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FIRE & EXPLOSION SAFETY GUIDELINE IN BOARD MANUFACTURING (B-SEF)

WHAT

This technical guideline describe the minimum requirements for fire & explosion safety in a factory producing wood based panels.

General fire prevention issues are discussed in the Fire Prevention Manual. The requirements described in this guideline come in addition of the Fire Prevention Manual and are mandatory for all units.

WHY

Due to the nature of its production, the factories that produce particle or fibre boards/panels have a high fire and explosion risk and therefore to protect co-workers' health and also the company assets, a set of clear rules have been prepared for all units to minimise this risk. Proper practices, procedures & protection of the equipment help to reduce the frequency and the consequences of fire and explosion on site.

HOW


This technical guideline is directed to design engineers, construction, technical, production & maintenance managers & leaders, EHS & fire safety coordinators.

The guideline is a binding document and all units shall strive to comply with its requirements. Compliance with this guideline is checked during EHS-G audit review.

Any potential deviations shall be evaluated in a structured approach, prioritized and based on that a mitigation plan shall be prepared.


REVISION LOG

Date	Edition	Revised by	Summary of changes
01/06/2016	1	Magali COLNEY	Edition 1

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1. BASIC DEMANDS

This guideline is mandatory to all IKEA Industry Division Board units producing wood based panels.

This guideline consists of one main document, the narrative part and three appendices:

- Appendix A: Detailed checklist of the protection to be installed on chip processing equipment.
- Appendix B: Technical requirements for installation of fire protection on chip processing equipment.
- Appendix C: Thermal-oil sampling methodology for measuring flash point.
- Appendix D: Maintenance plan for thermal-oil boilers


The narrative document is intended to:

- Describe the stricter requirements in regards to the Fire Prevention manual.
- Give an introduction to the philosophies and topics handled in the check list. It describes the fire and explosion prevention requirements for the following elements:
 - General Technical requirements/ Sprinkler Systems
 - Raw Material – Wet chip
 - Chip Drying
 - Dry Chip Processing
 - MDF Drying and MDF Processing
 - OSB / Strand processing
 - Press
 - Press Utilities
 - Cutting – Sanding
 - Dust Handling
 - Electrical Systems
 - Hot Thermal Oil

This fire safety guideline is mandatory and sets the minimum requirements for the building & equipment.

Any deviation from this guideline, either from the supplier of equipment or from the buyer shall be motivated or documented.

The following chapters describe the main elements of fire protection. A more detailed list is presented in form of checklist which is attached to this document in B-SEF Check list Appendix A.

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2. FIRE PROTECTION ELEMENTS


2.1 General technical requirements

Generally all production and storage buildings are sprinkler protected as per recognized guideline; e.g. EN, NFPA, VdS, SBF.

In all new board units or new building/extension in a board factory, automatic water sprinklers shall be installed in accordance with VdS CEA 4001, except units already equipped with NFPA.

Due to the generally high combustible load and process equipment to be protected, often automatic extinguishing systems need to be in place. To ensure their proper operation, fire extinguishing and detection systems are installed according to recognized guidelines; e.g. NFPA, VdS, SBF. This applies e.g. to gas, deluge and spark-detection/ -extinguishing systems. Fire detection systems need to be installed throughout the site. Alarms shall reliably be transmitted.

In all new board units or new building/extension in a board factory, spark detection & extinguishing, gas extinguishing systems (for electrical rooms) and press deluge "Minifog" systems shall be in accordance with VdS guidelines. See table below for further details.

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VdS Standards

Systems	VdS Standard*	Last known version May 2016 **
Sprinkler systems (Planning & Installation)	VdS CEA 4001 en	2014-04
Automatic detection & fire alarm systems	VdS 2095 en	2010-05
Sprinkler pumps (pump requirements & testing methods)	VdS 2100-07 en	2013-05
Low pressure water mist systems e.g. for the press deluge (Minifog) or electrical rooms	VdS 2109 en	2012-06
Foam extinguishing system for thermal-oil systems/press	VdS 2108 en	2005-09
Fire Extinguishing Systems using Halocarbon Gases (eg. NOVEC 1230 or FM200)	VdS 2381 en	2009-06
Fire Extinguishing Systems using non-liquefied Inert Gases, Planning and Installation (e.g. Inergen, Argon)	VdS 2380 en	2014-06
Fire Extinguishing Systems using CO ₂	VdS 2093 en	2009-06
Spark detection & extinguishing	VdS 2106 en	2012-12

*en indicates English

** Check always the latest version on <http://vds.de/en>

All other deluge systems, as fire detection & extinguishing systems for silos, conveyors, and filters shall be installed as per the Appendix A & B.

