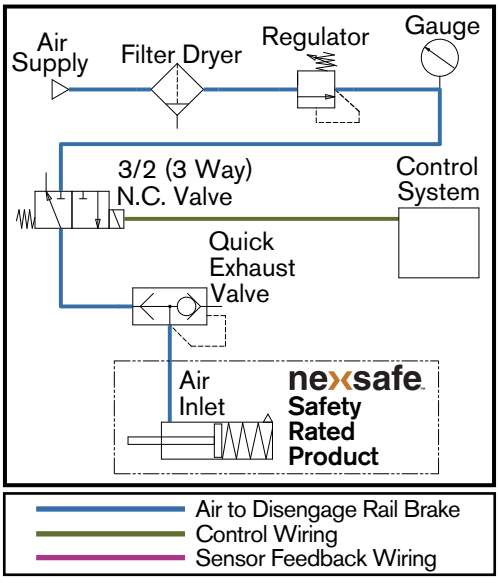
Compare Category, Diagnostic Coverage, and $MTTF_D$ to the Performance Level. Use this graph to determine if the capabilities of the safety related parts of the control system can achieve a given Performance Level.



Category 1 Control Circuit Example: One Brake, No Sensors Required:

	Category B (PLa, PLb) / Category 1 (PLb, PLc)	Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd)	Category 4 (PLe)
Rod Lock						
Rail Brake	Category B (PLa, PLb) / Category 1 (PLb, PLc)		Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd) / Category 4 (PLe)
Servomotor Brake	Category B (PLa, PLb) / Category 1 (PLb, PLc)	Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd)	Category 4 (PLe)
	No Sensors Required	1 Sensor Required	2 Sensors Required	No Sensors Required	1 Sensor Required	2 Sensors Required
	1 Safety Product Required			2 Safety Products Required*		

*Products may differ in technology.



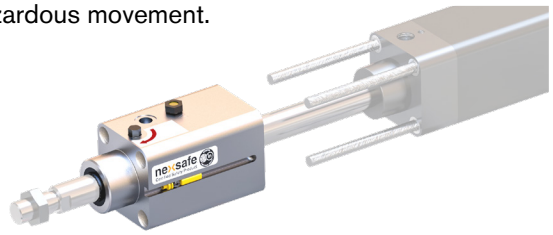
Safety Example: Category 2

Safety Function: Holding or emergency stopping a potentially hazardous movement.

Required Performance Level (PLr): d

System Structure: Category 2

Proposed Product: Nexen NexSafe™ Rod Lock



Calculate Mean Time to Dangerous Failure ($MTTF_D$):

Inputs:	
Average Cycle Time	48 seconds per cycle
Operating Hours per Day	16 hours per day
Operating Days per Year	260 days per year
Nexen Rod Lock B_{10D}	2 million cycles

$$MTTF_D = \frac{(10 * B_{10D} * t_{cycle(sec)})}{(\text{Days per Year} * \text{Hours per Day} * \text{3600 Seconds per Hour})}$$

$$MTTF_D \text{ 64 years, "high"} = \frac{(10 * B_{10D} \text{ 2,000,000 cycles} * t_{cycle(sec)} \text{ 48 sec per cycle})}{(\text{260 Days per Year} * \text{16 Hours per Day} * \text{3600 Seconds per Hour})}$$

Denotation of each channel	Range of each channel
Low	3 years ≤ $MTTF_D$ < 10 years
Medium	10 years ≤ $MTTF_D$ < 30 years
High	30 years ≤ $MTTF_D$ ≤ 100 years

