

Fachbereich AKTUELL

FBHM-032

Machine Tool Fire and Explosion

Prevention and Protection – *Translation of German version*

Machinery, Robotics and Automation

Issue: 13.08.2021

The trend of using non water-miscible, flammable metalworking fluids (MWF) brings the topic of fire and explosion prevention and protection for machine tools to the fore. Depending on the type of machining, violent flame ejections may occur in the machine surroundings due to the ignition of the MWF-air mixture in the interior of the machine.



Figure 1 – Flame ejections on a machine tool after ignition of MWF-air mixture [1]

Contents

1	Selection of low-emission MWF.....	2
2	Measures against hot surfaces and “other ignition sources“	2
3	Measures by design: machine tool...	3
4	Extraction systems.....	4
5	Pressure relief devices	5
6	Extinguishing machine fires.....	5
7	Protective measures in the machine surroundings	6
8	Instruction – Behaviour of workers in case of fire.....	6
9	Summary and limits of application ...	7

Even though the majority of such fires turned out without serious damages, in some individual cases, insufficient safety measures resulted in a total burn down of the workshop and damages running into millions.

In the following, a possible protection concept and measures for the protection of employees against fire and explosion hazards when using machine tools are described. Guidance for preparing the risk assessment is included in Annex 1 „The recurrent theme“ and in Annex 2 “Check lists”.

1 Selection of low-emission MWF

By selecting low-emission metalworking fluids (MWF), aerosols and vapours in the interior of the machine can be reduced. Low-emission metalworking fluids are characterized by the following properties:

- Formulated with low-evaporation mineral oils or
- Synthetic esters and/or special liquids
- Addition of anti-mist additives

It is principally recommended to select the MWF with the lowest vaporization losses (according to Noack procedure at 250°C), the highest flash point and if possible the highest viscosity required by the machining process.

Investigations show that increasing the temperature of a MWF by 10 °C results in the doubling of aerosol formations. If the MWF temperature is successfully monitored and kept at a low level by suitable measures, misting behaviour can be significantly improved.

This can be achieved by:

- Sufficient quantities of WMF
- Sufficient flooding of the cutting zone
- Baffle plates for improved cooling
- General cooling

Besides the vaporization and misting behavior of the MWF, the following technical safety characteristics are relevant for the evaluation of the explosion risk:

- Lower explosion threshold in g/m³,
- Maximum explosion pressure in bar (g),
- Maximum pressure increase, expressed by the KP value in bar X m/s.

For MWF aerosols, the following values for the above characteristics are given in technical literature [2,3,4,5]:

Characteristics	Values
Lower explosion threshold	25 g/m ³ - 60 g/m ³
Max. explosion pressure	7,2 bar - 7,7 bar
K _p -value	75 bar·m/s - 103 bar·m/s

(The explosion pressures and KP values are determined experimentally and are maximum values).

Table 1 – Characteristics and values for MWF aerosols

In practice, the introduction of tramp oils and residues such as

- Machine cleaning and care products,
- Cleaning agents and solvents on workpieces,
- Tramp oils etc.,

into the metalworking fluid circuit of the machine tool should therefore be avoided as far as possible (information on MWF care, see VDI 3397 Sheet 2 [6], DGUV Regel 109-003 [7]. A possibility of reducing the above hazards is the use of compatible multi-functional oils (see VDI 3035) [8]).

2 Measures against hot surfaces and “other ignition sources“

In most cases, machine fires during operation are started by an incandescent chip, a grinding spark or an overheated tool. Therefore, reliable and adequate cooling of the machining zone should be provided by the MWF.

The MWF circuit should be dimensioned (pipe cross-sections, storage tank, pumps etc.) so that a sufficient quantity of MWF is available to flood the cutting zone at all times and for every tool. For information on the design of the MWF circuit, see VDI 3035 and VDI 3397 Sheet 1 [9].

Measures for best possible flooding are e.g.:

- Cutting fluid flooding at low pressure (2 to 4 bar),
- Flushing (abrasive tools etc.) with 30 l/min at high pressure (up to 100 bar),

- Extinguishing of sparks with an additional MWF supply at the points of generation (lower nozzle during grinding)