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2.2 Raw material – Wet chips preparation

Essential element of fire protection is the separation of all kinds of foreign objects from the wet chip stream – e.g. stones, metal pieces. These objects can cause sparks and thus in dusty atmosphere a severe fire damage further down the process.

The processing of recycled wood represents an increased exposure as it is often a rather dry material and carries a lot of foreign objects. To cope with this risk, an additional protection needs to be in place, e.g. spark-detection and extinguishing upstream the flaker, explosion relief for the silo, a flame stop downstream the silo, etc.

Fire detection (temperature control) and extinguishing has to be installed for all silos/ bunkers. More details of equipment requirements are provided in the B-SEF Checklist – Appendix A.

2.3 Chip drying

This process presents a significant ignition source as wood chips are exposed to heat. For fire prevention of the dryer, process controls are very important (e.g. temperature monitoring) as well as dummy load/ extinguishing systems.

Spark-detection and -extinguishing systems need to be installed at several spots to eliminate a spark to become an ignition source.

A fire spread in this area can be very fast, separations (e.g. via emergency stops, discharge into the open or rotary valves) as well as the fire lock silo are critical. Additionally explosion potential is a concern.

Fixed extinguishing systems need to be in place to extinguish equipment from the inside. More details of equipment requirements are provided in the B-SEF Checklist – Appendix A.


2.4 Dry chip processing

These process steps are characterised by handling of dried material often pneumatically transported. As soon as an effective ignition source is present, an explosion respectively a fast fire spread can be expected.

Fire stops (e.g. rotary valves) shall be installed wherever possible to limit the extent of a fire spread.

Dry chip mills need special attention. Metal and gravity separators need to be in place upstream. Downstream of the mill, spark-detection and -extinguishing are required with an additional extinguishing at the mill entrance. Downstream of the mill, additional spark-detection/ -extinguishing need to be installed as well as a fire stop.

Ignition source control (e.g. via spark-detection/ -extinguishing) and explosion limitation (by explosion relief panels) are critical.

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Fixed extinguishing systems within the equipment have to be installed. More details of equipment requirements are provided in the B-SEF Checklist – Appendix A.

2.5 MDF Drying & MDF Processing

The first steps of raw material handling are similar to the chip processing.

Generating the actual fibre takes place in a refiner (wet process) which does not present a significant fire hazard.

With the drying process the fire hazards becomes critical again.

The dry fibre process steps are characterised by handling of dried fibre material often pneumatically transported. As soon as an effective ignition source is present, a fire spread can be expected.

Blockage detection, automatic fire detection & extinguishing shall be installed to limit the extent of a fire spread. More details of equipment requirements are provided in the B-SEF Checklist – Appendix A.

2.6 OSB/Strand processing

Essential element of fire protection is the separation of all kinds of foreign objects from the wet flakes stream – e.g. stones, metal pieces. These objects can cause sparks and thus in dusty atmosphere a severe fire damage further down the process.

The special hazard compared to chip processing is that no fire lock silo can be installed as it would break the flakes/ strand which need to be nice and long.

With the fire lock silo missing, a fire can easily spread from the dryer exit down to the press. To compensate for this exposure, extinguishing systems along this way need to be on automatic.

More details of equipment requirements are provided in the B-SEF - Checklist – Appendix A.


2.7 Press (including laminating)

The dry chip processing upstream the conti-press need to be protected by extinguishing systems and explosion relief.

The conti-press itself is the core-piece of equipment for a factory producing wood based panels. Therefore, special attention shall be made to functionality of fire protection equipment on the press.

Special exposures arise from the use of hydraulic and heat transfer oil. Continuous press shall be protected by water mist systems (e.g. Minifog) according to VDS guideline.

Foam needs to be added to the sprinkler system protecting for the press basement.

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Laminating presses are less critical, therefore the protection concept exist but is less demanding.

More details of equipment requirements are provided in the B-SEF Checklist – Appendix A.

2.8 Press utilities

The press utility rooms (for electrical supply and control, hydraulics and heat transfer fluid oil (HTF)) need to be well separated.

To limit the spill of oil, collection trays need to be installed and all pipe penetrations and doors properly protected against the spread of oil/oil mist.

Automatically operated fast closing slam shut valves need to be installed separating the HTF supply to the press. They shall be triggered by activation of extinguishing systems at press area and by emergency stop buttons at pump room access / exit points.

Automatic extinguishing systems shall be installed in all press utility rooms. Foam has to be added to the sprinkler systems protection of the HTF-rooms. Gas or pre-action dry type sprinklers are adequate for the electrical rooms. Dry powder system shall not be considered as an option.

