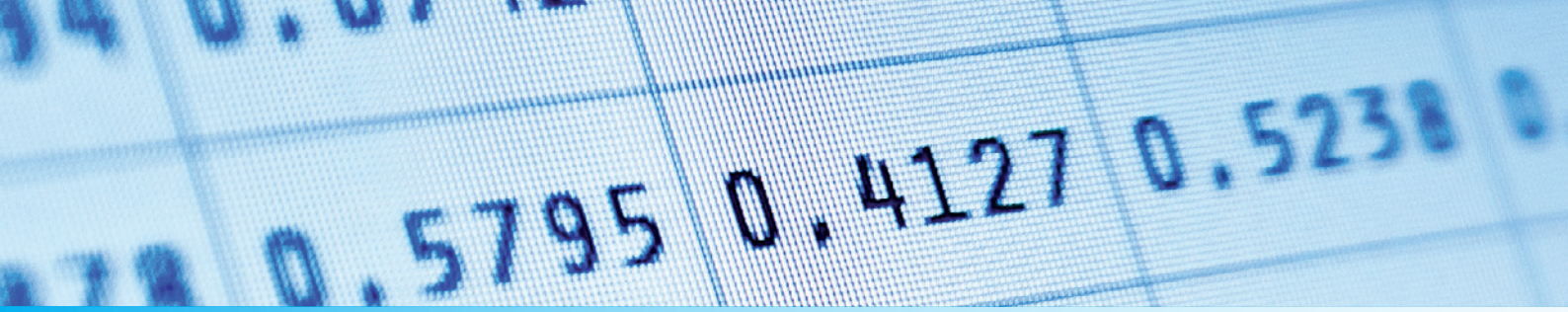
BSA
KUNSTSTOFFTECHNIK

CALCULATIONS

We calculate your security

MACHINE SAFETY GLAZING
LASER
SPECIAL GLAZING
AIRCRAFT GLAZING
PLASTICS PROCESSING
CALCULATIONS
DESIGN + DEVELOPMENT



Explanations of the calculations of the resistance classes according to the valid standards and draft standards

Retention capacity according to the DIN EN ISO 23125 standard

DIN EN ISO 23125 'Machine tools - Safety - Lathes' is applicable to
- Type 1: Manually controlled lathes without numerical control
- Type 2: Manually controlled lathes with limited numerical control capabilities
- Type 3: Numerically controlled lathes and turning centres
- Type 4: Single or multi-spindle automatic lathes

generally equipped with toolholders up to an outside diameter of 500 mm, and numerically controlled vertical lathes and turning centres equipped with toolholders up to an outside diameter of 1600 mm. In this standard, the classification of the retention capabilities is made according to Table 1. BSA safety discs are manufactured with 6, 8, 10, 12, 15, 18 or 20 mm thick polycarbonate and can be classified according to Table 2.

Clamping tool diameter (mm)		Peripheral speed v (m/s)	Projectile dimensions D x a* (mm x mm)	Projectile mass m (kg)	Impact velocity v_t (m/s)	Impact energy	Resistance class
about	up to						
	130	25	30 x 19	0,625	32	320	A1
		40			50	781	A2
		63			80	2000	A3
130	250	40	40 x 25	1,25	50	1562	B1
		50			63	2480	B2
		63			80	4000	B3
260	≤ 500	40	50 x 30	2,5	50	3124	C1
		50			63	4960	C2
		63			80	8000	C3

(Table 1)

	Resistance class of BSA safety glass panes								
PC Thickness (mm)	A1	A2	A3	B1	B2	B3	C1	C2	C3
6	+	+	-	+	-	-	-	-	-
8	+	+	-	+	+	-	+	-	-
10	+	+	+	+	+	-	+	+	-
12	+	+	+	+	+	+	+	+	-
15	+	+	+	+	+	+	+	+	+
18	+	+	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+	+	+

+ = Requirements of the respective resistance class fulfilled | - = Requirements of the respective resistance class not fulfilled

(Table 2)

The German Machine Tool Builders' Association (VDW) has defined supplementary test classes PK 1 to PK 5 for numerically controlled horizontal lathes, which take into account top jaws of up to 8 kg, see Table 3. BSA safety discs, which are ma-

nufactured with 15 and 18 mm polycarbonate, considerably exceed the requirements of the DIN EN ISO 23125 standard. Impact tests at the IWF in Berlin in accordance with the VDW guidelines with higher masses and velocities have shown that safety discs with 18 mm polycarbonate pass classes PK 1 and PK 2, and safety discs with 20 mm pass all classes PK 1 to PK 5.
It should be noted that these test classes are not currently included in the DIN EN ISO 23125 standard.