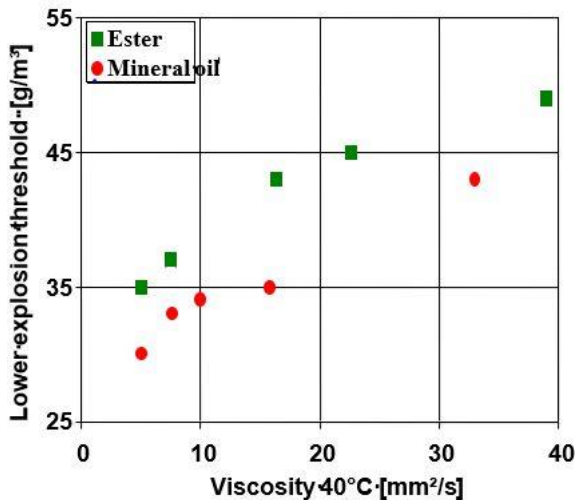


Figure 2 – Lower explosion thresholds of MWF emissions

The shape of the flushing nozzle (pressure, nozzle geometry and correct setting) is also relevant for the cooling effect and the degree of atomization. Flooding with large quantities and low pressures in the close vicinity of the tool is advantageous. By the installation of additional nozzles and their arrangement as “MWF rinsing curtains”, mist volumes can be further minimized. It is also important to correctly adjust and direct the nozzles towards the workpiece/cutting zone area.

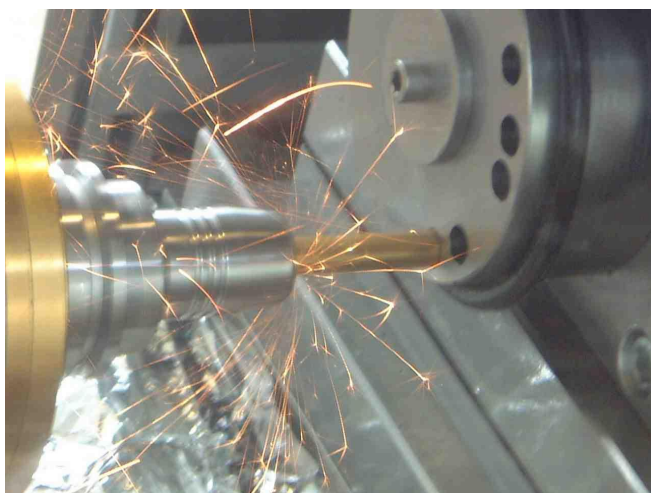


Figure 3 – Sparks during drilling

For monitoring the MWF supply, switches for high and low pressure or flow control devices or

monitoring of the pump motor currents are mainly used.

Generally, tools should be checked for their condition and exchanged when their service life specified by the manufacturer has elapsed. By means of process monitoring, the above situations affecting safety due to tool wear can be recognized.

3 Measures by design: machine tool

In case of an ignition of the WMF-air mixture and during fires, flames and hot gases may escape from the machine tool. In order to reduce the hazards by flames and hot gases for the operator and the surrounding, door labyrinths are installed in the area around the machine tool doors.

If parallel loading and machining is possible at the setting point of the pallet exchanger, the loading area should be separated from the working area with a flame retarding design.

Unavoidable openings such as workpiece openings should be carefully sealed, e.g. by flaps or sliders, which only release during a workpiece change. The transparent screens are made of framed polycarbonate. (DIN EN ISO 23125 [10]), Fachbereich AKTUELL FBHM-060 “Schutzsysteme an WZM” [11].

The optimum information exchange between the control systems of the machine tool, the extraction unit and the automatic discharge suppression system is the basis for the safe operation of the overall system.

It should only be possible to start the machine, if:

- The extraction and chip removal systems are ON
- The door is interlocked with guard locking
- The fire suppression system is ready to operate

Indicated failures should be automatically notified and cleared without delay. Only then may the system be started.

4 Extraction systems

In order to reduce enrichment of the flammable and possibly explosive MWF emissions inside the machine tool and in the immediate surroundings, they are captured, extracted and separated by extraction systems.

In general, systems for the extraction of flammable air impurities and explosive mixtures should be made of conductive or dischargeable electrostatic materials and should be earthed.

If a separator/pre-separator is used, it should be designed as ignition source free type, i.e. no moving parts or electric equipment with surface temperatures above the ignition temperature are on the intake gas side within the separator. The extraction fan is on the air intake side.

To avoid escaping of MWF aerosols and vapours, low pressure must be maintained inside the enclosure. The air motion should always be directed towards the machining room and not vice versa.

The extraction point (connector) in the machine interior should be designed so that no coarser particles, metalworking fluid and chips can get into the extraction system and accumulate in the pipes. This is achieved if the following criteria are observed:

- Extraction point as far away as possible from the machining zone
- Avoid lateral flows at the extraction point
- Consideration of the arrangement of MWF nozzles, nozzle placing, main atomization direction and chip flight when selecting the extraction point
- Baffle plates or mechanical pre-separators additionally reduce the introduction of MWF aerosols and chips into the extraction circuit.

- The air velocity at the extraction point should be as low as possible (< 8 m/s).

Ducting should be non-inflammable and should not be electrostatically chargeable (ensure that ducting is earthed, if possible, no use of folded spiral-seam ducts).

Ducting should be routed so that no introduced or condensed MWF can accumulate inside (avoid cavities and uneven ducting).