The press exhaust shall preferably be protected with extinguishing systems as well.

A sound maintenance and cleaning is important.

More details of equipment requirements are provided in the B-SEF Checklist – Appendix A

2.9 Cutting & Sanding

As sparks can arise from these processes, spark-detection and -extinguishing shall be installed downstream. Fast turning bearings of the sanding lines shall be temperature monitored.


More details of equipment requirements are provided in the B-SEF Checklist – Appendix A

2.10 Dust handling

Equipment like filter, silos or cyclones are very difficult to extinguish from the outside. Requirements for extinguishing system for various filters, silos or other piece of equipment are given in the checklist – Appendix A. High Rate Discharge (HRD) explosion protection shall be installed upstream to each filter.

A flame stop shall be present downstream to each piece of equipment to prevent a fire spread.

It is recommended to install fans downstream of the filter. This does reduce the ignition potential of the fan generating sparks.

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It's also recommended to at least have one dust evacuation hatch on the front side of silos in order to quickly be able to release contents of the silo.

More details of equipment requirements are provided in the B-SEF Checklist – Appendix A

2.11 Electrical systems

Most of the electrical systems are vital for plant operation. For this reason, protection level needs to be very high.

Electrical rooms need to be well separated and fire detection systems need to be installed in all electrical rooms.

Electrical rooms vital for plant operation need to be protected by automatic extinguishing systems. Gas (other than CO₂) or pre-action dry type sprinkler systems shall be used.

In addition to the conventional maintenance and testing, annual infrared thermography shall be conducted to the electrical equipment.

More details of equipment requirements are provided in the B-SEF Checklist – Appendix A

2.12 Hot thermal oil - (Hot Thermal Fluid - HTF)

2.12.1 Thermal oil risk

Hot thermal oil represents a severe fire and safety hazard. Operation temperature is always above its flash point.

Therefore, any spill might immediately ignite because of its high temperature.

Due to various reasons, the oil can decay and as a result its flash point decreases, further increasing the risk of fire. Therefore, beside other preventive maintenance controls (see Appendix C), frequent control of the flash point value is required.


It is unlikely that auto-ignition will degrade below operating temperature, however low flashpoints increase the likelihood of static ignition or ignition from adjacent electrical equipment (non ATEX).

It is essential therefore to manage 'point sources' around in Non ATEX Zone II area and be able to detect before release where possible.

Nota:

'Auto igneous ignition temperature' (auto-ignition / AIT) is the temperature at which a vapour release will ignite in air without the need for a source of ignition.

The likelihood of 'Static Ignition', is related to 'Closed Cup Flashpoint' as this represents the point at which the fluid becomes vapour positive and results in lower temperature flammable vapour gasses that can more easily generate a mist or spray. It is the generation of mists and sprays that have to be prevented to manage the likelihood of 'Static Ignition'. With 'jets' or 'rapid releases' of oil at or above 'Closed Cup Flashpoint'

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then due to the 'Venturi Effect' increased oxygen can further increase the likelihood of 'Static Charge / Ignition'.

Any release of fluid above 'Closed Cup Flashpoint' can be ignited by Non ATEX electrical ignition sources. If the fluid is above 'fire point' then this can result in a fire condition.

2.12.2 Thermal oil management

Each unit that operate the thermal fluid system above the actual operating closed flash point shall undertake a risk assessment of the system.

To insure a success of the risk assessment, each unit shall identify first the key persons responsible for the management of thermal-oil systems, as such:

Factory manager:


It is vital that the process gets Management support and as such the site 'Factory Manager' needs to give his support for the process and also be involved directly in the improvement plans.

2. Factory champion:

This person is key to maintain the momentum required to deliver on training, improvement plan implementation, communicating change and also to enable visibility across the site and at division level.

Key personnels to be identified on a site level and to be mandatory trained about thermal-oil risks & operation conditions.

- 1: Factory Manager
- 2: Sustainability Manager
- 3: Operations Manager
- 4: Production Manager
- 5: Maintenance Manager
- 4: Mechanical Maintenance
- 5: Electrical Maintenance
- 6: Automatician specialist (able to enter in interlocks software).
- 7: Press Operations: Shift/team leaders, press operators.
- 9: Dryer / Energy Plant Operations: Leaders, operators maintaining and driving Energy Plant.
- 10: Reliability Manager: Engineer having overview of the process & knowing details about maintenance, lubrication, vibrations.
- 11: Factory Thermal Oil Champion (to be one of the above)

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Every unit shall ensure that risk is either eliminated or reduced so far as is reasonably practicable. Where it is not reasonably practicable to eliminate risk the unit shall, so far as is reasonably practicable, apply measures, consistent with the risk assessment and appropriate to the nature of the activity or operation:

o to control risks.

o to mitigate the detrimental effects of a fire or explosion or the other harmful physical effects arising from dangerous substances.