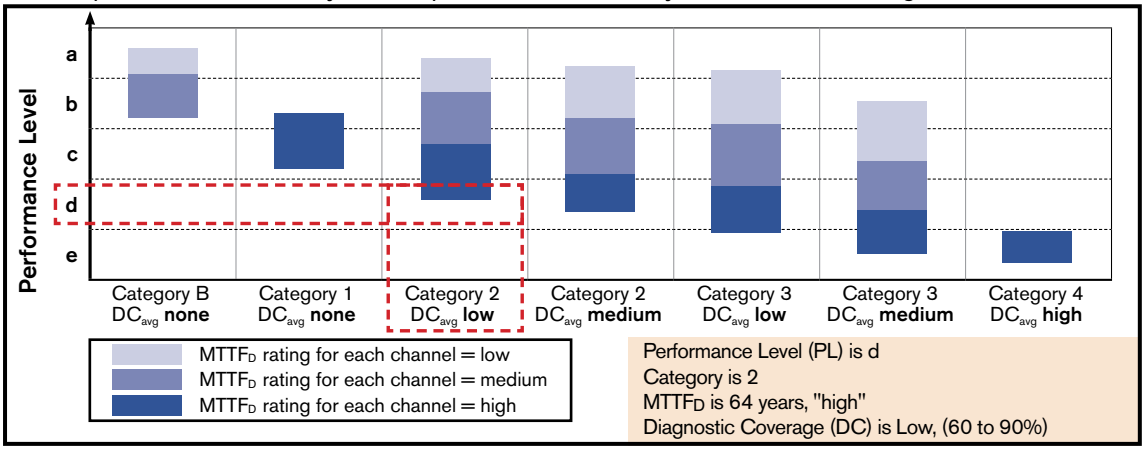
Calculate Useful Life (T_{10D}):

$$T_{10D} = \frac{MTTF_D}{10} \qquad T_{10D} \text{ 6.4 years} = \frac{MTTF_D \text{ 64 years}}{10}$$

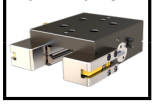
In this example the brake must be replaced after usage reaches B_{10D} life of 2,000,000 cycles or 6.4 years.

Reliability Data Relationships:

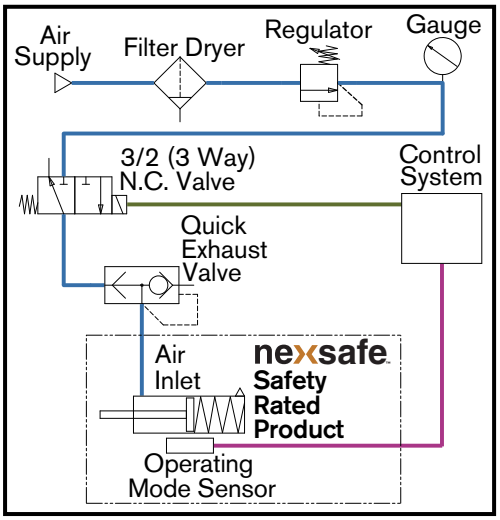
Compare Category, Diagnostic Coverage, and $MTTF_D$ to the Performance Level. Use this graph to determine if the capabilities of the safety related parts of the control system can achieve a given Performance Level.



Category 2 Control Circuit Example: One Brake, One Sensor Required:

Rod Lock 	Category B (PLa, PLb) Category 1 (PLb, PLc)	Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd)	Category 4 (PLe)
Rail Brake 	Category B (PLa, PLb) Category 1 (PLb, PLc)		Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd) Category 4 (PLe)
Servomotor Brake 	Category B (PLa, PLb) Category 1 (PLb, PLc)	Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd)	Category 4 (PLe)
	No Sensors Required	1 Sensor Required	2 Sensors Required	No Sensors Required	1 Sensor Required	2 Sensors Required
	1 Safety Product Required			2 Safety Products Required*		

*Products may differ in technology.



Safety Example: Category 3

Safety Function: Holding or emergency stopping a potentially hazardous movement.

Required Performance Level (PLr): d

System Structure: Category 3

Proposed Product: Nexen NexSafe™ Rod Lock

Calculate Mean Time to Dangerous Failure ($MTTF_D$):

Inputs:

Average Cycle Time	11 seconds per cycle
Operating Hours per Day	16 hours per day
Operating Days per Year	260 days per year
Nexen Rod Lock B_{10D}	2 million cycles

$$MTTF_D = \frac{(10 * B_{10D} * t_{cycle(sec)})}{(\text{Days per Year} * \text{Hours per Day} * \text{3600 Seconds per Hour})}$$

$$MTTF_D \ 14 \text{ years, "medium"} = \frac{(10 * B_{10D} \ 2{,}000{,}000 \text{ cycles} * t_{cycle(sec)} \ 11 \text{ sec per cycle})}{(260 \text{ Days per Year} * 16 \text{ Hours per Day} * \text{3600 Seconds per Hour})}$$