For the interior control of the ducting (oil deposits and chip accumulations), control/inspection hatches should be installed at required intervals.



Figure 4 – Pressure control

If there is a risk of flames entering the piping and ducting and propagating to other areas, rapid-action shut-off valves have to be used. In case of fire, the rapid-action shut-off valve seals off the machine tool from the extraction system and vice versa.

The precondition for the start of the machine is an operating extraction system maintaining the minimum volume flow/extracted air flow specified by the machine manufacturer (control e.g. by means of pressure or flow controls). If the required extraction rate is not achieved or in case of failure, the machine must be stopped.

5 Pressure relief devices

The pressure relief device (valve) has the purpose of releasing excess pressure generated by the ignition of a mixture within the machining room of the machine tool.

The pressure relief valve is usually installed in the cover of the machine tool. It is intended to relieve pressure as quickly and directly as possible and to direct flames and hot combustion gases into safe areas and thus reduce the risk to machine operators.

The response pressure of pressure relief devices for opening should be very low (e.g. < 5 mbar). The device only opens briefly and shuts back closed.

When an MWF/air mixture ignites, long jets of flame may escape from the pressure relief device which pose a hazard to the surroundings of the machine. As a result, no flammable materials (wooden crates, insulation, etc.) should be located above the pressure relief valve.



Figure 5 – Jets of flames

A more detailed design including transfer to common pressure relief devices may be carried out according to research report VDW 3002 „Explosion pressure relief of metal cutting machine tools“ [12].

6 Extinguishing machine fires

If the operation of a machine tool involves a high risk of fire, integrated fire detection and fire suppression systems must be installed. Here, the order should be as follows (DIN EN ISO 19353 [13]):

- Manual discharge suppression system
- Fire alarm system in combination with a manual discharge suppression system
- Fire alarm system in combination with an automatic discharge suppression system

In practice, the implementation ranges from a fixed fire extinguisher with corresponding piping to a fire alarm system coupled to an automatic discharge suppression system.

The choice of the extinguishing method and the integrated fire detection and fire suppression systems used for machine tools mainly depends on the degree of potential hazard to persons and secondarily, on the degree of damage to property and the environment.

In case of an existing high risk of personal injury, heavy damage to assets and the environment, and even of hazards of subsequent metal fires (e. g. magnesium), the fast fire detection and extinguishing by automatic fire discharge suppression systems is essential.

6.1 Extinguishing agent

Extinguishing agents for fires of flammable metalworking fluids can be:

- Extinguishing gases, e.g. oxygen displacing gases like CO₂, N₂, inert gases and their mixtures
- Water (using water atomizing technology/water misting technology)
- Foam
- Powders of fire classes ABC or BC (oil fires correspond to fire class B)

If carbon dioxide is used as the extinguishing agent, health hazards have to be anticipated at concentrations of 5 per cent by volume or more. Concentrations of more than 8 per cent by volume can pose a danger to life (see also DGUV Information 205-026 “Sicherheit und Gesundheitsschutz beim Einsatz von Feuerlöschanlagen mit Löschgasen”)[14].

Metal fires (for example Mg, Al, Ti) cannot be extinguished with extinguishing agents of fire classes A, B and C! At present, powder extinguishing agents of fire class D and the inert gas argon exist for the fighting of metal fires. Suitability for the extinguishing of metal fires must be proved for all other extinguishing agents.

Design and construction criteria for fire suppression systems are e.g. published by VdS Schadenverhütung GmbH, (see www.vds.de).

The planning and installation of the fire suppression system should be done by a specialist company, if possible, in collaboration with the machine tool manufacturer.

Further information on requirements for alarming and delay are contained in the corresponding regulations (for example DGUV Information 205-026).

7 Protective measures in the machine surroundings

In order to avoid propagation of a machine fire to its surroundings and personal injury during a fire or extinguishing, general rules of behaviour in case of fire and general rules of preventive fire protection must be observed (see DGUV Information 205-001 [15]):

- Reduction of combustible substances near to the machine (flammable materials, cardboard, oil)
- Provision of a sufficient number of manual fire extinguishers at the workplace [16]
- Enforcing smoking prohibition

- Keeping emergency exits, escape and rescue routes free
- Behaviour in the case of fire: rescue chain, emergency calls, fire service

To reduce fire hazards, there should be as few combustible materials in the immediate vicinity of a machine tool as possible.



Figure 6 – Source of ignition in the chip container

Packing materials or oil-soaked cleaning rags should, under no circumstances, be stored in the immediate vicinity. Regular emptying and cleaning of oil pans and gratings (provide drains, use oil extractors) and the disposal of cardboard boxes and oil-soaked rags significantly reduces fire hazards.

Used and soiled cleaning materials should be kept in non-flammable, closed containers.