Each unit shall prepare the 'Explosion Protection Document' completed with:

- The identification of the fire point sources identification on a drawing.
- The 'Cause and Effect' chart for the safe operation of the system.
- The Layer of Protection Analysis
- The standard operating procedures (SOP) for operating the energy plants in safest way (production & maintenance related).
- The analysis performed on the fluid and the consolidated table/graph.
- The 'Improvement Plan' highlighting the responsible persons and timescales for progression and implementation.
- The 'Risk Assessment' document (based on documents described before).
- The training support documentation & the trainings register performed to the managers & the main co-workers.

The complete 'Explosion Protection Document' is managed at a site level and requires regular updates with the 'Cause and Effect Chart' and 'Risk Assessments' provided as 'Control Documents' to be formally updated annually.

Maintenance plan for thermal-oil boilers is detailed in appendix D.

2.12.3 Personal training

Operation and safety training is minimum requirement for all operators, engineering and maintenance personnel working with or around thermal fluid systems. Input is required from process safety and operational parameters as well as from the thermal oil system itself.

All systems require a full understanding of the system and the process.

Very few systems are generic and as such the training has to be tailored to the system / process requirements.

The trainings can be aimed at many levels of technical expertise providing a thorough understanding of the systems and the risks involved.

The training packages shall provide system operators with a proven route to meet legal requirements while demonstrating knowledge transference and expert support.



2.12.4 Fire prevention & protection of thermal oil systems

To cope with this exposure, HTF utilities need to be well fire separated. Any spill needs to be contained within the HTF room. Fast closing slam shut valves need to be installed in the flow and return pipes supplying the utility room. They need to be automatically triggered; e.g. by emergency stop or activation of extinguishing systems.


Insulation:

Insulation is one of the greatest causes of fire and care must be taken in the selection and maintenance of the insulation systems. Oil soaking into insulation greatly increases the fire risk. This can be minimised by using a cellular glass insulation that will not absorb oil, particularly around valves and flanges. Jackets and mufflers can also be used as an alternative. Mineral wool is acceptable on straight pipe lengths.

Oil soaked insulation can spontaneously ignite. Around flanges and valves boxes should be fitted with drain holes. Spray from a faulty packing, increases the fire risk dramatically and valve boxes should always be replaced after inspection or maintenance.

Un-insulated areas of pipework, pumps, valves and chimneys not only are a significant fire risk but also a risk to health through burns.



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Spray protection:

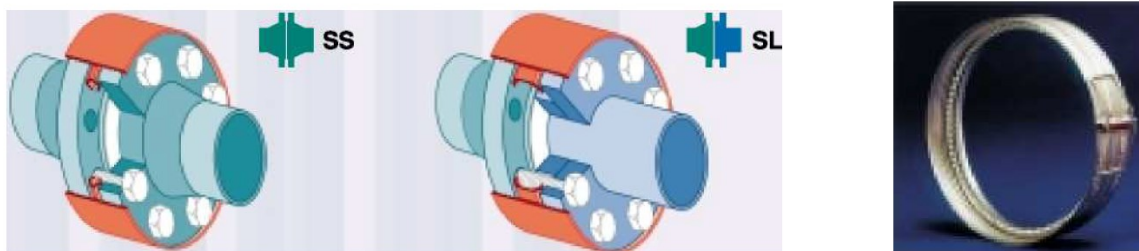
Spray protection shall be install on main point sources to prevent a spray or mist by ensuring a leak is released from a flange connection in liquid form.

Emergency stop buttons need to be place in a safe-operation position. Foam needs to be added to the sprinkler protection. To early detect leaks on the hot thermal oil pumps, temperature detection need to be installed in the pump seal leak detection and as well, bearing pump temperature control need to be installed on every pump.

To understand the safety requirements of any system a thorough risk assessment **MUST** be undertaken of the process and thermal fluid in conjunction.

The safety systems on the thermal oil system have to compliment the safety systems of the process.

More details of equipment requirements are provided in B-SEF Checklist – Appendix A.




Spray protection sheme.

2.12.5 Thermal-oil sampling

- Getting a representative sample is essential.
- Incorrect sampling renders all the tests inaccurate and can be dangerous.
- Sample stations are designed to allow a flow from the system flow into the sample container and back into the return. This is done for a few minutes to clear the bottle and pipework and make sure that the sample is representative.
- The valves are then closed and the sample allowed to cool.
- When cool the top vent is opened and the bottom valve opened to drain into a sample bottle. The sample is then taken to the laboratory for testing and analysis.