Denotation of each channel	Range of each channel
Low	3 years ≤ $MTTF_D$ < 10 years
Medium	10 years ≤ $MTTF_D$ < 30 years
High	30 years ≤ $MTTF_D$ ≤ 100 years

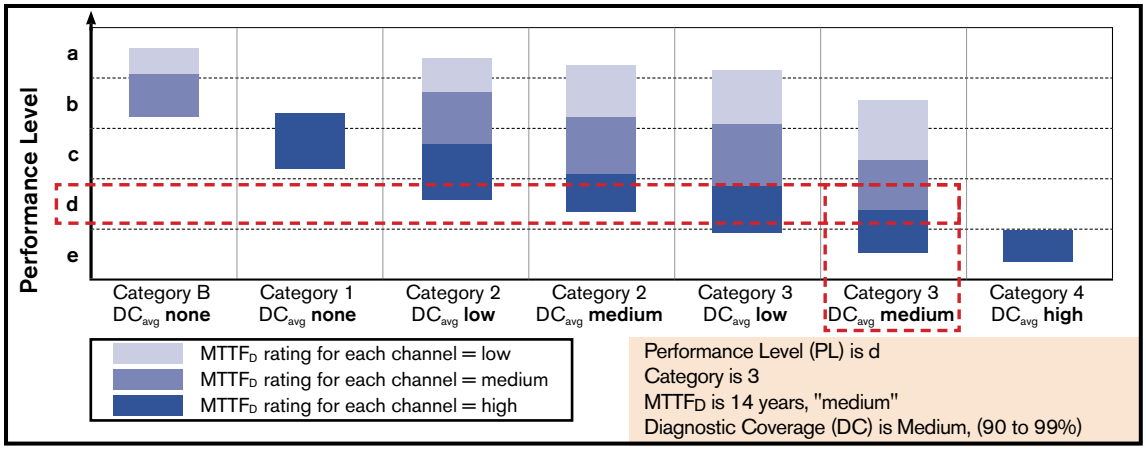
Calculate Useful Life (T_{10D}):

$$T_{10D} = \frac{MTTF_D}{10} \qquad T_{10D} \ 1.4 \text{ years} = \frac{MTTF_D \ 14 \text{ years}}{10}$$

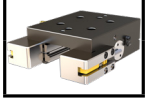
In this example the brake must be replaced after usage reaches B_{10D} life of 2,000,000 cycles or 1.4 years.

Reliability Data Relationships:

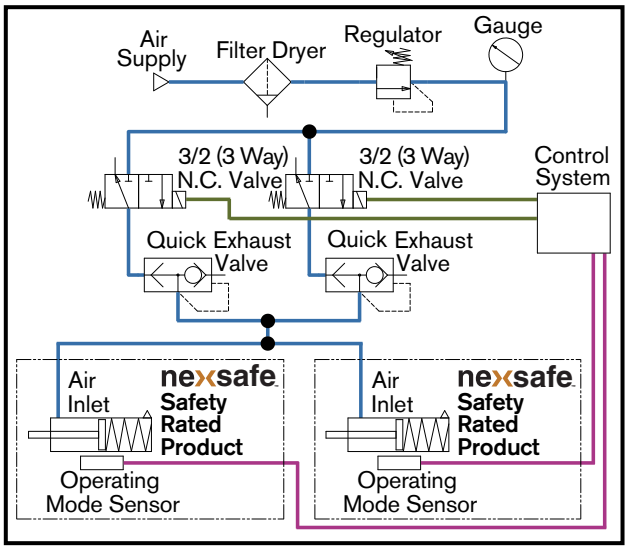
Compare Category, Diagnostic Coverage, and $MTTF_D$ to the Performance Level. Use this graph to determine if the capabilities of the safety related parts of the control system can achieve a given Performance Level.