Furthermore, the chip containers should be emptied regularly in order to reduce the fire hazard and prevent possible self-ignition. The observance of a general ban on smoking is indispensable in these areas.

8 Instruction – Behaviour of workers in case of fire

For activities at machine tools using flammable metalworking fluids, the instructions given in general rules of behaviour in case of fire should also point out to the following hazards:

- Hazard of backfire when opening the machine door after a fire
- Wearing of oil soaked clothing: increased fire hazard in case of backfire (wicking effect)
- Flame ejection at machine tool door gaps and openings
- Hazard of suffocation in confined spaces due to fire smoke and fumes
- Hazard of suffocation due to extinguishing gas carbon dioxide (from 5 Vol. %)
- Do not touch machine subsequent to a fire: possibly live, hot

In principle, the instruction includes briefing on the function, operation and handling of installed safety devices, such as e. g. suppression systems.

9 Summary and limits of application

This Fachbereich AKTUELL is based on experience gathered by the Expert Committee Woodworking and Metalworking (FB HM), Subcommittee Machinery, Robotics and Automation of DGUV.

It is particularly intended to provide orientation to designers, manufacturers as well as to safety officers and production engineers of users of metal working machinery on how the detailed requirements of the European standards in relation to the provisions of the Machinery Directive are implemented in practice.

The provisions according to individual laws and regulations remain unaffected by this Fachbereich AKTUELL. The requirements of the statutory regulations apply without restriction.

In order to obtain detailed information, it is necessary to consult the applicable regulation contents.

This Fachbereich AKTUELL replaces the same-titled version, published as DGUV Information FB HM 032 (issue 11/2013). Updating was required as a result of editorial adjustments. This

is the English translation of the German issue "FBHM-032" of 13 August 2021.

The Expert Committee Woodworking and Metalworking is composed of representatives of the German Social Accident Insurance Institutions, federal authorities, social partners, manufacturers and users.

Further Fachbereich AKTUELL or Information sheets of the Expert Committee Woodworking and Metalworking are available for download on the Internet.[17].

Bibliography:

- [1] DGUV Information 209-026 „Brand- und Explosionsschutz an Werkzeugmaschinen“; Ausgabe April 2009, Überarbeitung März 2012, DGUV, Berlin
- [2] Hirsch, W., Hempel, D., Förster, H.: Untersuchungen zum Explosionsschutz beim Einsatz von Kühlschmierstoffen in Werkzeugmaschinen, PTB-ThEx-2, Braunschweig, September 1997
- [3] Höppner, K.: Entwicklung und Erprobung eines Verfahrens zur Bestimmung der Explosionskenngrößen von Nebeln brennbarer Flüssigkeiten, Forschungsbericht IB-95-524, IBExU GmbH, Freiberg 1996
- [4] Freiler, C.: Brand- und Explosionsverhalten von nichtwassermischbaren Kühlschmierstoffen – Möglichkeiten der Minimierung von Gefährdungen, Fuchs Europe Schmierstoffe, Vortrag im Arbeitskreis Maschinensicherheit, Brand- und Explosions-sicherheit an Werkzeugmaschinen, BG Metall Süd, Mainz am 30.06.2005
- [5] Steen, H.: Handbuch des Explosionsschutzes, Wiley VCH, 2000, Kapitel 5.1
- [6] VDI 3397 Blatt 2:2014-06 „Pflege von Kühlschmierstoffen für spanende und umformende Fertigungsverfahren – Maßnahmen zur Qualitätserhaltung, Prozessverbesserung, Abfall- und Abwasserverminderung“; Beuth Verlag, Berlin