The old method and one still used by a lot of companies is to simply open a valve and discharge into a bucket the required sample. Firstly there are dangers – valve sticking, vapour discharge, burns and fire risk but the biggest danger is in the cloud of smoke produced. This smoke is the volatiles that we are trying to detect. A system that is potentially dangerous can appear within safety limits from a sample produced incorrectly. So sample stations will give a relevant sample.

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This chapter is issued to specify the frequency and methods of collecting thermal oil samples for analyses of flash point and other related parameters. When the frequencies of sampling are observed by the unit, the Danger situation (as described below) when the flash point temperature is below acceptable minimum, should not occur.

Sampling of thermal oil should be carried out according the instruction described in the appendix C.

The following parameters shall be checked:

Viscosity	mm ² /s @ 40 °C	DIN 51562-1
Flash point*	°C	EN 22719
Neutralisation number (acid value)	mg KOH/kg	DIN 51558-1
Conradson (carbon)	g/100g	DIN 51551-1
Water content	mg/kg	DIN 51777-1

*Pensky-Martens closed cup method

REVIEW OF ANALYZED DATA


The resulting flash point data shall be compared to the following limits:

210 – 230 °C	New oil
130 – 150 °C	Normal range approx. after 1 year without cooking
< 120 °C	Emergency situation: Cooking process required within next 2 months and email to Division Board Engineering & Sustainability managers
< 100 °C	Danger situation: Immediate cooking required and Safety Flash card.

FREQUENCY OF SAMPLING:

Each unit is required to organize for sampling of thermal oil in the following periods:

- ⇒ Normal situations
 - No later than 6 weeks before the scheduled summer stop
 - 6 months after the sample 1 is collected
- ⇒ Emergency situations

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Are defined as situations when the flash point analysis result is below 120 °C. If a sample flash point result is below 120 °C, then the unit is required to organize cooking process within 2 months and in this period, it should collect one sample per month to control the rate of oil decay.

⇒ After cooking process


When the cooking process is completed, an oil sample is collected directly after the test.

DATA FOLLOW UP:

Each unit shall collect all flash point data and register the results in table/graph form. The dates of the cooking or any relevant information shall be mentioned.

RESPONSIBILITY:

Maintenance Manager is responsible for correct and timely way of oil sample collecting, as well as collection & monitoring of data.

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Appendix A: Table sheet - Specific fire safety protections in board manufacturing processes (what to be installed).

Definition of fire-extinguishing systems – Appendix A

There are several types of systems:

Fire-extinguishing systems for manual fire-fighting

Only hydrants, wall hydrants and (where applicable) extinguishers, without additional fire extinguishing system.

Semi-stationary fire-extinguishing systems, consisting of fixed nozzles, pipes and feed points only become effective after extinguishing water has been supplied through hoses.

Manual fire-extinguishing systems, same as above but with a fixed supply of water. In the event of fire, these have to be released manually.


Note: When installing the above-mentioned systems, make sure that fire detection and alarm systems work reliably.

Automatic fire-extinguishing systems, same as above, but with automatic fire detection and automatic, instantaneous triggering. Automatic fire-extinguishing systems (except for sprinkler systems) have to be manual operation as well. Automatic fire-extinguishing systems are preferable.

Double click on the icon below to open the table sheet:



B-SEF Appendix A
Checklist

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Appendix B: Protection Scheme for Chip Processing Equipment (how to install the systems).

Protection Scheme for Chip Processing Equipment

General

This scheme covers the technical requirements of fire protection for equipment used for chip processing.

It is mandatory to adhere to these requirements when constructing new facilities or extensions. If there is any doubt concerning functioning of existing fire-extinguishing systems, existing facilities should be rebuilt following this concept.

The following principles should be applied in construction of fire-extinguishing systems.

Components

VdS certified components should be used. If these are not available, components approved by FM/LPCB may be used alternatively.

Component requirements apply in particular to:

- Extinguishing nozzles
- Mounts (pipes)
- Fittings (e.g flaps, valves, testing devices)

General Requirements

Nozzles

To prevent nozzles from getting clogged, on-off nozzles should be used whenever possible. Note: Experience has shown that protective caps are suitable to a limited extent only. If protective caps are necessary, connections should be removable.

Spray Characteristics

Full cone nozzles or analogous to sprinklers.

Nozzle Array


Maximum coverage area 9 m²

Note: Depending on filling levels (eg. in silos) coverage area may be reduced if necessary.