Category 3 Control Circuit Example: Two Redundant Brakes, One Sensor on Each:

Rod Lock 	Category B (PLa, PLb) Category 1 (PLb, PLc)	Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd)	Category 4 (PLe)
Rail Brake 	Category B (PLa, PLb) Category 1 (PLb, PLc)		Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd) Category 4 (PLe)
Servomotor Brake 	Category B (PLa, PLb) Category 1 (PLb, PLc)	Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd)	Category 4 (PLe)
No Sensors Required	1 Sensor Required	2 Sensors Required	No Sensors Required	1 Sensor Required	2 Sensors Required	
1 Safety Product Required			2 Safety Products Required*			

*Products may differ in technology.



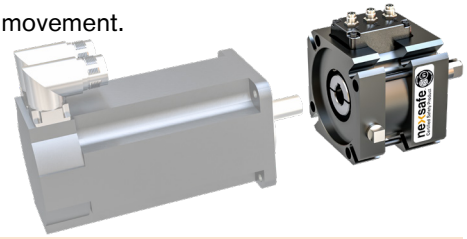
Safety Example: Category 4

Safety Function: Holding or emergency stopping a potentially hazardous movement.

Required Performance Level (PLr): e

System Structure: Category 4

Proposed Product: Nexen NexSafe™ Servomotor Brake



Calculate Mean Time to Dangerous Failure ($MTTF_D$):

Inputs:

Average Cycle Time	24 seconds per cycle
Operating Hours per Day	16 hours per day
Operating Days per Year	260 days per year
Nexen Servomotor Brake B_{10D}	2 million cycles

$$MTTF_D = \frac{(10 * B_{10D} * t_{cycle(sec)})}{(\text{Days per Year} * \text{Hours per Day} * \text{3600 Seconds per Hour})}$$

$$MTTF_D \text{ 32 years, "high"} = \frac{(10 * B_{10D} \text{ 2,000,000 cycles} * t_{cycle(sec)} \text{ 24 sec per cycle})}{(\text{260 Days per Year} * \text{16 Hours per Day} * \text{3600 Seconds per Hour})}$$

Denotation of each channel	Range of each channel
Low	3 years ≤ $MTTF_D$ < 10 years
Medium	10 years ≤ $MTTF_D$ < 30 years
High	30 years ≤ $MTTF_D$ ≤ 100 years

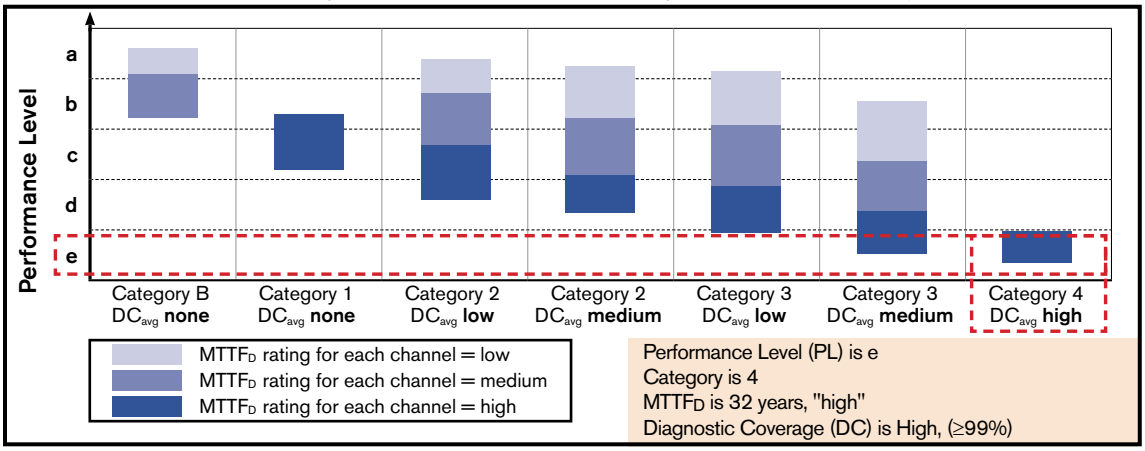
Calculate Useful Life (T_{10D}):

$$T_{10D} = \frac{MTTF_D}{10} \qquad T_{10D} \text{ 3.2 years} = \frac{MTTF_D \text{ 32 years}}{10}$$

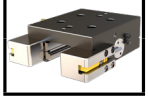
In this example the brake must be replaced after usage reaches B_{10D} life of 2,000,000 cycles or 3.2 years.