- [7] DGUV Regel 109-003 „Tätigkeiten mit Kühlschmierstoffen“; Ausgabe März 2011, DGUV, Berlin
- [8] VDI 3035:2008-05 „Gestaltung von Werkzeugmaschinen, Fertigungsanlagen und peripheren Einrichtungen für den Einsatz von Kühlschmierstoffen“; Beuth Verlag, Berlin
- [9] VDI 3397 Blatt 1: 2020-03 „Bearbeitungsmedien (BM) für die Umformung und Zerspanung – Kühlschmierstoffe, Umformschmierstoffe, Minimalmengenschmierstoffe, Multifunktionsöle“; Beuth Verlag, Berlin
- [10] DIN EN ISO 23125:2015-04 „Werkzeugmaschinen - Sicherheit – Drehmaschinen“; Beuth Verlag, Berlin
- [11] Fachbereich AKTUELL FB HM-060 „Schutzsysteme an WZM – Gegen Flammenaustritt beim Einsatz von brennbaren KSS“; Ausgabe 04/2013, Fachbereich Holz und Metall, Postfach 3780, 55027 Mainz
- [12] VDW 3002: Explosionsdruckentlastungen von spanabhebenden Werkzeugmaschinen; 15. Januar 1996 – 30. April 1996, Frankfurt
- [13] DIN EN ISO 19353:2019-06 „Sicherheit von Maschinen – Vorbeugender und abwehrender Brandschutz; Beuth Verlag, Berlin
- [14] DGUV Information 205-026 „Sicherheit und Gesundheitsschutz beim Einsatz von Feuerlöschanlagen mit Löschgasen“; Ausgabe 05/2018, DGUV, Berlin
- [15] DGUV Information 205-001 „Betrieblicher Brandschutz in der Praxis“; Ausgabe 12/2020, DGUV Berlin
- [16] Technische Regel für Arbeitsstätten, ASR A2.2: „Maßnahmen gegen Brände“, Ausgabe 05/2018, BAUA
- [17] Internet: www.dguv.de/fb-holzundmetall, Publikationen oder www.bghm.de Webcode: <626>
- [18] Brand- und Explosionsversuche an Werkzeugmaschinen mit brennbaren Kühlschmierstoffen: Abschlussbericht über Zündversuche in einer Werkzeugmaschine beim Institut für Sicherheitstechnik GmbH IBExU, Freiberg; Ausgabe 08/2009
- [19] DIN ISO 3448:2010-02 „Flüssige Industriel-Schmierstoffe – ISO-Viskositätsklassifikation; Beuth Verlag, Berlin
- [20] DIN 51562-1:Berichtigung 1:2018-11 „Viskosimetrie – Messung der kinematischen Viskosität mit dem Ubbelohde-Viskosimeter“ - Teil 1: Bauform und Durchführung der Messung; Berichtigung 1; Beuth Verlag, Berlin
- [21] DIN EN ISO 2592:2018-01 „Mineralöl-erzeugnisse und verwandte Produkte – Bestimmung des Flamm- und Brennpunktes – Verfahren mit offenem Tiegel nach Cleveland“; Beuth Verlag, Berlin
- [22] DIN 51581-1:2011-09 „Prüfung von Mineralölerzeugnissen – Bestimmung des Verdampfungsverlustes – Teil 1: Verfahren nach Noack“; Beuth Verlag, Berlin
- [23] DIN 51581-2:1997-05 „Prüfung von Mineralölerzeugnissen – Bestimmung des Verdampfungsverlustes – Teil 2: Gaschromatographisches Verfahren“; Beuth Verlag, Berlin
- [24] VDW 0209 M.Ising: Gestaltung und Dimensionierung von trennenden Schutzeinrichtungen. 1997, Frankfurt
- [25] DGUV Information 209-090 „Tätigkeiten mit Magnesium“; Ausgabe 06/2018, DGUV, Berlin
-

Picture credits:

The Figures shown in this Fachbereich AKTUELL

Figure 1 – Flame ejections on a machine tool
after ignition of MWF-air mixture

INDEX-Werke GmbH & Co. KG, Hahn und
Tesky, Plochinger Straße 92, 73730 Esslingen

Figure 2 – Lower explosion thresholds of MWF
emissions

Fuchs Europe Schmierstoffe GmbH
Friesenheimer Str. 19 68169 Mannheim

Figure 3 – Sparks during drilling

INDEX-Werke GmbH & Co. KG, Hahn und
Tesky, Plochinger Straße 92, 73730 Esslingen

Figure 4 – Pressure control

Keller Lufttechnik GmbH & Co. KG Neue
Weilheimer Str. 30 73230 Kirchheim u. Teck

Figure 5 – Jets of flames

DGUV, FBHM, SG MRF, Sefrin

Figure 6 – Source of ignition in the chip container

DGUV, FBHM, SG MRF, Sefrin

Figure 7 – “The recurring theme“: The process of
risk assessment at the workplace

DGUV, FBHM, SG MRF, Sefrin

Figure 8 – Characteristics of non-water miscible
metalworking fluids

have been kindly provided by:

DGUV, FBHM, SG MRF, Sefrin

Table reference:

Table 1 –Characteristics and values for MWF
aerosols

DGUV, FBHM, SG MRF, Sefrin

Annex 1: „The recurring theme“/characteristics of non-water-miscible metalworking fluids (MWF)