Drainage (Risk of frost damage)

To ensure safe drainage of water residue, in particular in pendent nozzles, appropriate measures should be taken. Blowing-off or heating devices are recommended. Any risk of explosion must be eliminated. Nozzles should be inspected at least once a year; ideally at the onset of frost season.

Proposed Nozzles for example

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Minimax nozzles MXD-SD cone K26 – 50

Design criteria (general)

Water discharge density

A minimum of 5 mm/min (unless otherwise stated).

Minimum pressure

1 bar

Operating time

A minimum of 30 min

Simultaneity

According to extinguishing area scheme

Pipes

Pipes should be installed laterally or below the device. In particular explosion openings and flaps as well, as maintenance openings must be freely accessible.

Example of conveyor design:

Width: 1,0 m

Spacing of nozzles: 4 m


Coverage area per nozzle: 4 m x 1,0 m = 4.0 m²

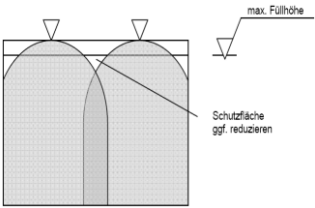

Nozzle: K 30

with $p_{\min} = 1$ bar

$Q_{\min} = 30$ l/min

Density = $30[\text{l/min}] / 4,0 [\text{m}^2] = 7.5$ mm/min.

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Components	Water discharge density	Nozzle	Array of Nozzles	Design	Diagram
Silos Bunkers Air separators	Minimum 5 mm/min (in relation to overall surface area)	Recommended: on-off-nozzles	Maximum spacing of nozzles 2 m, distance to wall 1 m	When the distance between maximum filling level and on-off nozzle is < 1.50 m the spacing of nozzles must be decreased or different nozzles must be used (e.g. open umbrella sprinklers). To allow for inspection of nozzles and cleaning, the nozzles must be removable from the outside (hose or screw connection).	
Conveyor	Min. 7,5 mm/min (to compensate for spraying obstructions)	On-off-nozzle 	<u>First and last nozzle</u> concentrically above each deflection <u>Increasing nozzle spacing</u> Increased spacing (as listed later) requires at least spray or, ideally, fire extinguishing tests. The same applies to inclined chain conveyors or belts, where bigger spacing is possible (provided necessary proof exists). Due to the lack of suitable policies and relevant knowledge and experience, in particular concerning spraying obstructions, increased nozzle spacing is currently not advisable.	Pipes should be installed laterally or below the conveyor. In particular explosion openings and flaps as well as cleaning and maintenance openings must be kept freely accessible.	
Chain conveyor (simple) up to a width of 1,2 m			Arrayed unilaterally, max. spacing (projected on the horizontal) 4.00 m.		



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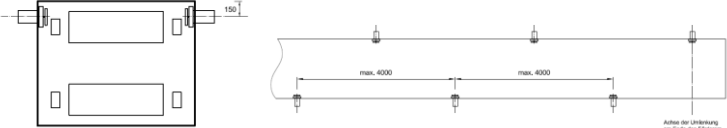
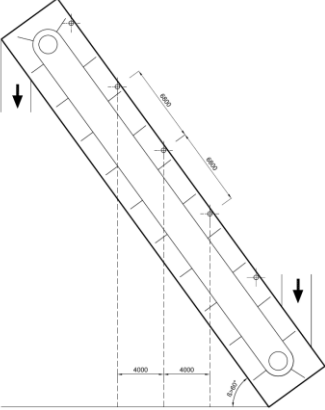
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<p>Chain conveyors (simple) from a width of 1,2 m</p>			<p>Staggered array</p>	 <p>Staggered array top view</p>
<p>Inclined conveyor</p>		<p>K 30; in inclined conveyors</p>	<p>With inclined conveyors (up to 60° to horizontal) the maximum spacing of nozzles may be increased. When projected on the horizontal plane, the maximum spacing may not be exceeded.</p> <p>Example: Conveyor 60° to horizontal -> max. 6.80 m</p>	