Reliability Data Relationships:

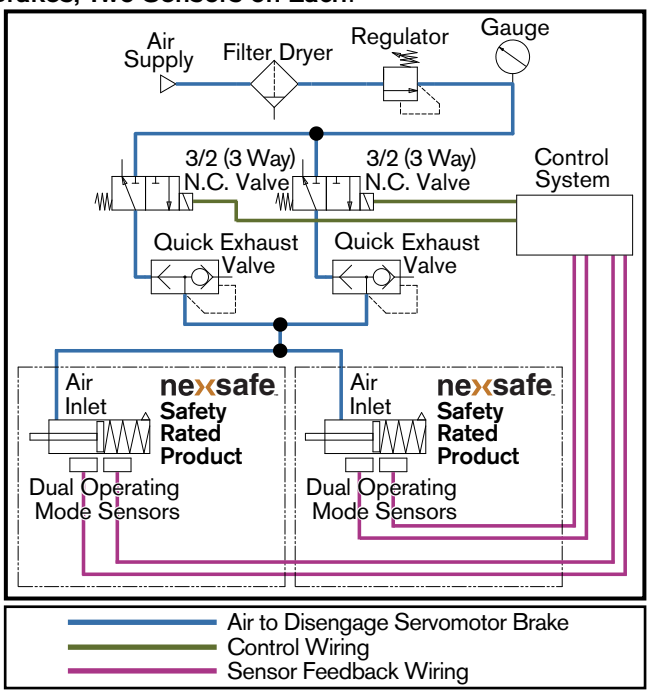
Compare Category, Diagnostic Coverage, and $MTTF_D$ to the Performance Level. Use this graph to determine if the capabilities of the safety related parts of the control system can achieve a given Performance Level.



Category 4 Control Circuit Example: Two Redundant Brakes, Two Sensors on Each:

Rod Lock 	Category B (PLa, PLb) Category 1 (PLb, PLc)	Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd)	Category 4 (PLe)
Rail Brake 	Category B (PLa, PLb) Category 1 (PLb, PLc)		Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd) Category 4 (PLe)
Servomotor Brake 	Category B (PLa, PLb) Category 1 (PLb, PLc)	Category 2 (PLa, PLb, PLc, PLd)			Category 3 (PLa, PLb, PLc, PLd)	Category 4 (PLe)
	No Sensors Required	1 Sensor Required	2 Sensors Required	No Sensors Required	1 Sensor Required	2 Sensors Required
	1 Safety Product Required			2 Safety Products Required*		

*Products may differ in technology.



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Certified Safety Products

NexSafe™ Functional Safety Certified Rail Brake.

Compact and powerful brakes compatible with most profile guide rails and carriages.

- ✓ CAT 4 PL e
- ✓ SIL 3

Certificate NO. FS-CRT-0006
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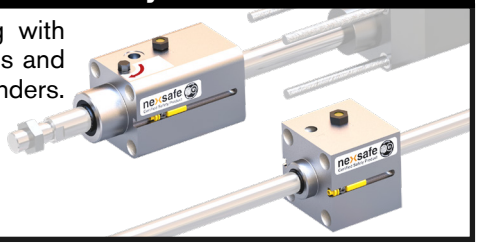
Rail Brake Functional Safety Certificate

NexSafe™ Functional Safety Certified Rod Lock.

Precision holding with guide rod systems and NFPA or ISO cylinders.



- ✓ CAT 4 PL e
- ✓ SIL 3

Certificate NO. FS-CRT-0007
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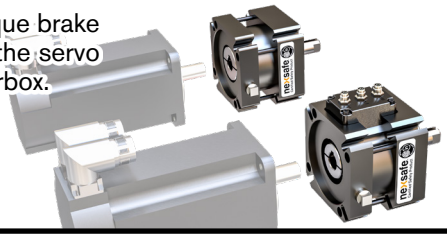
Rod Lock Functional Safety Certificate

NexSafe™ Functional Safety Certified Servomotor Brake.

Powerful, high-torque brake installed between the servo motor and the gearbox.



- ✓ CAT 4 PL e
- ✓ SIL 3

Certificate NO. FS-CRT-0008
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Servomotor Brake Functional Safety Certificate

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