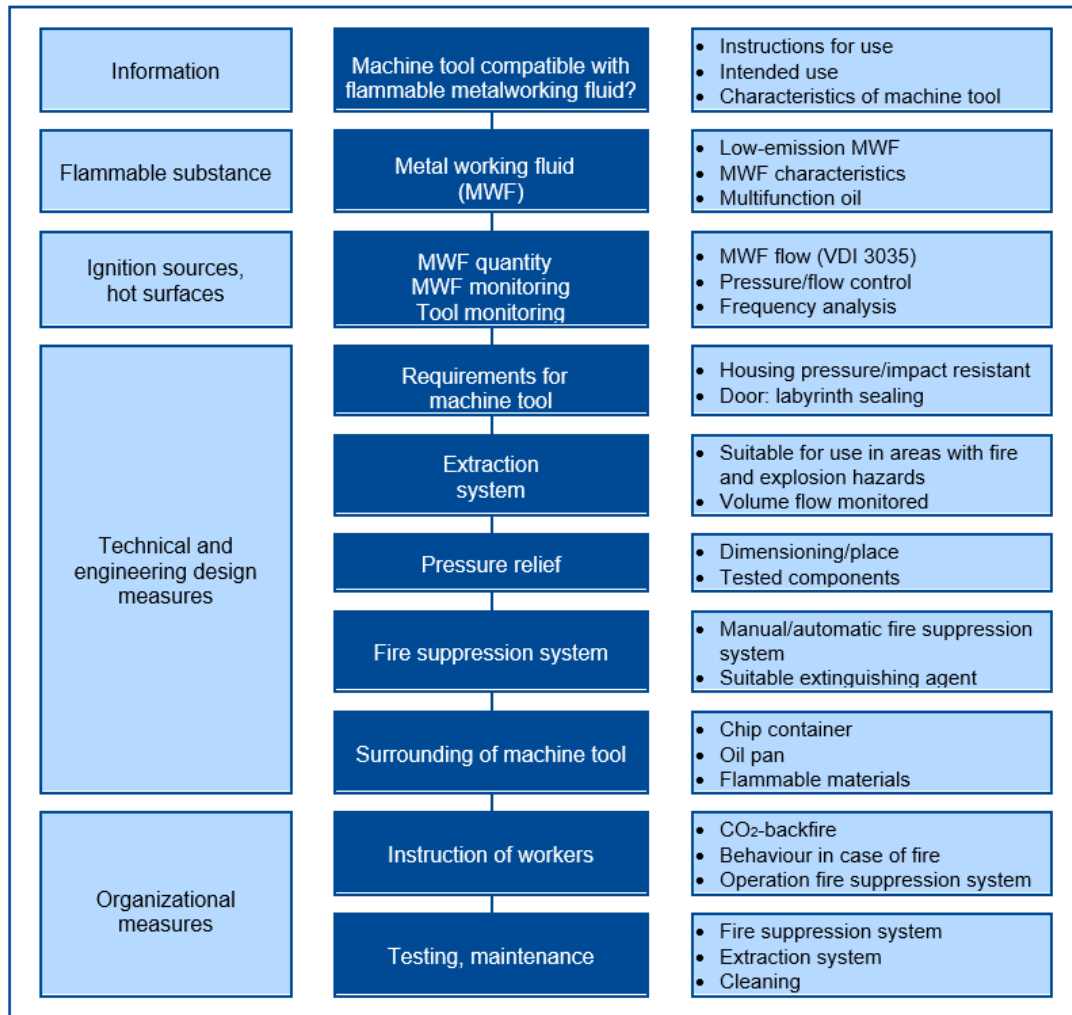


Figure 7 – “The recurring theme“: The process of risk assessment at the workplace

Tendency	Viscosity grade acc. to DIN ISO 3448 [19]	Viscosity at 40 °C acc. to DIN 51562 [20]	Flashpoint acc. to DIN EN ISO 2592 (COC) [21]	Evaporation losses at 250°C acc. to DIN 51581-1, -2 (Noack procedure) [22], [23]	Examples of machining processes
Decreasing fire and explosion hazard	ISO VG 5	4,14 - 5,06 mm ² /s	> 120 °C	< 85 %	Honing, reaming
	ISO VG 7	6,12 - 7,48 mm ² /s	> 145 °C	< 80 %	Grinding
	ISO VG 10	9 - 11 mm ² /s	> 155 °C	< 60 %	Deep hole drilling
	ISO VG 15	13,5 - 16,5 mm ² /s	> 190 °C	< 25 %	Turning, milling Drilling
	ISO VG 22	19,8 - 24,2 mm ² /s	> 200 °C	< 15 %	Threading,
	ISO VG 32	28,8 - 35,2 mm ² /s	> 210 °C	< 13 %	Thread rolling,
	ISO VG 46	41,4 - 50,6 mm ² /s	> 220 °C	< 11 %	Broaching

Figure 8 – Characteristics of non-water miscible metalworking fluids

Annex 2: Check lists: measures at machine tools with flammable metalworking fluids

Machine tool	yes	no
Machine tool suitable for neat oil machining (non water-miscible MWF)?		
Oil machining dealt with in the "Technical documentation"?		
Extinguishing system present?		
Extraction system present?		
Extinguishing system deactivated when machining room door open?		
Does guard locking of machining room door stay active during machining and emergency stop?		
Is guard locking of machine room door inactive when machine is open and switched-off?		
No oil pool formation in the machining area, drive room or handling area?		
No oil pool formation in the area outside the machine (oil pan regularly emptied)?		
Sufficient pressure resistance of guarding?		
Pressure relief device present?		
Door labyrinths resistant to outbreak of flames?		
Other openings (e.g. loading and unloading openings, gaps) in the operating area covered?		
If applicable, extinguishing hole present?		
Transparent screens made of polycarbonate undamaged (see DIN EN ISO 23125 [10], VDW 0209 [24])?		
Transparent screens positively fitted (not with rubber edging)?		
Alarm device present?	Optical	
	Acoustic	
Marking: Information signs, CO2 hazard warnings, extinguishing system?		