DIN EN 12415	VDW Test class (PK)				
C3	PK1	PK2	PK3	PK4	PK5
v = 80 m/s	v = 89 m/s	v = 63 m/s	v = 69 m/s	v = 55 m/s	v = 59 m/s
E = 8.000 Nm	E = 10.000 Nm	E = 10.000 Nm	E = 12.000 Nm	E = 12.000 Nm	E = 13.000 Nm
m = 2,5 kg		m = 5,0 kg		m = 8,0 kg	

(Table 3)

Retention capacity according to the DIN EN ISO 16090-1 standards

The retention capacity is tested in both standards using the same method and the same projectile mass of 100 grams.
The DIN EN ISO 16090-1 standard 'Machine tool safety - Machining centres' and 'Machine tool safety - Milling and drilling machines' relates to machine tools with rotating tools and 'stationary' workpieces for general cold metal cutting.
The retention capacity of BSA safety glass panes according to these standards can be found in Table 4.
These standards do not provide for test classes as in the DIN EN ISO 23125 standard.

Polycarbonate thickness (mm)	Projectile mass (kg)	Impact velocity (m/s)	Retention capacity (Nm)
4	0,10	85	361
6	0,10	100	500
8	0,10	120	720
10	0,10	145	1063
12	0,10	150	1125
15	0,10	155	1200
18	0,10	165	1350
20	0,10	175	1530

(Table 4)

Calculation of the kinetic energy and the required impact resistance of the Safety panes with polycarbonate in accordance with DIN EN ISO 23125 and DIN EN ISO 16090-1.

The retention capacity of a safety disc can be calculated with some machine data.
The maximum external speed of the largest approved chuck or milling tool (DIN EN ISO 16090-1) is determined using the diameter or radius:

$$v = \frac{2 \cdot \pi \cdot r}{T} \cdot 1{,}25 \quad \frac{\pi \cdot d \cdot f}{T} \cdot 1{,}25 \quad \frac{\pi \cdot d \cdot r}{60}$$

$$T = \frac{60}{f}$$ (Conversion from revolutions per minute to revolution time in seconds)

The kinetic energy that can be released when a clamping jaw or the milling tool comes loose or breaks off is determined as follows:

$$E_k = \frac{1}{2} \cdot m \cdot v^2$$

v = Track speed (m/s)
r = Circular path radius (m)
d = Circle diameter (m)
T = Turnaround time (s)
f = Rotation frequency (UpM)
1,25 = Safety factor

E_k = kinetic energy (Nm)
m= Clamping jaw dimensions or milling head dimensions (kg)
v = Track speed (m/s)

Example of a kinetic energy calculation according to DIN EN ISO 23125:

The largest jaw chuck that can be used has a circular diameter d of 25 cm (0.25 m).
According to the manufacturer, the maximum rotational speed of the lathe is 5000 rpm (rotational frequency f).
The weight m of a clamping jaw is less than or equal to 625 grams (0.625 kg). It follows from this that the rotation time T of the clamping jaw is jaw is 1/5000 minutes or 0.012 seconds.

Safety factor = 1.25
The path speed of the clamping jaw is then 65.45 m/s:

$$v = \pi \cdot 1{,}25 \cdot 0{,}25 \cdot 5000/60 = 81{,}81 \text{ m/s}$$

The kinetic energy Ek that can be released is 1339 Nm:

$$E_k = \frac{1}{2} \cdot 0{,}625 \cdot 81{,}81^2 = 2091{,}52 \text{ Nm}$$

This means that according to the classification of the DIN EN ISO 23125 standard, Table 1 requires safety glazing with resistance class B2. Table 2 then shows that polycarbonate with a minimum thickness of 10 mm must be used for the safety glass.

Further information on BSA safety discs

- When installing the panes, it must be ensured that the edge overlap of the safety pane with the machine casing is at least 25 mm all round on the operator side, and even up to 50 mm for large panes and large projectile masses. This over lap is necessary to prevent the safety glass from being bent so far during the projectile impact that the glass is pushed out of the machine casing. On the other hand, a smaller edge overlap of at least 10 mm may be sufficient for relatively small panes and low impact velocities with 100 gram projectiles.
- A protective film with a scratch- and abrasion-resistant coating, which also has dirt-repellent properties, is applied to the polycarbonate pane to protect it from cooling water and chemicals.
- In addition, the edge of the safety glass is sealed with a silicone-free sealant, which prevents coolants and lubricants from penetrating the polycarbonate.
- In addition to safety wheels that fulfil the standards DIN EN ISO 23125, EN 12417 and EN 13128, we also manufacture safety wheels that fulfil other standard requirements, such as the requirements of the standard DIN EN ISO 16089 'Machine tools - Safety of stationary grinding machines'.
- All BSA safety discs are free from silicone and materials containing silicone.
- We recommend using the original standards for the design of safety discs.

BSA KUNSTSTOFFTECHNIK GMBH
NIKOLAUS-OTTO-STRASSE 6
33335 GÜTERSLOH
PHONE (05241) 70919-30/-60
FAX (05241) 70919-39
EMAIL INFO@BSA-KUNSTSTOFFTECHNIK.DE
WEB BSA-KUNSTSTOFFTECHNIK.DE