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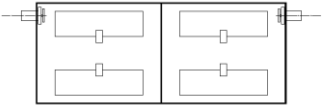
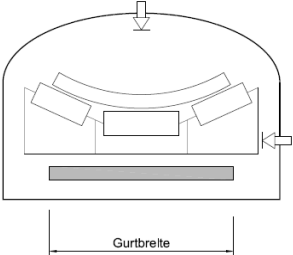
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<p>Chain conveyor (double) or simple chain conveyor < 2 x 1.2 m</p> <p>Wider double conveyors require individual consideration (reduction of spacing)</p>					 <p>Section of double chain conveyor</p>
<p>Belt conveyors with weather-protection cover < 1.5 m belt width</p>	<p>A minimum of 5 mm/min (in relation to belt dimensions = length x width)</p>	<p>In case of moderate dust exposure and/or when regular rinsing of nozzles is possible open nozzles may be used. In other cases on-/off-nozzles are preferable.</p>	<p>Maximum spacing 4 m in conveying direction, in offset arrangement, (nozzles on top and bottom see diagram)</p> <p>The bottom nozzle array may be omitted when belt is open at the bottom and manual fire suppression may be carried out safely. Conveyors in over 10 m above ground must be protected according to diagram.</p>		 <p>Cross-section of belt conveyor with cover</p>
<p>Tube belt conveyor</p>				<p>Tube belt conveyors need not be protected in their entire length. Protection is limited to open tube belt in inlet and outlet.</p>	



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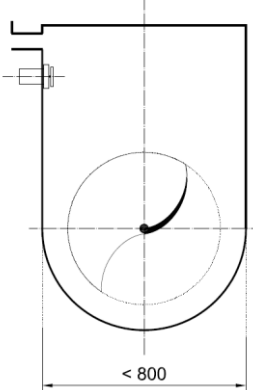
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				Extinguishing system is the same as for belt conveyors.	
Single or double trough screw (trough screw conveyor, no tubular screws)	Min. 7,5 mm/min (to compensate for spraying obstructions)	On-off-nozzle	At both entry and at discharge at least one nozzle is required		 <p>Cross-section of a screw in trough</p>
Trough screw conveyor				Protected analogous to scraper chain conveyors (nozzles in the upper section arrayed laterally, max. 4 m spacing of nozzles).	
Vertical tubular and plug screws				Technically cannot be protected	



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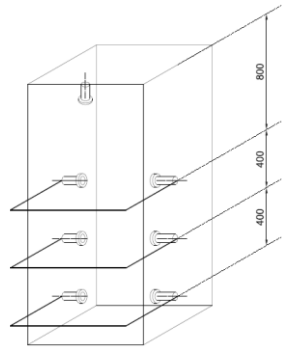
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(Vertical) bucket conveyor		Nozzles producing large droplets, minimum K-Factor 115	Min. 1 nozzle above the conveyor, so that the entire area is sprinkled. The spraying properties of installed nozzles must be considered.		
Bucket conveyor Height > 8 m		Preferable: on-off-nozzle, eg. K 30	On the perimeter of the housing	Additional "nozzle ring" every 4 m around the conveyor. A minimum of 1 nozzle on the two sides of the conveyor	 <p>Nozzle array</p>
Filter	minimum 5 mm/min (in relation to surface area = length x width)	<p><u>High pressure filter:</u> on-off-nozzles K 30</p> <p><u>Vacuum filter:</u> In case of moderate dust exposure and/or when regular rinsing of nozzles is possible open nozzles may be used. In other cases K30 on-/off-nozzles are preferable.</p>	<p>On the clean gas side. Arrayed according to filter elements in each element.</p> <p>Maximum spacing of nozzles 2 m.</p>		



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Cyclone	7,5 mm/min	On-off-nozzles	<p>Arrayed on the perimeter above the highest filling level or preferably on the top. To facilitate drainage, nozzles should be attached with tube or screw connectors.</p> <p><u>Internal diameter</u> < 2.50 m A minimum of 2 extinguishing nozzles per cyclone</p> <p><u>Internal diameter</u> 2.50 m to 3.5 m A minimum of 3 extinguishing nozzles per cyclone</p> <p><u>Internal diameter</u> > 3,50 m A minimum of 4 extinguishing nozzles per cyclone</p>		
Vibrating screens	10 mm/min (to compensate for spraying obstructions)	On-off-nozzles (lateral)		Hose connection and detailed construction following consultations with producers	
Drum sieves and glueing drums	7,5 mm/min	preferably on-off-nozzles	In inlet and outlet on the stationary parts of the drum		

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Appendix C: Thermal Oil Sampling – Working method

The analysis of thermal oil is meaningless unless the sample taken is representative.

Only trained personnel are allowed to take samples, wearing appropriate personal protective equipment (PPE) like heat-protective gloves, face shield (should be placed in the room to prevent fogging) and long-sleeve clothing. A second person wearing the same PPE with a foam extinguisher has to be always present.