Machine tool: Control system (example)	yes	no
Start of machine:		
• Extraction system on/chip removal on?		
• Door interlocked, guard locking active?		
• Extinguishing system ready to operate (optical and thermal sensors, activation)		
• MWF supply monitored?		
Extinguishing process:		
• For CO ₂ : If applicable, activation delay set (DGUV Information 205-026 [14])?		
• Extraction system inactive?		
• MWF supply inactive?		
• Extinguishing system ready to operate?		
• Doors interlocked (with guard locking active)?		
• Alarm device (optical/acoustic) active?		
• Machine drive inactive?		
Opening of the door:		
• Extinguishing system inactive?		
• MWF supply inactive?		
• Machining process safely stopped?		
• Extraction system: If applicable, keep in mind short overrun!		

Pressure relief device	yes	no
Are flames and hot gases routed into safe areas?		
Installation in the cover areas?		
Pressure relief area provided: ~ 0.1 m ² /m ³ work room (see VDW 3002)?		
Reliable opening at minimal excess pressure (<< 5 mbar)?		
Reliable closing subsequent to pressure relief?		
Suitability as protective device verified by the manufacturer (e.g. test)		
No flammable materials (wooden crates, insulation materials) in the danger zone around the pressure relief device		
Danger zone warning signs around the pressure relief device		

Extraction system	yes	no
Extraction system suitable for neat oil machining? (Instructions for use/technical documentation) e.g.:		
• Design free of ignition sources?		
• Arc-free fan drive on the intake side?		
• System and ducting earthed?		
Air flow monitored (pressure, flow controls)? • Extraction starts when machine starts (active)?		
• Flow too low: signal indication, machine tool failure indication?		
Extraction capacity adjusted via throttle valve/speed control?		
Extraction system integrated into extinguishing concept? • Sufficient quantity of extinguishing agent in extraction system and separator provided?		
• If applicable, extinguishing nozzle and fire detection in separator provided?		
• Has fan overrun been considered?		
Ducting: • Slightly inclined without depressions (if applicable, MWF drain provided)?		
• Inspection holes/control openings provided?		
• Regular inspection for deposits, cleaning required?		
For ducting systems: Prevention of fire propagation, e.g. by means of • flame arresters (in pipes and in the machining area) considered?		
• Shut-off valves (at the machine tool) available?		
• Effective pre-separation at the machine outlet, e.g. by means of baffle plates, pre-separators, available?		
Is regular maintenance of system and ducting carried out? Maintenance schedule (Instruction handbook) available?		
In case of fire: Interruption of extraction provided by means of? • fan motor-brake (overrun reduced)?		
• automatic shut-off valve		

Metalworking fluid (MWF)	yes	no
Low-emission metalworking fluid used??		
1: Characteristics observed, e.g. in the safety data sheet, product information?		
Example: for MWF with a viscosity of 4,1 [mm/min at 40°C]:		
• Flash point > 120 °C, (see Figure 8)		
• Noack evaporation loss [250°C] < 85 %, (see Figure 8)		
2: MWF with anti-mist additives (consider filterability)?		
MWF compatible with hydraulic oils, slideway oils (multi-functional oil)?		
Sufficient quantity of MWF (MWF circuit, storage tank) during machining (see VDI 3035)?		
No drag-in of large quantities of tramp oils into the MWF circuit ensured, e. g. by?		
• Cleaning agents and solvents (on workpiece /part)		
• Hydraulic oil into the MWF circuit		
MWF supply:		
• monitored (pressure or flow controls)?		
• sufficient cooling quantity, MWF nozzles?		
• MWF nozzles arranged in the best possible way?		
Is considerable temperature increase of MWF avoided (increase of MWF temperature by 10°C = doubling of misting)?		
• MWF temperature monitored?		
• Possibility of cooling: e.g. baffle plates, MWF container used sufficiently large?		

Instruction	yes	no
Function and handling of the machine tool and the extinguishing system in case of fire		
Optical sensors: Avoid light flashes (lighters, welding).		
Special hazards (NEVER!)		
• Opening of the machine door in the event of a fire in the interior: Hazard of backfire		
• Wearing oil soaked clothing: Fire hazard (wicking) in case of backfire		
In the case of fires or explosions (DGUV Information 205-001) [15]:		
• When the alarm activates: Leave the danger zone immediately.		
• Use escape and rescue routes.		
• Search for help: Fire service, emergency telephone numbers		
Hazards during ignition of the MWF mixture:		
• Violent flame ejections at pressure relief devices/ subsequent fires possible		
• Flame ejection at machine tool door gaps and openings		
• Extinguishing agent CO ₂ : Hazard of suffocation (above 5 % CO ₂ volume in air)		
• During extinguishing process: Ejection of flames in the door area		
• Hazard of suffocation in confined spaces due to fire smoke and fumes		
• Do not touch machine components subsequent to fire: Possibly live (electric shock) and hot (burns)		
Reduce fire hazard: Preventive measures:		
• Regular emptying of chip container to avoid self-ignition		
• Regular emptying of machine tool oil pans (extract oil)		
• No combustible materials (cardboard/carton/oil-soaked rags) in the vicinity of the machine tool		
• General smoking prohibition: No cigarette ends in chip containers/oil pans		

Fire suppression system	yes	no
Use suitable extinguishing agent (consider fire class).		
Attention:		
<ul style="list-style-type: none"> For extinguishing gases, e.g. carbon dioxide (CO₂) consider danger to personnel (see DGUV Information 205-026). 		
<ul style="list-style-type: none"> For metal fires (magnesium, aluminium, titanium): only use suitable extinguishing agents, e.g. fire class D! (see DGUV Information 209-090) [25] 		
<ul style="list-style-type: none"> For powder extinguishers: considerable material damage in the interior of the machine tool possible 		
Provide a sufficient quantity of extinguishing agent:		
<ul style="list-style-type: none"> Also consider extraction system, chip conveyer, holes 		
<ul style="list-style-type: none"> Consider flow-off losses (e.g. overrun extraction ...) 		
Fire suppression system:		
<ul style="list-style-type: none"> Planning and installation: By a specialist company, possibly in agreement with the manufacturer 		
<ul style="list-style-type: none"> Components, planning and installation: consider the state-of-the-art (e.g. VdS Directives.) 		
<ul style="list-style-type: none"> Planning and installation: Demand approval test and approval protocol 		
<ul style="list-style-type: none"> Positioning: No adverse effects by pressure or flame propagation 		
<ul style="list-style-type: none"> Electrical supply and control system independent of machine tool 		
<ul style="list-style-type: none"> Interlocking of the extinguishing gas supply during setting and maintenance work (non-electrical or electrical shut-off devices, see DGUV Information 205-026) 		
<ul style="list-style-type: none"> Regular checking of extinguishing agent tanks fill-levels: e.g. pressure controls, weighing devices 		
<ul style="list-style-type: none"> Gas extinguishing system: Provide sufficient pressure relief options 		
<ul style="list-style-type: none"> Considerable personnel injuries, considerable material and environmental damage: Automatic suppression systems! 		

Fire suppression system	yes	no
Fire detection and extinguishing		
<ul style="list-style-type: none"> Use optical and/or thermal fire detection elements. 		
<ul style="list-style-type: none"> Fire detection elements: Consider the state-of-the-art (e.g. VdS Directives) 		
<ul style="list-style-type: none"> Optical sensors: <ul style="list-style-type: none"> consider suitability (e.g. MWF mist). keep clean (e.g. by air purging). 		
<ul style="list-style-type: none"> Thermal sensors: <ul style="list-style-type: none"> fire detection slower than with optical sensors 		
<ul style="list-style-type: none"> Extinguishing nozzles: <ul style="list-style-type: none"> suitable for the relevant extinguishing agent consider arrangement: if possible, do not direct towards door labyrinths. 		
Extinguishing hole and machining area door in case of fire:		
<ul style="list-style-type: none"> Only to be opened by fire service and specially instructed persons 		
Regular testing of the fire suppression system (see DGUV Information 205-026)		

Publisher

Deutsche Gesetzliche
Unfallversicherung e.V. (DGUV)

Glinkastraße 40
10117 Berlin
Telefon: 030 13001-0 (Zentrale)
Fax: 030 13001-9876
E-Mail: info@dguv.de
Internet: www.dguv.de

Sachgebiet Maschinen, Robotik und
Fertigungsautomation
im Fachbereich Holz und Metall
der [DGUV www.dguv.de](http://www.dguv.de)
Webcode: d544779

The DGUV Expert Committees are governed directly by the public sector accident insurers (UKs), the institutions for statutory accident insurance and prevention (BGs) and the umbrella association, the DGUV. The Berufsgenossenschaft Holz und Metall (accident insurer for woodworking and metalworking branches) is responsible for the Expert Committee Woodworking and Metalworking and thus the main contact on Federal level for questions concerning safety and health at work in these areas.