To achieve this, the following rules **MUST** be adhered to:

- 1:** The fluid **MUST** come from the primary circuit at operational temperature.
- 2:** The sample **MUST** be taken from turbulent flow.
- 3:** The sample **MUST NOT** be taken through atmosphere at elevated temperature.
Any 'smoke' released will make the sample **INVALID!**
Any 'smoke' will also be hot, toxic, and flammable!!
- 4:** The sample **MUST** be taken through a sample station or cooler.
- 5:** The valve that you take the sample through **MUST** be rated to temperature and preferable double isolation practices should apply!
- 6:** The sample **MUST ONLY** be dropped into the sample container when the fluid is below **40°C** either by forced or natural cooling!
- 7:** The sample container should be completely full and then sealed.
- 8:** The fluid 'Material Safety Data Sheet' **MUST** accompany the sample.
ONLY if these RULES are followed can you be confident that the analysis will be representative of the system!

For units without sampling cooler there are two possibilities to do so:

1) Using the pressure gauge valve on the primary circuit pipe and assemble a pipe coil (Ermetorohr – see picture 1) which is put during sample taking into a large container with cold water.



Picture 1: Ermetorohr

2) Using the pressure gauge valve on the primary circuit pipe to connect a pipe (DN 50; approx. 1m length – able to take 300°C @10 bar) with a second valve on the other end. The first 5 liters have to be drained directly to a vessel and then the pipe gets filled with hot thermal oil and both valves will be closed. When the oil in the tube is cooled down, the second valve gets opened and the cool oil is drained into a 2-liter container.

SAMPLE SHIPMENT

A date and time label along with shipping papers describing the sample are attached to it. The label should contain following information:

- Unit name
- Date and place of sample taking
- Type of technical installation (place, firing capacity, type of fuel, etc.)
- Type of thermal oil (technical datasheet)
- Producer/Supplier of thermal oil
- Total amount of thermal oil in the system Thermal oil temperature at inlet of the heater
- Duration the thermal oil is in use
- Date of last sample taking

Samples are shipped in a shock-proof packaging to the address below:

ROTHOS Energy Systems GmbH, Maxim-Gorki-Straße 2, 01445 Radebeul, Germany

Appendix D: Maintenance plan for thermal-oil boilers

Pos.	Equipment	Daily	Weekly	Monthly	2 per year	Yearly	Every 5 years	Every 10 years
1	Heater / Consumers / Production parts							
1.1	Conditions (from outside)							
	Contamination	Blue				Red		
	Leakage	Blue				Red		
	Noise	Blue				Red		
	Vibration	Blue				Red		
1.2	Conditions (from inside)							
	Contamination of heating surface					Red		
	Corrosion					Red		
	Wear and tear					Red		
	Pressure test						Red	Red
	Functional test soot blower		Blue					
2	Firing system							
2.1	Firing systems for gas, light and heavy oil					Red		
	Visual check	Blue						
	Functional test	Blue						
	Adjustment of burner				Yellow			
3	Control and safety equipment for thermal oil boilers							
3.1	Functional test temperature controller					Red		
3.2	Safety temperature limiter							
	Functional test thermal oil feed line (inlet flow)					Red		
	Functional test flue gas					Red		
3.3	Flow control heater							
	Visual check		Blue					
	Functional test					Red		
3.4	Temperature sensor and thermometer							
	Functional test			Blue				
	Operating values			Blue				
3.5	Pressure sensors							
	Functional test			Blue				
	Operating values			Blue				
3.6	Safety valve thermal oil heater							
	Visual check			Blue		Red		
	Adjustment or replacement							Red
3.7	Safety valve pressure overlay tanks							
	Visual check			Blue		Red		
	Adjustment or replacement							Red
3.8	Level control expansion tank							
	Visual check			Blue		Red		
	Adjustment or replacement							
4	Pumps / fans / transport systems							
4.1	Running noise	Blue						
4.2	Leakage, visual check	Blue						
4.3	Clutch, visual check	Blue						
4.4	Operating point (pressure gauge)			Blue				
5	Pipes and instruments							
5.1	Valves (manual, electric, pneumatic or fast closing valve)							
	Visual check, Leakage	Blue						
	Noise	Blue						
	Clearance (easy movement)					Blue		
	Functional test					Blue		
5.2	Compensators and metal tubes							
	Leakage	Blue						
	Clearance (easy movement)					Blue		
	Replacement after load cycles (documentation)					Blue		
5.3	Insulation							
	Visual check				Blue			
6	Tanks							
6.1	Expansion tank							
	Visual check			Blue				
	Leakage			Blue				
	Temperature			Blue				
	Level			Blue				
6.2	Drain tank							
	Visual check, Leakage			Blue				
	Temperature			Blue				
	Condensate			Blue				
	Nitrogen system			Blue				

Inspections and modifications have to be documented and stored in a proper way.

Blue	Trained personal
Yellow	Supplier of equipment or specialist
Red	Technical expert (TÜV, etc.)